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Oncoplastic Surgery: Is It Time to Change? From Innovation to Adoption Using Mentorship Program

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ABSTRACT

Oncoplastic surgery is considered the standard of care for breast cancer therapy in numerous Western World countries, particularly in Europe. Despite the advancement of knowledge, Canada still lags in adoption of oncoplasty into the standard surgical practice. In our study, a mentorship program was used to introduce oncoplastic surgery to practicing breast surgeons at LHSC. The change in perception and adoption of oncoplastic surgery were evaluated using semi-structured interviews, before and after the intervention, by qualitative thematic analysis method. Mentorship program was validated as a superior method of learning new surgical techniques by practicing surgeons, demonstrating acceptance of different levels of oncoplastic surgery. Identified barriers to acceptance included surgeon satisfaction with their initial work, lack of formal training, limited availability of courses, and the limitations within the Canadian healthcare system. Mentorship program was found to be a valid, accessible method for adopting new surgical techniques and needs. As a result, oncoplastic surgery started to be adopted at LHSC, providing an example of how to facilitate the adoption to other surgical communities.

Keywords: *oncoplasty; breast cancer; knowledge translation; mentorship; surgeon training;*

THE CO-AUTHORSHIP

While each of the co-authors listed below made important contributions to this work, I am the principal author who designed all the projects, performed all of the experimental design, data collection and analysis. This thesis was prepared by me, with the consultation and critical review by the co-authors.

Dr. Muriel Brackstone and Dr. Sayra Cristancho, in their capacity as supervisors, assisted with study design, data acquisition and analysis, as well as critical review and editing of the thesis.

DEDICATION

I dedicate this thesis to my Mom, who is not with me now to celebrate my success because of breast cancer. My Mom was the first guidance for me to go this way. She was the reason behind what I am now, and how I will be in the future. To you, Mom, I hope you are proud of me and I promise that I will work hard to help people through their journey with this disease, to be able to celebrate their successes with their family and loved ones.

I dedicate this thesis to my Dad, without whose continuous support and endless love I wouldn't continue this way or wouldn't be at this stage with my thesis. He was my role model and his prayers always surround me.

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LIST OF ABBREVIATIONS

AC-T, adriamycin-cyclophosphamide followed by taxane

ALH, atypical lobular hyperplasia

BCS, breast conserving surgery

BRCA, breast-related cancer

CT, computerized tomography

DCIS, ductal carcinoma *in situ*

ER, estrogen receptor

FEC-D, fluorouracil-epirubicin-cyclophosphamide followed by docetaxel

FISH, fluorescent *in situ* hybridization

HER2, human epidermal growth factor *erb2*

IDC, invasive ductal carcinoma

ILC, invasive lobular carcinoma

IMF, inframammary fold

KT, knowledge translation

LCIS, lobular carcinoma *in situ*

LHSC, London Health Sciences Centre

LN, lobular neoplasia

MRI, magnetic resonance imaging

NAC, nipple-areola complex

OPS, oncoplastic surgical techniques

PMLCIS, pleomorphic lobular carcinoma *in situ*

PR, progesterone receptor

PROM, patient-reported outcome measures

QIRC, quality initiative in rectal cancer

RT, radiotherapy

SJHC, St. Joseph's Healthcare Centre

SLN, sentinel lymph node

SLNB, sentinel lymph node biopsy

CHAPTER 1

General Introduction and Literature Review

CHAPTER 1: GENERAL INTRODUCTION AND LITERATURE REVIEW

1.1 BREAST CANCER

Breast cancer is the most common non-cutaneous cancer diagnosis for women in Canada, with approximately 26,300 Canadian women and 230 Canadian men diagnosed in 2017, and almost 5,000 women and 43 men dying of the disease (CanadianBreastCancerFoundation 2017). One out of every eight women will develop breast cancer in their lifetime (Canadian Breast Cancer Foundation 2017).

Cancer development is a complex process that is thought to occur as a result of an interaction between an environmental factor(s) and a genetically susceptible host (Fearon 1997, Tomasetti and Vogelstein 2015). Cell division is a physiological process that occurs in most tissue types in the body. In order to maintain tissue and organ integrity, the highest degree of regulation of cell division must be occur to achieve the proper balance between proliferation and programmed cell death (typically occurring in the form of apoptosis). Any imbalance in this process, by mutation of the genes responsible for the control of either of these processes, can lead to cancer. Cancer cells, therefore, behave as cells that have lost the control over their cell replication and tissue growth. As a result, they gain the ability to invade into surrounding tissues and spread to other areas of the body, ultimately interfering with organ function. This can lead to death if not treated or removed.

The primary cause of any cancer is thought to be irreparable DNA damage. While normal damage to DNA is common (e.g. errors in replication, exposure to damaging ionizing radiation), cells contain inherent repair machinery that is designed to detect and subsequently fix mutations. If, however, there is some form of deficiency in the DNA repair mechanism, more and more DNA damage accumulates, thus increasing the risk of cancer. There are two main types of genes that are responsible for regulation of cancerous cell growth and differentiation: oncogenes – genes normally responsible for regulation of cellular growth that have become mutated, resulting in constitutive activation (such that protein products are present in inappropriately high numbers, or altered proteins that now exhibit new tumour-promoting properties), and tumour suppressor genes – mutated genes that normally inhibit cell division or survival of cancer cells, but in their absence, the cells suffer a loss of function, which can lead to the development of cancer (Fearon 1997, Tomasetti and Vogelstein 2015).

1.1.1 Brief Historical Review of Breast Cancer Treatment

Breast cancer is an extremely old disease, which has been recorded in texts since the ancient times. Breast cancer had been described in the writings of that era more than any other form of cancer (Sakorafas and Safioleas 2009).

The first account of breast cancer comes from the Edwin Smith papyrus of the ancient Egyptians, written more than three thousand years ago (about 1600 BC). The papyrus reported five cases in which a ‘fire drill’ was used to treat breast tumours by cauterization (Ekmektzoglou, Xanthos et al. 2009). In the pre-

Christian era, however, surgery was rarely used as a treatment option, since it was believed that only a divine intervention from God could cure the disease (Sakorafas and Safioleas 2009).

The first detailed description of breast cancer originated from Hippocrates (460-377 BC). Hippocrates differentiated it from a benign tumour and, based on its appearance of a “crab with a center and extending legs”, named it ‘carcinoma’ (Ekmektzoglou, Xanthos et al. 2009, Sakorafas and Safioleas 2009). He claimed that surgical removal was good for ulcerating tumours, but not for hidden or silent ones, as surgery in those cases would only lead to the patient dying sooner. In line with the beliefs of his era, Hippocrates attributed the development of a cancer to an increase in the level of ‘black bile’ in the body, believing that it happened more often in older women, due to the cessation of the menstrual cycle. Thus, he introduced the concept of breast cancer as being a systemic disease (Ekmektzoglou, Xanthos et al. 2009, Sakorafas and Safioleas 2009).

Several centuries later, Galen (131-203 AD) further expanded upon Hippocrates’ theory that breast cancer occurs as a result of black bile accumulation. Galen recommended that breast cancer be treated with purging techniques followed by surgical removal. He was the first to discuss disease margins, and how they could be damaged by cauterization (Cotlar, Dubose et al. 2003).

It wasn’t until the 18th century that early stage of breast cancer began to be considered a localized disease, with surgery offered as an effective treatment. Henri François Le Dran (1685-1773) suggested that, in addition to excision of the

breast tumour, in any cases where the disease had progressed beyond the breast, the lymph nodes should also be resected, with the thought that this would reduce the likelihood of the disease progressing further to other areas of the body (Sakorafas and Safioleas 2010).

The first proper description of a surgical mastectomy came from Jean-Louis Petit (1674-1750), a Fellow of the Royal Society of London, and the founding director of the Académie Français de Chirurgie (Sakorafas and Safioleas 2010). Petit described the details of the ablative cancer surgery which included the removal of the breast, removal of any palpable axillary lymph node and excision of the pectoralis fascia and muscle as required, to fully remove all of the disease. Although not clear how this might have been helpful, Petit used to leave most of the skin and the nipple intact, with the notion that it could aid with hemostasis, as long as the tissue was not affected by the disease process.

It was Charles Hewitt Moore (1821-1870) of London who reported that a non-enlarged lymph node could still carry the disease, and described that the cancer recurrence always occurred in the skin (not the node). He advised that a complete axillary dissection should be carried out in breast cancer patients, and that as much skin as possible should also be removed (Cotlar, Dubose et al. 2003).

William Stewart Halsted (1852-1922) also described the surgical treatment of breast cancer as involving removal of the breast, axillary lymph nodes, and as much skin as possible, including the pectoralis fascia and muscle. He termed it a ‘radical mastectomy’. His *en bloc* resection included the breast with its skin,

axillary lymph nodes, pectoralis fascia and the muscle (or at least a part of it), through a tear-drop incision. Halsted would leave the wound open, to heal by secondary intention (Ekmektzoglou, Xanthos et al. 2009). In his 1894 publication, Halsted described 50 cases of breast cancer treated by the radical mastectomy approach at Johns Hopkins University, demonstrating that this resulted in a breast cancer recurrence rate of 6% – significantly better than other approaches that had been previously reported (i.e. 50-80% recurrence rate) (Sakorafas and Safioleas 2010).

The advent of radiation therapy brought a big change in the therapeutic approach to breast cancer. George Edward Pfahler (1874-1957) introduced routine post-operative radiation to improve the 5-year survival in stage II breast cancer (Ekmektzoglou, Xanthos et al. 2009). Robert McWhirter further transformed clinical care by reporting that a simple mastectomy (breast and skin only) coupled with post-operative regional radiation would yield 5-year survival rate of 62%, results similar to those achieved by radical mastectomy (Cotlar, Dubose et al. 2003, Ekmektzoglou, Xanthos et al. 2009). David Patey (1899-1977) standardize the modified radical mastectomy (removal of breast and overlying skin with axillary lymph nodes), preserving the pectoralis major muscle unless it was also involved (Ekmektzoglou, Xanthos et al. 2009).

The next advancement in breast cancer therapy came from George Crile, Jr., of the Cleveland Clinic. Crile was an early proponent of breast conservation. In his 1971 publication, he reported on 57 patients with operable stage I/II breast cancer that had undergone local excision of the tumour without axillary dissection

or post-operative radiation. He found that the 67% 5-year survival was almost identical to that of over 300 patients that had been treated with simple or modified mastectomy (with or without radiation). Based on his findings, a randomized control trial was designed to compare the outcomes of mastectomy versus the new breast conserving surgery. The results demonstrated an important difference between stage I and stage II outcomes: while the 10-year survival rates were similar between the two surgical approaches, the prognosis was worse for patients who had stage II breast cancer (Crile 1971, Ekmektzoglou, Xanthos et al. 2009).

This, as well as many subsequent trials that followed and supported the findings (many conducted by the National Surgical Adjuvant Breast and Bowel Project (NSABP)), led to breast-conserving surgery being recommended as the standard of care the treatment of early stage I/II breast cancer by the National Cancer Institute (Ekmektzoglou, Xanthos et al. 2009).

1.1.2 Anatomy of the Breast

The breast is a paired structure located on the anterior thoracic wall, overlaying the pectoral region. Breasts are present in both males and females, although they are more developed in females following puberty. In females, the breast is composed of mammary glands (the key structures involved in the production of milk for lactation) surrounded by a connective and structural supportive (fibrous) tissue.

Mammary glands are thought to be modified sweat glands, as they consist of a series of ducts and secretory lobules. Each lobule is made up of many alveoli draining into a single lactiferous duct. The ducts then progressively meet and drain into 12-20 main ducts behind the areolar complex that then converge and drain out the nipple (Figure 1.1).

Connective tissue is made up of fibrous and fatty components. It functions as a support structure, surrounding the mammary glands and ducts. The fibrous stroma condenses to form suspensory ligaments (responsible for the fixation of the breast to the dermis and underlying pectoral fascia, and separation of the secretory lobules). Pectoral fascia lies at the base of the breast, acting as an attachment point to the suspensory ligaments. A layer of loose connective tissue, the retromammary space (often used in reconstructive plastic surgery), is found between the breast and pectoral fascia (Gray 2000).

The blood supply to the breast is provided medially by the internal thoracic artery (an arterial branch of the subclavian artery), while the lateral part receives blood supply from the lateral thoracic and thoracoacromial branches (which, in turn, are branches of the axillary artery), lateral mammary branches (originating from the posterior intercostal arteries), and mammary branch of the anterior intercostal artery (Gray 2000). The venous supply corresponds with the arteries, draining into the axillary and internal thoracic veins. Innervation to the breast is via the anterior and lateral cutaneous branches of the 4th to 6th intercostal nerves; these contain both sensory and autonomic nerve fibers.

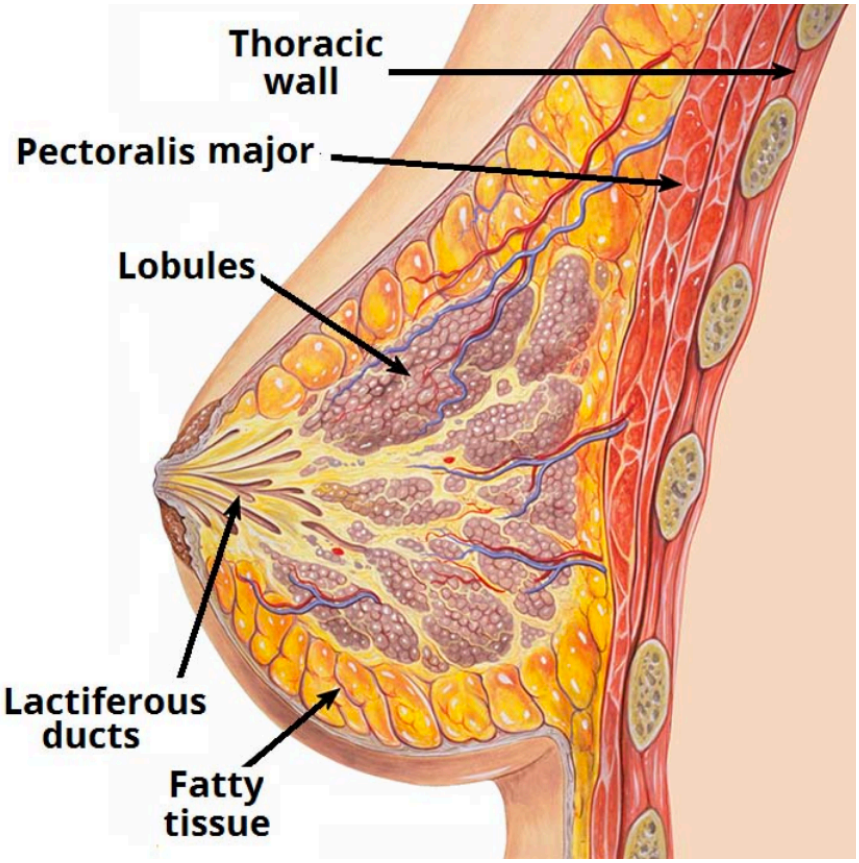


Figure 1.1 Anatomy of the breast.

Adapted from Wikimedia Commons 2017.

(https://commons.wikimedia.org/wiki/File:Breast_anatomy_normal_scheme.png)

There are three groups of lymph nodes that serve as the lymphatic drainage of the breast: axillary nodes, retrosternal nodes and variable internal mammary nodes. Lymphatic drainage of the breast is of great clinical importance, as it plays a significant role in the breast cancer metastasis and staging.

1.1.3 Types of Breast Cancer

Breast cancer is a general term that encompasses several types of neoplasm arising from breast tissue. The most common one is adenocarcinoma, a term for all cancers originating in glandular tissues; this cancers is felt to originate from the epithelial cells lining the milk ducts (termed 'ductal carcinoma') or the terminal duct lobular units (termed 'lobular carcinoma'). Over 80% of breast adenocarcinomas are derived from the epithelial cells lining the ducts specifically, thus often referred to as mammary ductal carcinoma. *Ductal carcinoma in situ* (DCIS) is proliferation of cancer cells within the duct itself but without invasion through the myoepithelial and basement membrane lining of the ducts (considered Stage 0 breast cancer). *Invasive ductal carcinoma* (IDC) is composed of cancer cells that have invaded through the myoepithelial lining of the ducts into the surrounding stromal tissue of the breast. Although DCIS is believed to be a non-obligate precursor of IDC, approximately 40% of DCIS will progress to IDC if left untreated, evidenced by DCIS and IDC having very similar gene expression patterns (Cowell, Weigelt et al. 2013, Harris, Lippman et al.

2014). The drivers of invasion, or epithelial-to-mesenchymal transition, remain unknown.

Classic type lobular carcinoma in situ (LCIS) is a marker of increasing risk of developing breast cancer in the future (ductal or lobular) in either breast (Weigelt, Geyer et al. 2010), although a more aggressive from of LCIS (pleomorphic LCIS) is considered a non-invasive lobular carcinoma of the breast and is treated the same as DCIS (excision and adjuvant radiation) (Flanagan, Rendi et al. 2015). LCIS and its lesser form termed Atypical Lobular Hyperplasia (ALH) are relatively uncommon, and are usually an incidental finding in a core biopsy that had been indicated for another finding on mammogram. These lobular neoplasias are defined by the World Health Organization as "a spectrum of atypical epithelial lesions originating in the terminal duct-lobular unit and characterized by a proliferation of generally small, non-cohesive cells, with or without pagetoid involvement of the terminal ducts" (Harris, Lippman et al. 2014). In other words, lobular neoplasms (*'in situ'* or invasive) are characterized by neoplastic cells originating in the terminal ductal units, whereas ductal neoplasms (*'in situ'* or invasive) are characterized by neoplastic cells originating in the main breast ducts. They differ histologically as lobular neoplastic cells do not express e-cadherin, whereas ductal neoplastic cells do, and this can be tested by the pathologist using immunohistochemistry staining.

Invasive lobular cancer (ILC), arising from the lobules of the breast, is the second most common type of breast pathology. Approximately 10% of all breast cancer cases are of ILC type. This is a highly invasive form that can spread

through breast tissue and metastasize to other body parts. ILC is usually a multifocal disease and is more commonly bilateral than any other type of breast cancer (Harris, Lippman et al. 2014). The clinical and radiological presentations of ILC are subtle: while LCIS and ILC may present as a palpable mass, the most common presentation is a thickening or induration, or what the patient may describe as a ‘shrinking of the breast’. ILC is often mammographically occult (not visible on screening mammogram), and thus presents as a contour distortion of the breast (contracture or elevation of the affected breast compared with the other) rather than a palpable discrete mass.

Medullary cancer is one of the rare breast tumours, accounting for about 3-5% of all breast cancer. It affects mainly middle-aged women. Although it does have an aggressive appearance in the breast primary, it can behave in a less aggressive way in terms of propensity for distant metastases (Harris, Lippman et al. 2014). Patients usually present with a palpable mass and possible axillary lymphadenopathy. Treatment consists of surgery, followed by adjuvant radiation, as these tumours tend to be less chemosensitive.

Papillary cancer accounts for about 1-2% of breast cancer cases, and is usually found in older women, who typically present with axillary lymphadenopathy, similar to that of medullary cancer.

Tubular cancer is one of the least aggressive types of breast cancer, and it doesn’t usually metastasise outside the breast. It used to account for less than 4% of the cases, but with the advancement of screening programs, tubular cancer diagnosis is becoming more common. Patients are usually in the later

decades of life, and it is rarely seen in men. The majority of patients have an abnormal finding on mammogram, with the absence of any clinically palpable findings. The mammogram finding tends to be hard to distinguish from IDC, due to the speculated margins (Harris, Lippman et al. 2014). The treatment regime for tubular cancer is similar to that for IDC.

Mucinous (or colloid) cancer, as the name suggests, this a tumour surrounded by mucus, secreted by the cancer cells. It is considered to be a less aggressive type. It is unusual for it to spread to the lymph node. Studies have demonstrated that less than 5% of invasive cancer would have some mucinous component, with the pure mucinous cancer representing less than half of these (Harris, Lippman et al. 2014). Mucinous cancer is usually diagnosed in patients in their seventies and eighties. The patients usually present with a palpable mass. While the usual treatment is surgical, a controversy exists about the role of radiation therapy, considering the benign behaviour of this type of cancer (Harris, Lippman et al. 2014).

Cribriform cancer is a subtype that presents as an invasive carcinoma of low-grade, accounting for about 5% of breast cancer cases. The type is well differentiated, with features similar to those of tubular cancer. Following surgical treatment, cribriform cancer carries a good prognosis (Harris, Lippman et al. 2014).

Finally, there are other, less common types of breast cancer. These include micropapillary carcinoma, metaplastic carcinoma, carcinoma with neuroendocrine features, adenocystic carcinoma, carcinoma with apocrine

differentiation, secretory carcinoma, as well as other miscellaneous rare invasive breast cancers. The primary management of all breast cancer subtypes is surgical excision (Harris, Lippman et al. 2014).

1.1.4 Risk Factors for Developing Breast Cancer

Many risk factors are associated with the development of breast cancer. These include gender (females are more prone than males), age (the risk of developing breast cancer increases with age, particularly after menopause), reproductive history (risk increases with higher number of ovulatory cycles and nulliparity), lactation (lactational changes related to breast feeding reduces risk of developing breast cancer), exposure history (ionizing radiation exposure, alcohol intake and hormone replacement therapy all increase the risk of having breast cancer), height and weight (taller women and those of higher BMI have a higher chance of developing breast cancer), family history and Breast Related Cancer (BRCA-1/BRCA-2) gene mutation (these significantly increase the chance of breast cancer) (Duncan, Reeves et al. 1998, Anand, Kunnumakkara et al. 2008).

A number of inherited tumour suppressor gene mutations can lead to breast cancer, particularly those within the BRCA1 and BRCA2 genes. BRCA gene mutations significantly increase the risk of breast cancer development, from a 1 in 8 risk for an average woman, to 65-80% lifetime risk for those who are BRCA gene mutation carriers (Antoniou, Pharoah et al. 2003).

Hormones appear to have an important influence over the development, progression and recurrence of breast cancer, particularly estrogen and

progesterone. These are steroidal sex hormones produced by the ovaries in premenopausal women. In postmenopausal women, both hormones are derived from the conversion of androgens to estrogen by aromatase in the adrenal glands, and (to a lesser degree) in peripheral tissues such as adipose tissue (Ryan 1982). Progesterone is derived from pregnenolone, a precursor originating from cholesterol (Ryan 1982). Circulating estrogen promotes the upregulation of progesterone receptors, particularly in breast tissue (Ryan 1982). Both estrogen and progesterone play a role in the female sexual development, maintenance of sex characteristics and fertility.

Two different types of estrogen receptors (ER) have been described: alpha (α) and beta (β) (ERα and ERβ, respectively). Various tissues express ER (breast, ovaries and the endometrium express ERα, while the kidneys, brain, lungs and several other organs express ERβ). The role of ERβ in carcinogenesis remains controversial, whereas a clear link between ERα protein and breast cancer has been established (Rizza, Barone et al. 2014). Most breast cancers (at least 80%) are ER positive and/or PR positive (Ryan 1982).

A third cell surface receptor is called Her2-neu (transmembrane protein from the class of epidermal growth factor receptors) (Hammond, Hayes et al. 2010). It is present in most tissue types, but can be over-expressed in a number of cancers, including breast. It is associated with higher grade and more aggressive breast cancers and conveys a worse prognosis. Her2-neu-overexpressing tumours are treated with chemotherapy in addition to a targeted monoclonal antibody treatment called Herceptin, which negates the negative

prognosis associated with Her2-neu overexpression, as it significantly reduces recurrence and is associated with an improved survival (Rao, Shetty et al. 2013, Blanchette, Desautels et al. 2018).

A number of tumour and patient factors determine the risk of recurrence or death from breast cancer (Cianfrocca and Goldstein 2004): tumour stage, menopausal status (worse prognosis with pre-menopausal status), tumour grade (worse prognosis with higher grade), and tumour phenotype (ER+/PR+/Her2-neu- are most favourable, followed by ER and/or PR+/Her2+, followed by ER-/PR-/Her2+ and finally ER-/PR-/Her2- or 'triple negative', which carries the worst prognosis for survival (Diab, Clark et al. 1999).

1.1.5 Epidemiology

The total number of diagnosed breast cancer cases progressively increased in the 1990s-2000s, but started to decrease after that. This spike is most likely due to the improvement in and standardized use of screening mammograms, as those assist with the early diagnosis of breast cancer (Canadian Cancer Society, 2017).

Incidence, defined as the number of new cases diagnosed in a population over a specified period of time, provides an understanding of the risk of developing breast cancer to the general population. Prevalence is the number of people living with breast cancer within a population at any give time point. Mortality, the number of people that are likely to die from breast cancer in a population over a specified period of time, can improve our understanding of the

impact that breast cancer has on society, based on the number of lives lost to the disease.

In 2017, it was estimated that 25% of all cancer diagnoses in women were those of breast cancer, which makes breast cancer the most common non-cutaneous malignancy diagnosis for Canadian women. This represented about 26,300 females in the Canadian population (CanadianBreastCancerFoundation 2017). The total number of women diagnosed appears to be increasing, most likely due to the total population increase (cbcf.org). The incidence of breast cancer is known to increase with age, since 83% of breast cancer cases diagnosed are in women over the age of 50. Data available from 2009 suggests that more than 157,000 Canadian women and over 1,000 Canadian men diagnosed with breast cancer since 1999 were still living (cbcf.org), meaning that survivorship issues are becoming more and more important (long-term form therapy, improved surgical scars and appearance, emotional sequelae from the diagnosis and treatment, etc.).

The last estimated 5-year net survival is about 87% for women, and 79% for men (cancer.ca). Approximately 5,000 women, representing 13% of all cancer deaths, are anticipated to die this year of metastatic cancer (cancer.ca).

Breast cancer in young women is known to behave more aggressively, leading to a faster progression and a higher cancer-related death. The incidence of young onset breast cancer in 2016 was estimated to be around 4,495 (cbcf.org). Male breast cancer typically has a delayed diagnosis, resulting in a more advanced stage at presentation than in females and a lower 5-year survival

rate overall. The incidence of Canadian male breast cancer in 2016 was around 230 (cbcf.org).

1.1.6 Diagnosis of Breast Cancer

Patients usually present with cancer in one of two ways: a palpable breast mass or change in breast appearance, or an abnormality such as a mass or microcalcifications seen on screening mammogram. The diagnostic approach begins with the appropriate medical imaging for any suspicious finding, with mammogram as the first-line gold standard in breast imaging (May L 2014). Ultrasound is used to interrogate any area in question on mammogram, as well to investigate any palpable concern. Other modalities, including breast magnetic resonance imaging (MRI) or contrast-enhanced mammography, are added as needed, in order to obtain definitive information regarding the breast tissue and whether any area is deemed suspicious and worthy of tissue biopsy for diagnosis. Such suspicious results on mammogram or other imaging modality are further assessed by an image-guided core needle biopsy. If the clinical finding persists but the mammogram and ultrasound are negative, a surgical consultation is obtained to determine whether this is an abnormal finding requiring an excisional biopsy procedure, or whether further imaging (such as magnetic resonance imaging (MRI) if not already done) might be warranted for the few cancers which present as mammogram and/or ultrasound occult (May L 2014).

Once a biopsy is done using image guidance, the specimen is processed by the pathology team, using formalin fixation and paraffin embedding for

microscopic examination, with hematoxylin and eosin staining. The pathologist determines the tissue of origin of the cancer, whether the cancer is *in situ* or invasive, and if invasive, its histologic type and grade. Immunohistochemical staining is done to determine whether the cancer cells are ER and/or PR positive and whether the cells are HER2 overexpressing (Hammond MEH 2010). If the tumour is HER2 equivocal by immunohistochemistry, testing for the HER2 gene may be performed by fluorescent *in situ* hybridization (FISH), to determine whether or not the HER2 gene is amplified.

Distant staging investigations (searching for distant metastases using imaging tests) are not recommended for early breast cancers; however, as the risk of distant metastases rises, then staging investigations are recommended prior to any systemic therapies. These standardly include a computerized tomography (CT) scan of the chest, abdomen and pelvis, and a full body bone scan. Imaging of the brain is not indicated in the absence of symptoms, as the yield for detecting metastases is otherwise low (May L 2014).

1.2 CLASSIFICATION AND STAGING OF BREAST CANCER

1.2.1 Classification

Breast cancers can be classified and substratified using a number of clinically relevant features. The purpose of classification is to select the best therapy and treatment algorithms, as well as to prognosticate. The major classification features include histopathological type, the grade of the tumour, the

stage of the tumour, and the molecular (ER/PR/HER2) subtype (a surrogate for gene expression profile classification).

Histopathological classification involves the differentiation between *in situ* and invasive breast cancers, as well as their histologic type and grade. Histological features roughly stratify the invasive cancers as either no special type (infiltrating ductal) or special type (medullary, mucinous, lobular, tubular, cribriform), although there are also other more rare forms (e.g. metaplastic, apocrine, adenosquamous, etc.) (Bloom and Richardson 1957). Tumours showing mixed 'no special type' and 'special type' features usually behave and are classed as a 'no special type' tumour of the same histologic type and grade.

Grading focuses on the differentiation of the breast cancer cells compared to that of the normal breast cells. As the cell division becomes uncontrolled, nuclei become less uniform and cell arrangement more disorganized. The grade of an invasive carcinoma is assessed using the Scarff-Bloom-Richardson grading system, which involves three criteria: tubule formation (the percentage of tumour made up of tubular structures (1 point for >75% tubules; 2 points for 10-75% tubules and 3 points for <10% tubules)); nuclear pleomorphism (the degree of change in the shape and size of the cells' nuclei (1 point for small and uniform nuclei; 2 points for medium to large nuclei but they remain consistent in shape); and 3 points for large and varied nuclei)); and mitotic count (number of cells under microscope that are actively dividing (1 point for slow mitotic rate; 2 points for medium mitotic rate and 3 points for rapid mitotic rate)) (Elston and Ellis 1991). Thus every tumour is graded out of a possible 9 points. This is then further

collapsed into a score for grade out of three (grade 1=1-5 points; grade 2=6-7; grade 3=8-9 points). These could also be described as well differentiated (low-grade), moderately differentiated (intermediate-grade) and poorly differentiated (high-grade) as the cells progressively lose the features and arrangement of normal breast cells. The poorer the differentiation is (or the higher the grade), the worse the prognosis for the patient.

1.2.2 Staging

Staging of breast cancer is based on the extent to which the cancer has spread away from the primary site of origin. There are two different staging approaches used in breast cancer: the Roman numeral staging system, and the tumour, lymph nodes, metastasis (TNM) staging system, developed by the American Joint Committee on Cancer (AJCC) (Edge, Byrd et al. 2009). The most clinically utilized staging is TNM (Edge, Byrd et al. 2009). Although lymphovascular space invasion does not change the stage of cancer, it is usually associated with a more aggressive phenotype, where the cells have infiltrated into veins or lymphatic channels in the area where the tumour is located. According to the NSABP-B04, patients with negative nodes have a better 10-year survival in comparison to patients diagnosed with node positive invasive breast cancer (Harris, Lippman et al. 2014). Therefore, having a precise staging for each patient is critical in guiding treatment decisions and providing accurate prognosis.

1.2.2.1 Roman Numeral Staging System

Roman numeral staging involves assigning a number to describe the progression of cancer. The following stages are recognized:

Stage 0: carcinoma *in situ*.

Stage I: T1 tumours that are lymph node negative.

Stage II: tumours up to T2 in size, with up to N1 nodal metastases, or T3 in size but no nodal metastases. This is the most common stage at diagnosis for breast cancer. Distant staging is indicated from this stage forward.

Stage III: This stage is considered locally advanced. These cancers are all lymph node positive (N1-N3) or invading surrounding structures (T4).

Stage IV: cancer has metastasized to other organs or throughout the body.

1.2.2.2 TNM Staging System

Tumour: tumour classification (TX, T0, Tis, T1, T2, T3 or T4) depends on the cancer site. TX refers to an inability to assess that site; T0 means that no primary cancer was found; Tis refers to ductal *in situ* carcinoma, lobular *in situ* carcinoma or Paget's disease of the nipple; T1 represents tumours up to 2cm in size; T2 represents tumours more than 2cm but less than 5cm; T3 represents tumours 5cm or greater; T4 represents tumours invading surrounding structures including chest wall, skin, both or infiltrating dermal lymphatics resulting in a clinical diagnosis of inflammatory breast cancer.

Lymph Node: lymph node involvement with cancer (NX, N0, N1, N2 or N3) depends on the number and location of the involved lymph nodes, whether

axillary lymph nodes, the infra or supraclavicular lymph nodes, or the internal mammary lymph nodes are affected. NX designation means the lymph nodes have not been assessed; N0 signifies no lymph node metastases; N1 means 1-3 lymph nodes are involved; N2 means 4-9 nodes are involved and N3 means 10 or more nodes are involved. Clinically, all nodal basins are examined and any biopsy proven nodes are classed based on their location: N1 means palpable but mobile axillary nodes; N2 represents matted nodes in the axilla or infraclavicular or internal mammary nodes; N3 represents nodes found in the supraclavicular nodal basin.

Metastases**:** The clinically relevant classification for distant metastases for breast cancer are M0 and M1, which refers to distant detectable metastases or absence thereof. The most likely areas for breast cancer cells to harbour clinically visible or relevant metastases are bone, lung, liver and brain.

1.3 THERAPEUTIC APPROACH TO BREAST CANCER

Treatment of breast cancer is usually multimodal, and requires the involvement of many specialties. General approaches to breast cancer treatment include surgery, chemotherapy, radiation therapy and hormonal manipulation therapy.

1.3.1 Surgery

Surgery is one of the primary lines of therapy for breast cancer. The purpose is to remove all of the cancerous tissue (tumour), plus some of the normal breast tissue all around the tumour to constitute its margins. The extent of surgery is dictated by the staging and the type of tumour, and may include lumpectomy (removal of the lump) or mastectomy (removal of the whole breast). Most early breast cancers (stage I and II) consist of small primary breast cancers easily resectable by lumpectomy – 'breast conserving surgery' – whereas stage III advanced cancers tend to occupy a larger portion of the breast and, therefore, require a mastectomy for successful removal of the entire involved area. Standard practice requires the surgeon to establish margins clear of cancer, indicating that the cancer has been completely excised. If the removed tissue does not have clear margins, further operations to remove more tissue may be necessary. Therefore, in an effort to minimize the risk of margin positivity while reducing the amount of normal breast tissue that needs to be resected, particularly in the later stages, neoadjuvant chemotherapy (systemic cytotoxic chemotherapy prior to surgical excision rather than afterwards) may be used to downsize the primary tumour to render operable breast cancers amenable to breast conserving surgery (Wolmark, Wang et al. 2001).

For larger breast neoplasms that remain extensive despite neoadjuvant chemotherapy, or which consist of separate tumours distributed throughout different quadrants of the breast, a mastectomy remains the standard of care. This involves removing the glandular breast tissue from the pectoralis fascia,

resecting overlying skin and nipple-areolar complex and achieving primary skin closure over the chest.

During the operation, the lymph nodes in the axilla must be sampled or removed entirely, in order to stage the patient for regional metastases (N stage). Until the early 2000s, the standard of care for staging the axilla involved resection of all axillary lymph nodes in the level I and II zones, resulting in reduced arm mobility, dysesthaesias of the upper arm and a 10-20% risk of permanent lymphoedema of the upper extremity. More recently, the technique of sentinel lymph node (SLN) dissection has become popular, as it requires the removal of far fewer lymph nodes (i.e. fewer side effects) (George, Quan et al. 2009, Brackstone, Fletcher et al. 2015). SLN mapping can spare 65-70% of patients from having a complete lymph node dissection, for what could turn out to be a negative nodal basin, but is indicated for early breast cancers felt clinically to be lymph node negative.

Patients with Stage IV breast cancer are deemed incurable and, therefore, goals of care are shifted to extension of quality of life. As a result, there is great debate whether the patient should undergo surgery to remove the primary cancer if it has already metastasized, especially if the primary tumour appears to be well managed by the systemic therapies being given to control the distant disease.

1.3.2 Chemotherapy

Systemic chemotherapy can be delivered in two main regimens: neoadjuvant (prior to surgery) and adjuvant (following surgery). Multiple

chemotherapeutic agents may be used in combination. Determining the appropriate regimen depends on the character of the tumour (i.e. its hormonal status), lymph node status, and the age/health of the patient. Many regimens have been clinically evaluated and found to be efficacious in clinical trials, but for the majority of breast cancers, the regimens typically used contain an anthracycline and a taxane, as these have demonstrated superior survival to regimens not containing these classes of drugs (Brackstone, Fletcher et al. 2015).

The most common regimens used to treat breast cancer include AC-T (anthracycline and cyclophosphamide IV, q3 weekly x 4 or dose-dense as q2 weekly x 4) followed by taxane (paclitaxel or docetaxel, either q3 weekly x 4 or q-weekly x 9-12) and FEC-D (5-fluorouracil, epirubicin and cyclophosphamide IV q3 weekly x 3) followed by a taxane (docetaxel IV q3 weekly x 3 cycles, or paclitaxel IV qweekly x 12 cycles).

1.3.3 Radiation Therapy

Radiation therapy (RT) is used to reduce the risk of locoregional recurrence, and is almost always delivered in the adjuvant setting to the surgical field. It is the standard of care for *in situ* or invasive disease in patients treated by breast conservation, for reducing by more than 50% the risk of local recurrence in the breast following lumpectomy, or following mastectomy for lymph node positive breast cancers (Dayes, Rumble et al. 2015).

RT involves the delivery of high-energy X-rays that target the tumour, or post-surgery tumour site. It can be delivered in the form of external beam

radiotherapy (linear accelerator), or brachytherapy (radiation source is placed directly at the treatment site). Given that all tissue types are susceptible to radiation damage, the dose of radiation must be strong enough to be cytotoxic to proliferating cancer cells, but tolerable by the surrounding normal cells. Therefore, the radiation delivery is planned using a CT scan where radiation oncologists and physicists calculate dosage to deliver even radiation to the area in question while constraining doses to critical structures. Acute and late radiotherapy sequelae are then minimized by delivering the treatment over many fractions at a low dose per fraction (typically 2-3.4Gy/fraction each day).

Despite the benefits of RT in lowering the rate of recurrence, RT carries a lot of negative effects on the cosmetic outcome (Whelan, Pignol et al. 2010). Due to RT-induced various degree of fibrosis, a distortion of breast shape can occur, dramatically worsening the cosmetic result of breast conservation. In addition, the retraction of the lumpectomy scar towards chest wall is very common following the absorption of the seroma in the cavity following the use of standard techniques of lumpectomy, particularly when breast tissue mobilization and contouring techniques are not used.

Other complications of radiation therapy include (but are not limited to) fat necrosis and breast fibrosis, radiation pneumonitis and lung fibrosis, radiation-induced malignancy, as well as skin and soft tissue changes (Yi, Kim et al. 2009).

1.3.4 Hormone Manipulation Therapy

Systemic hormonal manipulation therapy is recommended for all ER and/or PR positive breast cancers where there is a significant risk of distant relapse, balanced against the toxicity profile of these agents for each individual patient. Current recommendations support the use of a selective estrogen receptor modulator for 10 years in premenopausal patients, and an aromatase inhibitor for 5 years (Brackstone, Fletcher et al. 2015). Thus, the choice of hormone manipulation therapy depends on the menopausal status of the patient, as well as the response of the patient to treatment.

Selective estrogen receptor modulator is usually employed as a first-line hormonal manipulation therapy in the premenopausal women. An example of this type of medication is Tamoxifen, administered once a day for 5-10 years.

Aromatase inhibitor is employed as a first-line hormonal manipulation therapy in post-menopausal women, in patients who failed the first-line Tamoxifen, or instead of surgery for elderly patients with non-operable/metastatic breast cancer. For example, Letrozole is administered once a day for 5 years.

1.4 ONCOPLASTIC SURGERY

Oncoplastic surgery is a form of breast cancer surgery that combines the techniques for lumpectomy with those of plastic surgery, to achieve defect closure (Urban, Lima et al. 2011, Rassu, Serventi et al. 2013, Santos, Urban et al. 2015). By combining the techniques of tumour removal with those used in

plastic and reconstructive surgery, it allows for the maximum preservation of the appearance of the breast, all without compromising therapeutic outcome.

In the past, the primary goal of any breast cancer surgery was a satisfactory oncological outcome; cosmesis was not regarded as important. However, studies have shown that many patients perceive their scar as a very negative outcome after several years of survivorship. Up to 30% of women surveyed have reported being unhappy or unsatisfied with their cosmetic result, significantly worsening their quality of life (Veronesi, Banfi et al. 1990, Driul, Bernardi et al. 2013).

Self-esteem, confidence, social interactions, sexual and emotional relations all affect a woman's self-image. Therefore, it was identified as very important to find a reasonable alternative to breast cancer surgery that would not only be oncologically safe, but also improve the self-image of the patients after the surgery. This gave rise to the field of oncoplastic surgery: a multi-disciplinary approach between general and plastic surgeons that offers a breast conserving surgery (BCS) techniques in conjunction with chemotherapy and radiation therapy, optimizing the rate of breast conservation with much improved cosmetic outcomes and patient satisfaction.

The history of oncoplastic surgery is difficult to trace, as it has not been extensively documented. Although the term 'oncoplastic surgery' was originally proposed by Werner Audrescht in Germany in the 1990s (Audretsch, Rezai et al. 1998), several sources indicate that the combination of BCS and plastic surgery techniques had already been in use well before, in the 1980s, in France (Urban,

Lima et al. 2011). Nowadays, the oncoplastic surgery has expanded well beyond the almost-exclusive use by the European surgeons. Currently it is employed as a standard practice for breast cancer surgery in Europe and some places in the United States, North America, Australia, and is just beginning in Canada.

1.4.1 Indications for Oncoplastic Surgery

Oncoplastic surgery offers a solution for patients who would not be good candidates for BCS for a variety of reasons, including the presence of large lesions, tumours that are not chemo-sensitive (e.g. ILC, DCIS), size and location of the tumour, particularly those in the upper inner quadrant or around the 6 o'clock position, and multifocal/multicentric tumours (Cil and Cordeiro 2016).

Oncoplastic surgery offers many advantages, particularly in the adjuvant radiotherapy setting: less exposure of the breast tissue to radiation, hence fewer complications attributable to radiation (Munhoz, Montag et al. 2013). For example, in their clinical series, Gray et al (1991) found that patients with larger breast and more fatty tissue are more prone to radiotherapy complications, particularly retraction, symmetry issues and necrosis (Gray, McCormick et al. 1991).

1.5 CLASSIFICATION OF ONCOPLASTIC SURGICAL TECHNIQUES

Several methods can be used to classify oncoplastic surgical techniques in order to facilitate a better understanding of the variety of procedures that fall under the umbrella of oncoplastic surgery. There are two fundamentally different

approaches used to manage breast defects created by lumpectomy surgery: volume displacement and volume replacement techniques. Volume displacement techniques combine resection of the tumour followed by breast tissue rearrangements with mammoplasty, breast reduction and reshaping cosmetic techniques, all done as part of the same operation. On the other hand, volume replacement procedures combine resection with immediate reconstruction using loco-regional flaps with tissues outside the breast. While volume displacement methods are good for a D or larger-cup-sized breast, small to medium-sized breast derives the maximum benefits from volume replacement techniques (Noguchi, Yokoi-Noguchi et al. 2016).

Volume displacement oncoplastic surgery can be further divided into Level 1 and Level 2, according to the quantity of breast tissue to be removed, the quality of the breast tissue and the tumour location (Clough, Kaufman et al. 2010).

Level 1 oncoplastic techniques are used for defect closure and tissue undermining when the anticipated volume loss in a glandular breast is less than 20%, without the need for skin excision or mammoplasty. Level 2 includes techniques that are more complex: they are used in fatty breasts, in instances where the anticipated resection of the breast volume is 20-50%, and excision of the excess skin is required to reshape the breast. The mastery of level 2 oncoplastic techniques requires specialized training in various mammoplasty techniques.

1.5.1 Level 1 Oncoplasty

The techniques, originally described in detail by Clough et al (Clough, Kaufman et al. 2010) include general standard steps that can be adapted or modified according to necessity in each individual case (Figure 1.2). The main aim of the procedure is to close the defect of lumpectomy in such way as to eliminate the formation of seroma and avoid resultant contour deformity.

The surgical procedure begins with a skin incision, followed by undermining of the skin and nipple areolar complex to obtain easy mobilization of the breast gland itself. Lumpectomy then proceeds as planned. Once the excision is completed, the breast gland is mobilized off the pectoralis fascia (dual gland mobilization from skin and chest wall) to close the defect. At this stage, recentralization of the nipple is performed using de-epithelization, i.e. the removal of the skin epidermal layer to plicate the dermis and recentralize the nipple over the breast mound. No other skin removal is required, thus the existing dermal layer with the dermal plexus and nerves provides the blood supply to the mobilized skin of the breast and the nipple.

1.5.2 Level 2 Oncoplasty

The techniques of mammoplasty utilized in level 2 oncoplastic surgery vary (Figure 1.3), depending on the region to which the tumour is localized and in which breast quadrant the surgery will be performed.

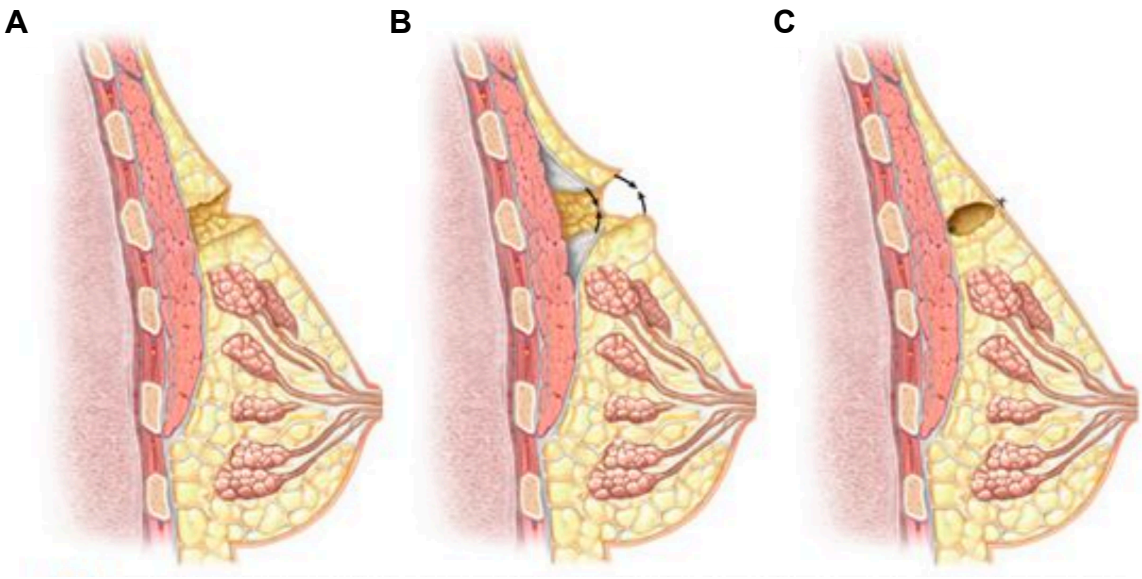


Figure 1.2 **Level 1 oncoplastic surgery**. The fibroglandular tissue is advanced over the pectoralis muscle to separate deeper tissues from the overlying skin. (A) lumpectomy, (B) apositioning of margins, (C) defect closure.

Adapted from Oncoplastic Breast Surgery (https://plasticsurgerykey.com/oncoplastic-breast-surgery).

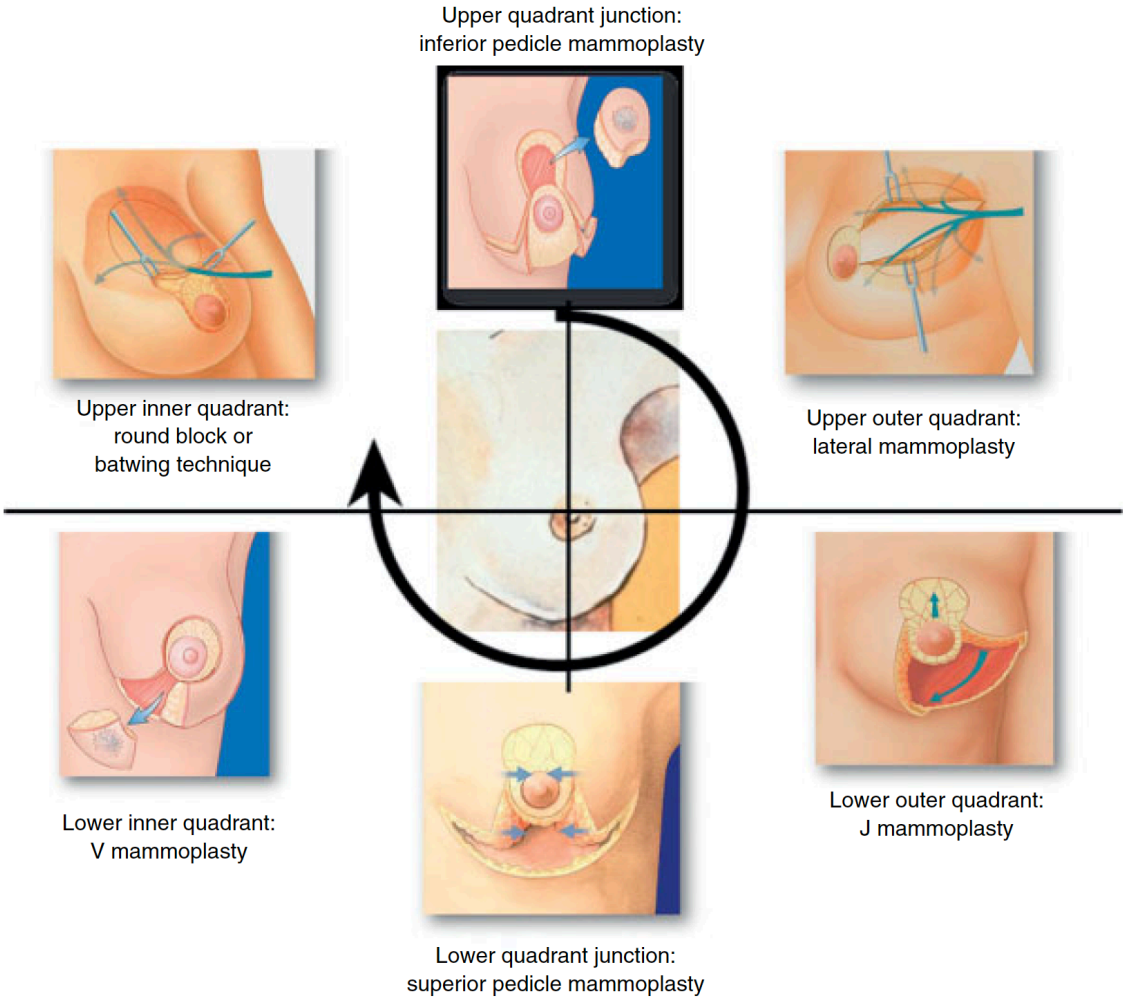


Figure 1.3 Overview of level 2 oncoplastic surgical reconstruction techniques. A quadrant-per-quadrant approach to the choice of surgical technique depends on the area of tumour localization.

Reproduced with permission from Clough et at (2012).

1.5.2.1 Tumours at the Upper Pole (at 12 O'Clock Position)

For tumours in the upper pole of the breast, i.e. those localized in the superior aspect of the breast from 11-1 o'clock based on the lock orientation, two most appropriate techniques to be used are the 'round block' (Benelli 1990) (Figure 1.4) and the inferior pedicle mammoplasty (Robbins 1977) (Figure 1.5). Inferior pedicle mammoplasty involves the use of existing breast tissue and its blood supply from the lower pole of the breast, to fill in the generated defect in the superior pole, as one would do in a cosmetic 'breast reduction' or 'breast lift'.

1.5.2.2 Upper Inner Quadrant

Tumours in the upper inner quadrant are those localized to 9-11 o'clock position of the left breast or 1-3 o'clock position of the right breast. The best approach to these is to use the batwing (Figure 1.6) and the round block (Figure 1.3) procedures (Anderson, Masetti et al. 2005, Clough, Ihrai et al. 2012).

1.5.2.3 Upper Outer Quadrant

For the tumours localized to the upper outer quadrant, i.e. at 1-3 o'clock in the left breast and 9-11 o'clock in the right breast, lateral or raquet mammoplasty is the most suitable technique (Ballester, Berry et al. 2009) (Figure 1.7). The procedure consists of the removal of a lateral wedge of breast tissue, including the tumour and the overlying skin. Briefly, an incision is made that extends laterally from the edge of the nipple areola complex (NAC), as necessary. The same incision is then utilized for SLN biopsy (SLNB). Glandular mobilization is

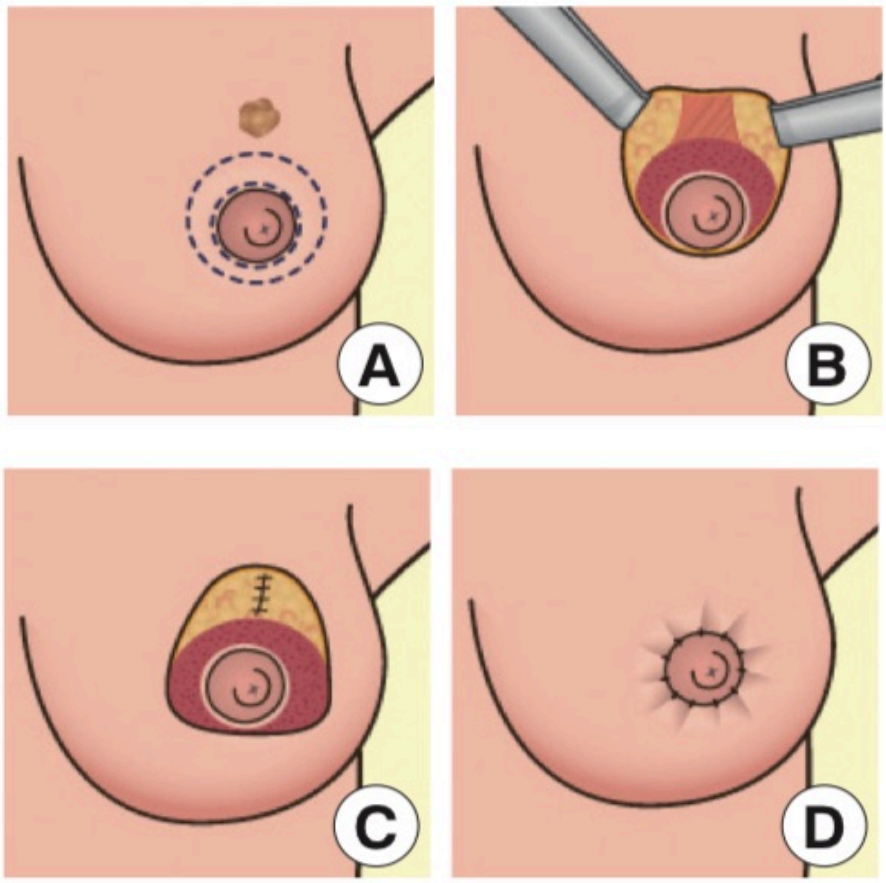


Figure 1.4 **Round block mastopexy technique in level 2 oncoplastic surgery**. (A) Preoperative design with two circular skin markings, (B) lumpectomy and de-epithelization, (C) undermining and approximation of nearby breast tissue, (D) postoperative periareolar scar.

Adapted from Yang et at (2012).

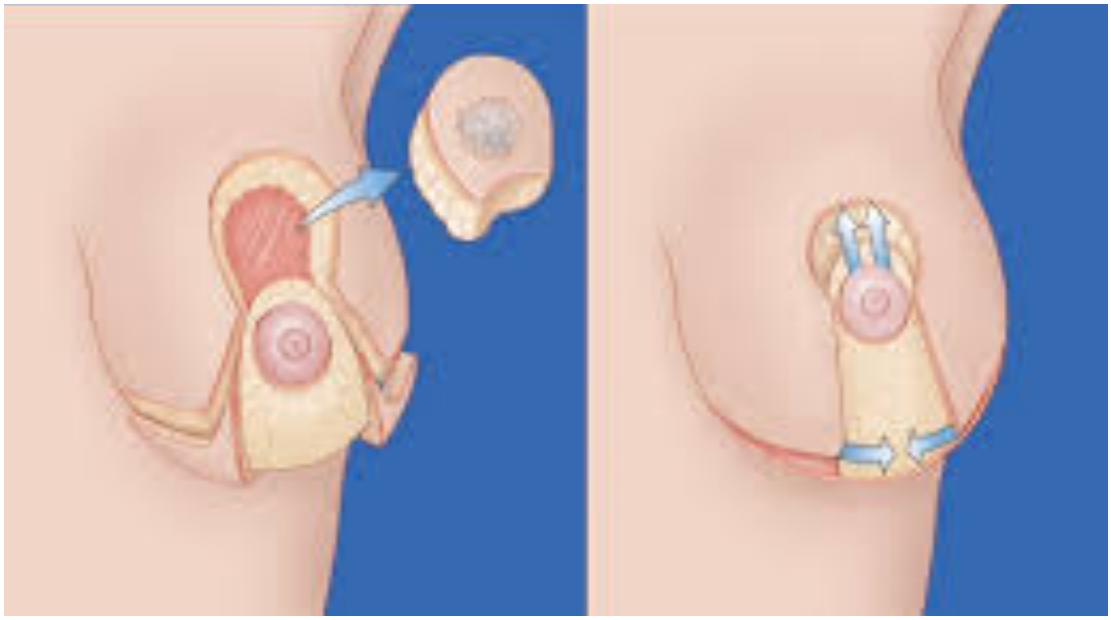


Figure 1.5 Inferior pedicle mammoplasty in level 2 oncoplastic surgery. The existing breast tissue and its blood supply from the lower pole of the breast is used to fill in the generated defect

Adapted from Clough et at (2010).

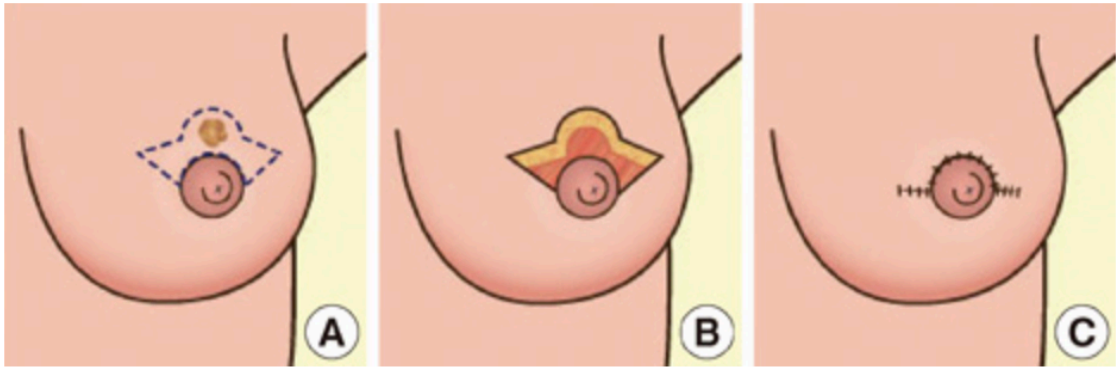


Figure 1.6 **Batwing mastopexy in level 2 oncoplastic surgery**. Batwing mastopexy. (A) Preoperative design with batwing form, (B) lumpectomy, (C) pulling up the inferior breast tissue.

Adapted from Yang et at (2012).

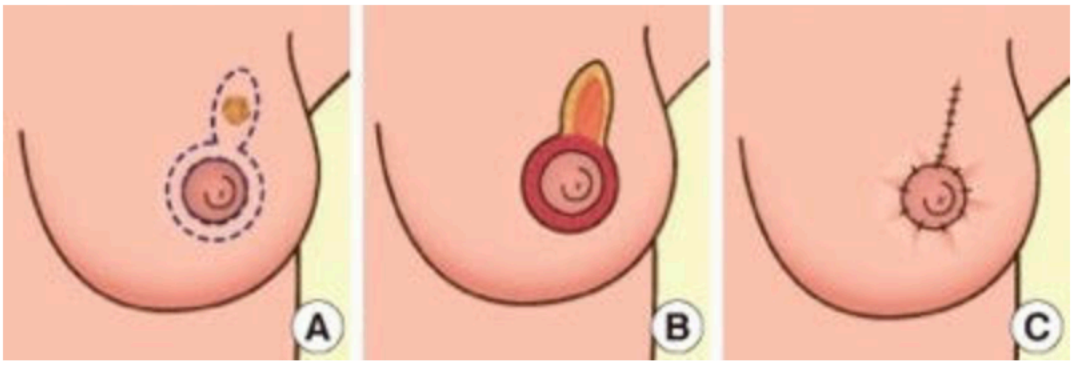


Figure 1.7 **Lateral mammoplasty (‘tennis racket’) in level 2 oncoplastic surgery**. (A) Preoperative design with racket form, (B) lumpectomy and de-epithelization, (C) filling and nipple-areolar complex reposition.

Adapted from Yang et at (2012).

then carried out at the level of pectoralis major muscle. The remaining lateral and central glandular tissue is mobilized while keeping the skin attached to the glands; this is then used to fill the defect while preserving a good blood supply to the tissue. Complete detachment of NAC from the underlying tissue assists with mobilization of the central glandular tissue for volume replacement at the lumpectomy defect (Clough, Ihrai et al. 2012). Once the defect is closed, re-centralization of the nipple is carried out by de-epithelization of the crescent of skin medial to NAC.

1.5.2.4 Tumours at the Lower Pole (at 6 O'Clock Position)

For the tumours localized to the lower pole of the breast, i.e. those at 5-7 o'clock position, superior pedicle mammoplasty offers the most appropriate approach. The technique employs an inverted T-shaped skin incision. The procedure begins by marking the superior pedicle and the tumour, followed by de-epithelization of the pedicle. An incision is made at the infra-mammary fold (IMF), and a wide dissection at the level of pectoralis major is carried out. Ensuring a wide clinical margin around the tumour, the lower pole tissue and some of the central tissue are all removed *en bloc*. Lateral and medial tissues are re-approximated, and sutured to the IMF. During the final stage of the procedure, the nipple is recentralized over the new breast mound (Clough, Ihrai et al. 2012).

This technique is also commonly used for 'breast reduction' or 'breast lift' procedures, where up to 60% of the breast volume can be resected, providing an oncologically sound breast conserving surgery while recreating a smaller, but

rounder and more aesthetically pleasing breast mound, that is usually cosmetically better after surgery than before.

1.5.2.5 Lower Inner Quadrant

For tumours of the lower inner quadrant, i.e. those localized to 7-9 o'clock position in the left breast and 3-5 o'clock position in the right breast, V mammoplasty (Figure 1.8) is the best option (Clough, Ihrai et al. 2012). The technique involves making a V-shaped incision over the tumour, with the apex pointing towards the margin of the areola, carrying out the dissection to the level of pectoralis major. Following tumour excision, another incision is made at the level of the IMF, extending to the anterior axillary line. Breast tissue is dissected at the level of pectoralis major, and the entire inferolateral breast tissue is mobilized medially to fill the defect, suturing it to the medial breast tissue. Following this, the skin around the NAC is de-epithelized and the NAC is then positioned over the superomedial pedicle.

Although more appropriate for the lower pole tumours, superior pedicle with inverted T-shape incision is another technique that may be, in some cases, useful on tumours of the lower inner quadrant (Clough, Ihrai et al. 2012).

1.5.2.6 Lower Outer Quadrant

Tumours of the lower outer quadrant are those localized to 3-5 o'clock position in the left breast and 7-9 o'clock position in the right breast. For these, J mammoplasty (Figure 1.9) is the best option. In this technique, the vascularity of

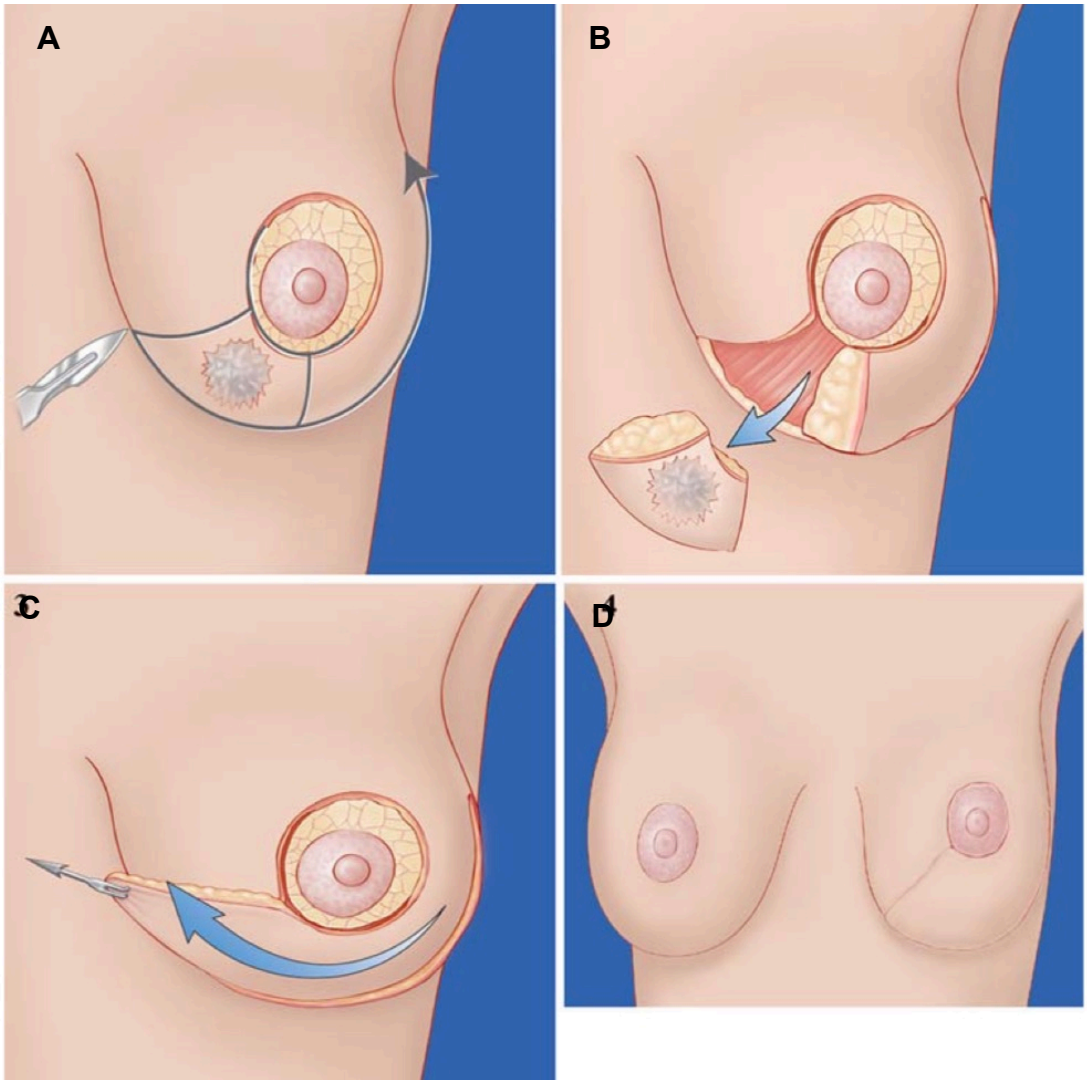


Figure 1.8 V mammoplasty technique in level 2 oncoplastic surgery. (A) V-shaped incision, (B) lumpectomy, (C) inferolateral tissue mobilization, (D) scar.

Adapted from Clough et at (2010).

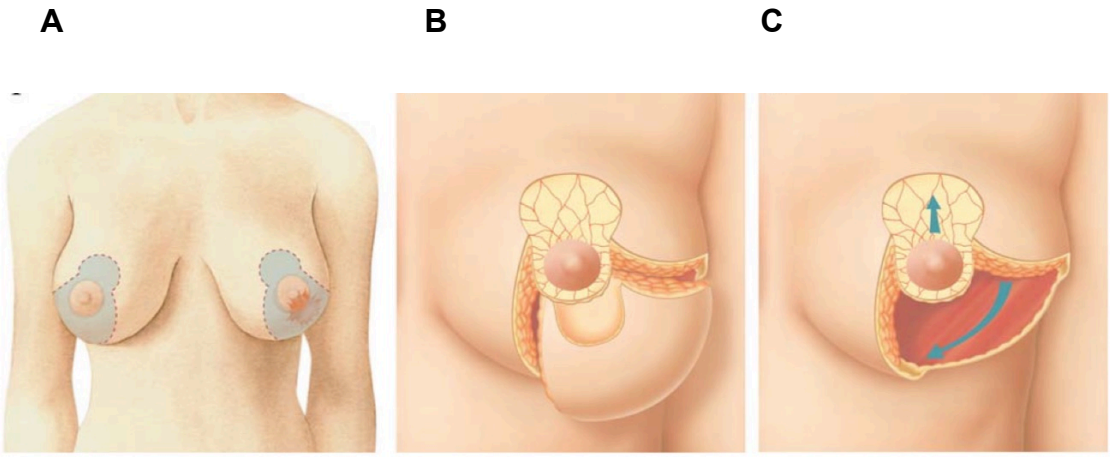


Figure 1.9 J mammoplasty technique in level 2 oncoplastic surgery. (A) J-shaped, oblique incisions from both sides of NAC, (B) lumpectomy, (C) lateral, medial and central glandular tissue are pulled together to achieve defect closure.

Adapted from Clough et at (2010).

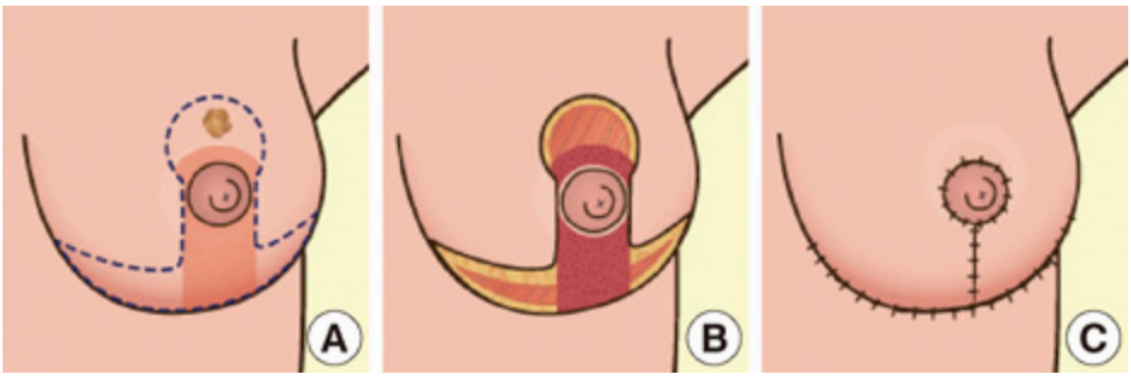
the NAC is primarily dependent on the de-epithelized superior pedicle. The procedure begins by making an oblique incision originating at the edge of de-epithelized skin and extending towards the IMF. Another, similar incision is made from the other side of de-epithelized skin edge, directed towards the IMF, to meet the end of the first incision. Glandular dissection follows the pattern of skin incision. The defect is closed by complete separation of the NAC from the underlying glandular tissue; the lateral, medial and central glandular tissue are then pulled together to fill the defect and to reshape the breast (Clough, Ihrai et al. 2012).

1.5.3 Level 3 Oncoplasty

Classification of oncoplasty can be further enhanced to incorporate Level 3 procedures. Level 3 oncoplasty techniques are utilized to perform the reduction mammoplasty that is coupled with the contralateral breast symmetrization. Level 3 oncoplastic surgical procedures are carried out in tandem with the plastic surgery team, particularly when the balancing procedures are planned. Level 3 oncoplasty requires additional plastic surgery training to properly balance these techniques and the contralateral cosmetic balancing component.

Surgical procedures employed include the use of wise pattern reduction (Figure 1.10), vertical mammoplasty (Figure 1.11) and J/V mammoplasty techniques (Figures 1.8 and 1.9). Depending on the tumour position, wise pattern reduction uses the superior, superomedial or inferior pedicle, and results in an anchor-shaped scar. For the tumours in the lower pole, the most optimal choice

INFERIORLY BASED PEDICLE



SUPERIORLY BASED PEDICLE

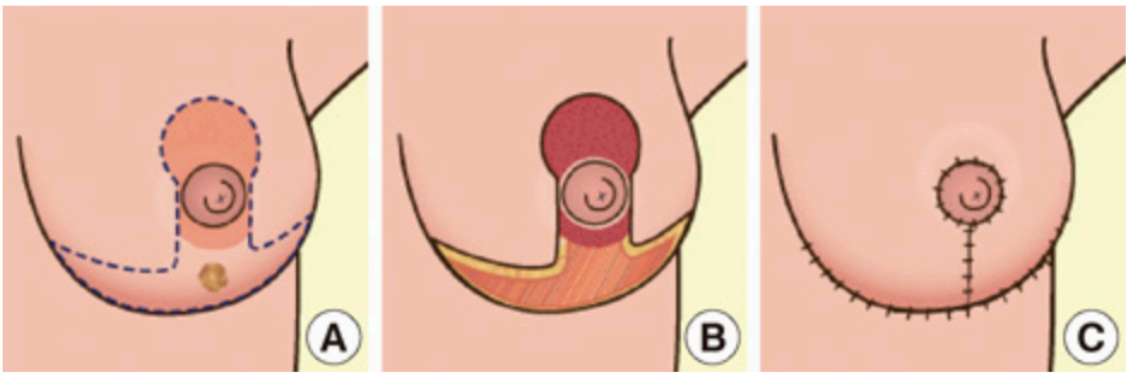


Figure 1.10 Wise pattern reduction in level 3 oncoplastic surgery. Wise pattern (inverted T) reduction with inferiorly based (top row) or superiorly based (bottom row) pedicle. (A) Preoperative design, (B) lumpectomy and de-epithelized pedicle elevation, (C) transposition of the pedicle into the new location.

Adapted from Yang et at (2012).

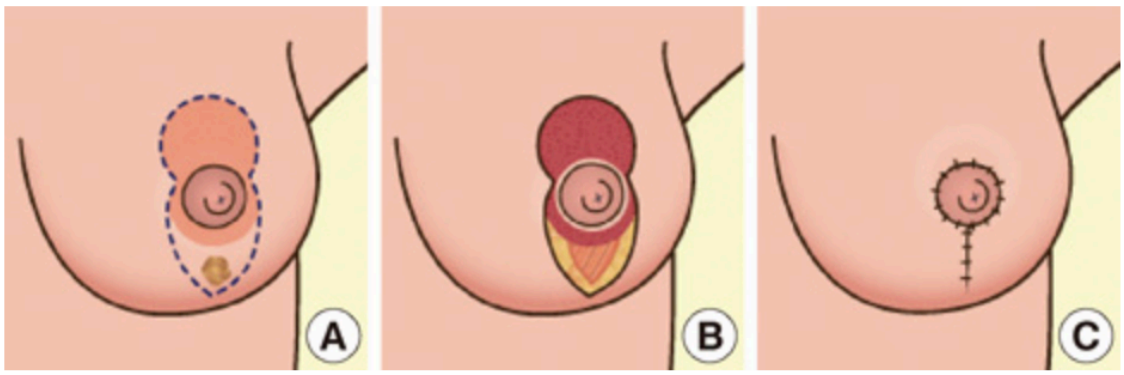


Figure 1.11 Vertical mammoplasty in level 3 oncoplastic surgery. (A) Preoperative design, (B) Lumpectomy and de-epithelized pedicle elevation, (C) new nipple positioning.

Adapted from Yang et at (2012).

of technique is vertical mammoplasty, which uses the superior pedicle to maintain the blood supply to the nipple.

1.6 OUTCOMES OF ONCOPLASTIC SURGERY

In general, the outcomes of oncoplastic surgery appear very favourable. The main aspects that always must be considered are oncological safety, cosmetic outcome and patient satisfaction (Noguchi, Yokoi-Noguchi et al. 2016).

1.6.1 Therapeutic Outcome

As with any cancer surgery, the most important outcome is the complete removal of malignancy together with a maximally safe oncological margin to minimize the risk of recurrence. In breast cancer surgery, particular attention must be paid to invasive tumours, ensuring that there remain no cancer cells at the margin of the lumpectomy specimen. In DCIS, the goal is to remove the complete area of involved ducts plus a 2mm margin of normal tissue in all directions within the lumpectomy specimen, again to minimize the risk of local recurrence. During a standard lumpectomy, glandular resection of surrounding normal tissue is minimized in order to diminish the amount of volume loss and asymmetry, given that cosmesis is directly related to the volume of tissue resected. However, with this oncoplastic approach, glandular tissue can be excised widely around the tumour while reshaping the breast without compromising the cosmetic outcome. This not only ensures a clear margin, but

also provides the patient with a nice breast shape (Ho, Stallard et al. 2016). Ensuring wide margins at the time of the oncoplastic lumpectomy reduces the likelihood that the margins are positive, thus reducing the need for further surgeries to resect more and achieve a clear margin.

Cosmetic results have been proven to be superior following oncoplastic surgery when compared to standard lumpectomy techniques (Veronesi, Banfi et al. 1990). Reshaping of the breast according to the tumour position and the nature of the breast tissue yields a round, smaller breast that is more youthful and aesthetically pleasing. As such, the patient satisfaction is significantly improved over standard techniques (Noguchi, Yokoi-Noguchi et al. 2016).

1.6.2 Risks and Complications

As with any other surgical technique, oncoplastic surgery also carries risks and a range of complications, as reported in the literature. The reported overall rate of complications in oncoplastic surgery has been reported to be 16%, versus those of 20% in BCS (Losken, Dugal et al. 2014). Therefore, although more involved technically, oncoplastic surgery is not associated with a significantly worsened complication rate.

Oncoplastic surgical complications are generally divided into early and late (Munhoz, Montag et al. 2013). The early complications include wound healing problems and post-operative bleeding among others (Cil and Cordeiro 2016), posing a potential delay to the administration of adjuvant therapy, although it does not appear that oncoplastic surgery results in a clinically meaningful delay

for any adjuvant therapy (Munhoz, Montag et al. 2013). Although requiring additional operative time and more tissue resection, oncoplastic surgery has not resulted in any changes in the rate of early complications (Cil and Cordeiro 2016).

The risk of a positive margin after resection must be considered: while uncommon considering the wider excision margin and larger specimen, some risk is always present (Piper, Peled et al. 2015). Thus, the surgeon must decide whether the tumour bed can be properly identified, and how much mobilization needs to be carried out, not discounting the possible need for future re-excision. If during the first surgery, significant tissue advancement and mobilization was required, the difficulty in taking all of this apart and finding the original tumour bed during a second operation in order to perform a re-excision for margins is high. As such, a completion mastectomy would be the appropriate option to consider in these cases. Therefore, one can appreciate the importance of a detailed operative report describing all the specifics of the procedure in a step-wise, clear and concise manner, facilitating margin re-excision if required as a second surgery.

Fat necrosis (ischemia of the fatty tissue in the breast) is a surgical complication that must always be considered, particularly in breast surgical procedures requiring significant amounts of tissue undermining, mobilization and with potentially tenuous blood supply (Munhoz, Montag et al. 2013). As with any surgical procedure, a full grasp of the anatomy and blood supply is crucial for a successful outcome. The quality of the breast tissue has to be considered on a case-by-case basis, prior to making any decision regarding surgery: fatty

replaced breast tissue carries a higher risk of infection and fat necrosis when mobilized at two levels. The risk of nipple ischemia and resultant nipple loss depends on the amount of vascular compromise, making the preservation of appropriate vascularity to the nipple crucial to the planning process. Some loss of nipple sensation is always expected, particularly if a complete nipple undermining is carried out.

Asymmetry is an issue that must be addressed with the patient ahead of time. Some surgeons prefer to offer the patient a concurrent symmetrization of the contralateral side if the patient requires a level 2 or 3 oncoplastic procedure, but this needs to be discussed well ahead of the surgical date if the best outcome is to be achieved. In addition, the need for post-surgical radiation therapy has to be considered, as an extra volume of 15-20% of normal breast tissue must be preserved on the affected side (in comparison to the healthy side) to compensate for radiation-induced fibrosis and volume loss.

Proper identification of the tumour bed (the location where the tumour was originally situated, representing the area at highest risk for local recurrence and therefore the area requiring adjuvant radiation the most) remains a great challenge in oncoplastic surgery, constituting a major problem for patients needing a boost of additional radiation treatment to the tumour bed specifically for higher risk tumours (Munhoz, Montag et al. 2013). To address this issue, several solutions have been proposed. First, multiple use of titanium clips on the original tumour bed prior to tissue mobilization has been recommended, advising the placement of at least four clips on the pectoralis overlying the chest wall.

Second, intra-operative radiation treatment has been suggested, where a pre-calculated dose is delivered to the lumpectomy cavity prior to tissue mobilization (Silverstein, Mai et al. 2014); it is widely available in Canada. Following this, the oncoplastic mobilization can then be completed.

1.7 THESIS RATIONALE

Oncoplastic surgery is considered a standard of care in breast cancer, particularly in developed countries, such as in Europe, the United States and South America, as well as Australia. Unfortunately, Canada lags behind in the routine use of these techniques. One of the major barriers to the uptake of oncoplasty is the necessity of very specialized training in the use and methods of oncoplastic surgical techniques. While some hands-on training is offered through specific oncoplastic surgery courses, particularly in European countries, the workshops are expensive, time-consuming (the surgeon must travel to the destination) and take time away from patient care. The purpose of this thesis is to evaluate dissemination of specialized knowledge such as oncoplastic surgery, using intra-operative mentorship as a method, to enhance the adoption of novel surgical techniques.

1.7.1 Thesis Outline

This thesis monograph describes on the practice of oncoplastic surgery as a therapeutic option for patients with breast cancer. The purpose of the study was to evaluate a strategy of intra-operative mentoring as a method of

influencing the current surgical practice into adopting the novel oncoplastic surgical techniques.

In Chapter 1, breast cancer is introduced and summarized; epidemiology, diagnostics, current therapeutic options and outcomes are reviewed. Oncoplastic surgery is introduced, providing some technical details of this surgical method, indications, outcomes and complications.

In Chapter 2, the qualitative method of data analysis and evaluation are introduced. For the purpose of this study, intra-operative mentoring as a means of knowledge translation was chosen to assist with the dissemination of technical knowledge to breast surgeons already in practice, with the aim of initiating or improving the adoption of oncoplastic surgery into standard practice. The details of this intervention, the intra-operative mentorship of practicing breast cancer surgeons at the University of Western Ontario by an oncoplastic surgery-trained breast surgeon, as well as the pre- and post- intervention evaluations through semi-structured interviews with qualitative thematic analysis are also described.

In Chapter 3, the results of this mentorship trial are detailed. Study limitations and barriers to adoption of these complex techniques are also summarized.

Finally, Chapter 4 discusses the outcomes of this intervention, in terms of knowledge dissemination, as well as implications for the adoption of new and complex techniques into an existing surgical repertoire. Study limitations and barriers to adoption of these complex techniques are further expanded. Future directions for this project are also provided.

CHAPTER 2

Materials and Methods

CHAPTER 2: MATERIALS AND METHODS

The study was conducted within the Department of Surgery, Schulich School of Medicine at the University of Western Ontario, and at London Health Sciences Centre and St. Joseph's Healthcare Centre, London, ON. The study used qualitative research design, and employed Rogers' diffusion of innovation theory (Rogers 1983).

2.1 QUALITATIVE RESEARCH

Qualitative research is a method of inquiry used in many different academic disciplines (Denzin and Lincoln 2005). It encompasses a broad methodological approach that includes many research methods. While the purpose of qualitative research may vary with the disciplinary background, the methods examine or interpret phenomena in terms of the meanings that people bring to them (Greenhalgh and Taylor 1997).

2.1.1 Overview

Research in the clinical setting can be broadly divided into two techniques: those using quantitative and those using qualitative methods. Quantitative methods use measureable numeric data, attempting to answer the questions of *what* in an objective manner. On the other hand, qualitative methods focus on *how* and *why* aspects, in order to gain deep understanding of the topic by

analyzing narratives in a systemic and rigorous process, following the routes of standard scientific inquiry (Sim and Wright 2000).

Qualitative analysis is frequently used to explore new areas that have not yet been examined; it broadens the research field to include evaluations that give greater insight to both the research question and the data collection, and is usually the first step undertaken in understanding a phenomenon (the how and why of something) before quantitative research can be carried out. When applied properly, qualitative research is a valuable method used to develop theory, evaluate programs and design interventions (Baxter and Jack 2008, Choo, Garro et al. 2015).

Qualitative research has its foundation in social sciences, and the humanities — from disciplines such as anthropology, sociology, education, and history (Lingard and Kennedy 2007). The importation of methods from these disciplines into research in the clinical setting began in the 1980s, when more prescriptive theory was called for to complement the dominant paradigm of a controlled experiment.

Qualitative methods use an inductive approach to knowledge generation, allowing an individual experience to form the basis of understandings of phenomenological experiences. In the healthcare setting, qualitative research may be used to identify and describe new clinical problems, develop surveys, generate standards of care, as well as evaluate an intervention (Lingard and Kennedy 2007, Choo, Garro et al. 2015). The main differences between qualitative and quantitative methods are summarized in Table 2.1.

Table 2.1 Comparison of qualitative and quantitative studies

Adapted from Choo et al, 2015.

CHARACTERISTIC	QUALITATIVE	QUANTITATIVE
Nature of concept	Unfamiliar, poorly defined	Clearly defined
Main goals of the study	Gain in-depth understanding	Obtain detailed numerical description or functions of a representative sample. Find generalizable results.
Types of Measurement	Exploratory, formative, confirmatory	Structured; hypothesis-driven, with intent to test hypothesis
Data Collection	Flexible, to allow in-depth understanding and discovery of the unexpected. Questions posed to participants can be modified in the course of the study.	Validated; repeatability of measure is important. Research questions and measures decided *a priori*, not subject to change.

Table 2.1 Comparison of qualitative and quantitative studies – con't

CHARACTERISTIC	QUALITATIVE	QUANTITATIVE
Data Collection (con't)	Typically concludes when data saturation is met and no new information is discovered.	Concludes at an established sample size.
Data Analysis	Iterative; used to modify research questions for ongoing study	Constructed *a priori*; not influenced by data collection.

2.1.2 Types of Qualitative Designs and Research Questions

Qualitative research design allows multiple methodological approaches to be used in order to understand complex situations. Widely used designs include narrative research, case study, grounded theory, phenomenology and participatory action research (Cresswell 2007) (Table 2.2).

Key features of a qualitative research study design include the sampling framework employed, the data collection methods, types and sources used, and the data analysis methods undertaken. Qualitative research designs more often than not evolve during data collection and analysis (Devers 1999). Therefore, it is critical to remember that it is the research question that drives the research approach as well as the data collection methodology.

Qualitative research has several recognizable characteristics, and is frequently done in natural settings, usually as part of an observation or analysis of the behaviour of an individual or a group. This observation is then presented with a description rich with both detail and insight into the setting (Pope and Mays 2000).

2.1.3 Types of Qualitative Data Collection Methods

Qualitative researchers face many choices for techniques to generate data. These range from grounded theory development and practice, narratology, storytelling, state/governmental studies, research and service demonstrations, to focus groups, case studies, participant observation, qualitative review of statistics in order to predict future happenings, or shadowing (Choo, Garro et al. 2015).

Table 2.2 Research questions and their qualitative design.

Adapted from Cresswel et al, 2007.

TYPE OF RESEARCH QUESTION	QUALITATIVE DESIGN
Chronological/story-oriented questions: Questions about the life experiences of an individual and how they unfold over time	Narrative research
In-depth; descriptive questions: Questions about developing an in-depth understanding about how different cases provide insight into an issue or unique case	Case study
Process questions: Questions about experiences over time or changes that have stages and phases	Grounded theory
Essence questions: Questions about what is at the essence that all people experience about phenomenon	Phenomenology
Community action questions: Questions about how changes occur in a community	Participatory action research

Qualitative research is there to explore and develop a hypothesis, whereas quantitative research is structured and aims to confirm a hypothesis. While quantitative research is inductive, qualitative research is deductive. Quantitative research quantifies variations and determines cause and effect with closed questions, whereas qualitative research describes variation and group norms with open-ended questions. Data within the qualitative method is verbally focused while quantitative data is numerically focused. Thus, the study designs of the two methods are quite different: within quantitative research, the study design is set and does not change, whereas qualitative research allows the design to emerge and evolve based on the research findings.

2.1.3.1 Data Collection Models

The collection methodology is always driven by the research question. Sometimes, a number of different techniques are needed to gather enough data for a complete picture. Data collection models most often used in qualitative research include the interview, focus group, written narratives, observations and document reviews (Sullivan and Sargeant 2011).

The most common method used to generate data is an interview, which may be structured, semi-structured or unstructured. During the interview, the person's feelings, thoughts and experiences can be discussed with the appropriate questioning or probing by the researcher.

Group discussions or focus groups offer another way to generate data (Savin-Baden and Major 2013). The focus group usually includes about 8-10

people from whom information pertinent to the research is elicited; the information (including confirmation or clarification) is usually documented and coded later.

Written narratives require the person writing the narrative to critically reflect on the circumstances or events being studied.

Simple observations can also be used to gather data; however, the person observing a group needs to be aware of their personal bias so as not to interrupt the flow of the group being observed (Savin-Baden and Major 2013).

Finally, document review can also be used for data gathering. Although important, the review of documents does not appear to involve the human quality found in most of the other data collection methods. Yet, clearly it is needed in some instances, e.g. background information to the research (Savin-Baden and Major 2013).

2.1.4 Qualitative Interviewing

Qualitative data collection that involves interviewing can be broadly subdivided into three categories: structured, semi-structured or unstructured (Gill, Stewart et al. 2008). Structured interviews are relatively quick and easy to administer. Usually, they are verbally administered questionnaires asking a list of predetermined questions, with little or no variation, and with no scope for follow-up questions to responses that warrant further elaboration. Structured interviews may be of particular use if clarification of certain questions is required, or if there is likely to be literacy or numeracy problem with the respondents. However, their

nature only allows for limited participant responses, thus they are of little use if 'depth' is required (Gill, Stewart et al. 2008).

Unstructured interviews do not reflect any preconceived theories or ideas. They are performed with little or no organization, and very time-consuming (often lasting several hours). This makes them difficult to manage and to participate in, as the lack of predetermined interview questions provides little guidance on what to talk about (which many participants find confusing and unhelpful) (May 1991). The interview may start with a simple opening question, and will then progress based upon the initial response. Their use is generally only considered where significant 'depth' is required, or where virtually nothing is known about the subject area (or a different perspective of a known subject area is required) (May 1991).

Semi-structured interviews consist of several key questions that help to define the areas to be explored. At the same time, they allow the interviewer or interviewee to diverge, in order to pursue an idea or response in more detail (Pope and Mays 2000). They are usually scheduled in advance at a designated time and location, usually taking between 30 minutes to several hours to complete, and are only conducted once for an individual or a group. This interview format is used most frequently in healthcare, as it provides participants with some guidance on what to talk about. The flexibility of this approach allows for the collaboration between investigator and participants, and the elaboration of information that is important to participants, but may not have previously been thought of as ‘pertinent’ by the research team (Gill, Stewart et al. 2008).

2.1.5 Thematic Analysis of Qualitative Data

Thematic analysis, one of the foundational evaluation methods in qualitative research, is defined as a technique for identification, analysis and reporting of patterns (i.e. themes) within data. The method is characterized by its flexibility: it allows the researcher to develop a rich and detailed set of data in order to understand the phenomenon in question. This makes it ideal for use in new or under-researched areas. The advantages include flexibility, ease of learning, ease of access to researchers with little qualitative research experience, and the ease of access of the results to general public (Braun and Clarke 2006) (Table 2.3).

Themes are defined as patterns across data sets that are important to the description of a phenomenon, and are associated to a specific research question (Fereday and Muir-Cochrane 2006). Therefore, the themes become the categories for analysis.

2.1.5.1 Steps Undertaken to Perform Thematic Analysis

Thematic analysis is performed through the process of coding in six phases to create established, meaningful patterns: familiarization with data, generation of initial codes, search for the themes among codes, review of themes, definition and naming of themes, and production of the final report (Braun and Clarke 2006) (Table 2.4).

Table 2.3 Advantages of thematic analysis.

Adapted from Braun and Clarke 2006.

ADVANTAGES

- Flexibility
- Relatively easy and quick method to learn and do
- Accessible to researcher with little or no experience of qualitative research
- Results are accessible to educated general public
- Useful method for working within participatory re-search paradigm, with participants and collaborators
- Can usefully summarize key features of a large body of data, and/or offer a ‘thick description’ of the data set
- Can highlight similarities and differences across the data set
- Allows for social as well as psychological interpretations of data
- Can be useful for producing qualitative analyses suited to informing policy development

Table 2.4 Steps in Thematic Analysis

Adapted from Braun and Clarke 2006.

PHASE	ACTION	DESCRIPTION
Phase 1	Familiarizing oneself with one's data	Transcription of data (if necessary), reading and re-reading the data, noting ideas
Phase 2	Generation of initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code
Phase 3	Search for themes	Collating codes into potential themes, gathering all data relevant to each theme
Phase 4	Review of themes	Checking if the themes work in relation to the coded extracts and the entire data set, generating a thematic 'map' of analysis
Phase 5	Definition and naming of themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme
Phase 6	Producing report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report

2.1.5.1.1 Familiarize Yourself with the Data

In this step, the researcher should be looking for potential patterns and themes. It can be started as soon as the data collection begins, using an iterative process, hand-in-hand with the transcription of the data source. Prior to reading the interview transcripts, researchers may create a ‘start list’ of potential codes.

2.1.5.1.2 Coding Process

Codes identify a feature of the data that appears interesting to the analyst. It refers to the most basic segment (element) of the raw data or information that is to be assessed in a meaningful way regarding the phenomenon. The coding process evolves through an inductive analysis and is not considered to be a linear process, but a cyclical one, in which codes emerge throughout the research process. The cyclical process involves going back and forth between phases of data analysis as needed, until one is satisfied with the final themes (Braun and Clarke 2006). Coding and data organization can be performed manually or using computer software (e.g. MAXQDA, XSight, NVivo).

2.1.5.1.3 Search for Themes

This phase involves sorting initial codes into potential groups (themes) and collation of all relevant data within the groups (Braun and Clarke 2006). Searching for themes and considering what works and what does not work within themes enables the researcher to begin the analysis of potential codes. It is important to begin by examining how codes combine to form over-reaching

themes in the data. At this point, researchers have a list of themes and begin to focus on broader patterns, combining coded data with proposed themes. Researchers also begin considering how relationships are formed between codes and themes and between different levels of existing themes.

Themes differ from codes: themes are phrases or sentences that identify what the data means, describing an outcome of coding for analytic reflection.

2.1.5.1.4 Revision and Confirmation of Themes

In this step, the initial candidate themes are reviewed. The phase requires the researchers to search for data that supports or refutes the proposed theory. At this point, the researcher has to decide which theme will have enough codes to support them, and/or which ones might be combined (Braun and Clarke 2006). Codes within themes should cohere together meaningfully, while there should be clear and identifiable distinction between themes.

By the end of this phase, researchers have an idea of what themes are and how they fit together so that they convey a story about the data set.

2.1.5.1.5 Definition of Themes

The following step is to define, refine and name the themes that will be presented in the final analysis. Identification of the essence of what each theme represents, what aspects of data each theme captures and how each specific theme affects the entire picture of the data is the most important part (Braun and Clarke 2006).

It is important to consider themes within the whole picture and also as autonomous (i.e. each theme separately), in order to identify whether current themes contain sub-themes and to discover further depth of themes. Researchers conducting thematic analysis should attempt to go beyond surface meanings of the data to make sense of the data and tell an accurate story of what the data actually means.

2.1.5.1.6 Writing Report

The last phase of thematic analysis, following the review of final themes, is the production of the final report, presenting data analysis in a convincing and clear way (Braun and Clarke 2006). While writing the final report, researchers should decide on themes that make meaningful contributions to answering research questions, to be refined later as final themes. The goal of this phase is to write the thematic analysis to convey the complicated story of the data in a manner that convinces the reader of the validity and merit of the analysis: a clear, concise, and straightforward logical account of the story across and with themes to make the readers understand the final report. The write-up of the report should contain enough evidence demonstrating that themes within the data are relevant to the data set.

A fifteen-point checklist was developed by Braun and Clarke (2006) to summarize the thematic analysis, and to simplify the review process for researchers (Table 2.5).

Table 2.5 Fifteen-point check list for thematic analysis.

Adapted from Braun and Clarke (2006).

PROCESS	CRITERIA
Transcription	1. The data have been transcribed to an appropriate level of detail, and the transcripts have been checked against the tapes for 'accuracy'.
Coding	2. Each data item has been given equal attention in the coding process. 3. Themes have not been generated from a few vivid examples (anecdotal approach); instead, the coding process has been thorough, inclusive and comprehensive. 4. All relevant extracts for each theme have been collated. 5. Themes have been checked against each other and back to the original data set. 6. Themes are internally coherent, consistent, and distinctive.
Analysis	7. Data have been analyzed, interpreted, made sense of rather than just paraphrased or described. 8. Analysis and data match each other, the extracts illustrate the analytic claims. 9. Analysis tells a convincing and well-organized story about the data and topic. 10. A good balance between analytic narrative and illustrative extracts is provided.
Overall	11. Enough time has been allocated to complete all phases of the analysis adequately, without rushing a phase or giving it a once-over-lightly.
Written report	12. The assumptions about, and specific approach to, thematic analysis is clearly explicated. 13. There is a good fit between what you claim you do, and what you show you have done. 14. Language and concepts used in the report are consistent with the epistemological position of the analysis. 15. The researcher is positioned as active in the research process: themes do not just 'emerge'.

2.1.6 Challenges of Qualitative Research

Just like any research model, qualitative research has to overcome some challenges: determination of a conceptual framework that is thorough, concise and elegant; development of a design that is systemic and manageable, but remains flexible; integration of these into a coherent unit (Marshall and Rossman 1999).

There is the perception within medical research suggesting that qualitative research is cumbersome and difficult to analyze. Some also suggest that analysis requires a high degree of interpretive skills, and that the number of participants being studied is too small (Pope and Mays 2000). However, this should not become an issue, provided that the data analysis is done well.

Often, due to misunderstandings about the nature of qualitative methods and their use in healthcare, qualitative research is labelled as 'unscientific'. Finally, the most frequent criticism is the subjective nature of qualitative research, implying that 'subjective' equals 'biased' or 'prejudicial'. However, subjectivity stems from the fact that the researcher is also the tool that gathers data. Many qualitative tools are in place, and when used concurrently, they can guard against overly subjective research or identify the role of the researcher in the data collection (Pope and Mays 2000).

2.2 KNOWLEDGE TRANSLATION

Due to its relevancy to the data analysis process (see Section 2.5, below), the description of Knowledge Translation is included in this part of the thesis.

Knowledge translation (KT) is a “dynamic and iterative process that includes the synthesis, dissemination, exchange, and ethically sound application of knowledge to improve the health of patients, provide more effective health services and products, and strengthen health care systems” (Rogers 1983). Many methods of KT exist, including continuing medical education, clinical practice guidelines and systematic reviews, audit, feedback, and reminders, educational outreach, reward and punishment programs, and operative demonstrations. Previous studies have demonstrated that the majority of the above methods have done little to change physician practice. This has led to the conclusion that physicians are reluctant to change their practice, and that improved KT interventions are necessary.

2.2.1 Diffusion of Innovations

Diffusion of innovations is a theory within KT, popularized by Rogers (1983), that pursues an explanation of how, why, and at what rate new ideas and technologies spread (Rogers 1983). Rogers argued that diffusion is the process by which an innovation is communicated over time among the participants in a social system.

The theory proposes that four main elements influence the spread of a new idea: the innovation itself, communication channels, time, and a social system. The process relies heavily on human capital, and must be widely adopted in order to self-sustain. The rate of adoption (defined as the relative speed at which participants adopt an innovation) is usually measured by the

length of time required for a certain percentage of the members of a social system to adopt an innovation. The rates of adoption are determined by an individual's adopter category. In general, individuals who first adopt an innovation require a shorter adoption period (adoption process) when compared to late adopters. At some point, critical mass will be reached within the adoption curve (Rogers 1983), ensuring that the innovation is self-sustaining.

Five categories of adopters have been identified: innovators, early adopters, early majority, late majority, and laggards (Rogers 1983). Diffusion manifests itself in different ways, thus being highly subject to the type of adopters and innovation-decision process. The criterion for the adopter categorization is innovativeness, defined as the degree to which an individual adopts a new idea.

The process of diffusion entails a five-step decision making system. Adoption occurs through a series of communication channels over a period of time among the members of a similar social system. Integral to the theory are Rogers' five stages of the process: awareness (knowledge), interest (persuasion), evaluation (decision), trial (implementation), and adoption; an individual might reject an innovation at any time during or after the adoption process (Rogers 1983).

2.2.1.1 Process of the Adoption of Innovation

The first stage (Knowledge) occurs when the individual is first exposed to an innovation, but lacks information about it. During this stage, the individual has not yet been inspired to find out more information about the innovation.

The second stage (Persuasion) occurs when the individual is interested in the innovation and actively seeks related information/details.

The third stage (Decision) occurs when the individual takes the concept of the change, weighs the advantages/disadvantages of using the innovation and decides whether to adopt or reject it. Due to the individualistic nature of this stage, this stage is the most difficult one on which to acquire empirical evidence.

During the fourth stage (Implementation), an individual employs the innovation to a varying degree, depending on the situation. It is during this stage that the individual determines the usefulness of the innovation, and may search for further information about it.

Finally, during the fifth (last) stage (Confirmation), the individual finalizes his/her decision to continue using the innovation. The stage is both intrapersonal (may cause cognitive dissonance) and interpersonal, and confirms that the group has made the right decision.

2.2.1.2 Failed Diffusion

Just because a diffusion failed, it does not mean that the innovation was adopted by no one; rather, failed diffusion often refers to diffusion that does not reach or approach 100% adoption. This is most likely due to its own weaknesses, competition from other innovations, or simply a lack of awareness. From a social networks perspective, a failed diffusion might be widely adopted within certain clusters, but fail to make an impact on more distantly related people. In addition,

over-connected networks might also suffer from a rigidity that prevents the changes an innovation might bring.

2.3 STUDY SETTING

This study, conducted at the London Health Sciences Centre and St. Joseph's Healthcare Centre, in London, ON, Canada, was approved by the Research Ethics Board at the University of Western Ontario (Appendix I). Informed consent was obtained from each participant prior to the beginning of the study.

In this study, we focused on a process question, exploring the dissemination of new knowledge (oncoplastic surgical techniques) to practicing surgeons, and how intra-operative mentoring as the mode of knowledge dissemination might change their already-established surgical practice. The main purpose was to examine the barriers and opportunities for adopting new techniques (such as oncoplastic surgery) at the University of Western Ontario, and to test the perception of those techniques by the surgeons before and after a period of intra-operative mentoring.

Six surgeons participated in the study. Participants were selected from a group of attending general surgeons practicing breast surgical oncology at the University of Western Ontario. All breast general surgeons in London, Ontario agreed to participate in this study. The surgeons represented a spectrum of experience in breast surgery (both in volume of breast surgeries and years in

practice, ranging from first year of practice to almost 20 years of practice). All surgeons had subspecialty training in breast surgical oncology, or special interest in breast surgery; they worked on daily basis at three different locations across the City of London, ON (London Health Sciences Centre – University Hospital, London Health Sciences Centre – Victoria Hospital and St. Joseph's Healthcare Centre's Breast Centre). Most breast cases used for the intra-operative mentoring were seen, and had the appropriate surgical planning done, at St. Joseph's Healthcare Centre. Surgeons were invited to participate in the study via e-mail invitations, sent by the principal investigator.

2.4 DATA COLLECTION

An interview guide (pre-intervention and post-intervention, Tables 2.5 and 2.6, respectively) was compiled by the principal investigator, based on similar topics in the literature, as well as the data provided by other studies (Ritchie, Lewis et al. 2013). The initial guide was approved by the research team, and was adjusted throughout the process of data collection as needed. It was designed in semi-structured format with an open-ended question, to facilitate guiding the purpose of the study.

All materials (study proposal, letter of information (Appendix II), details of the study, consent forms) were sent to participating surgeons via e-mail. All interviews were conducted by the principal investigator at one of the three above-mentioned hospitals where the surgeons practice, according to their availability.

Table 2.1. Pre-Intervention Interview Guide.

1. What kind of surgeries do you perform in your practice? Which ones do you consider yourself particularly experienced with and interested in?
2. What is your opinion about oncoplastic breast surgery? What patient population you think will be suitable for oncoplastic techniques?
3. What do you think would be the expected outcome from changing the current practice to accommodate those new techniques?
4. What are your thoughts about the balancing procedure during and after the oncoplastic surgery?
5. Have you performed this procedure in your practice? If so, how was your experience? If not, in your opinion, what are the barriers in applying oncoplastic techniques to your daily surgical practice?
6. Would you be interested in exploring more about these techniques... why? If you are interested, in your opinion, what would be the best way to explore and learn more about these techniques? Are there any courses you know about or will be interested to join in order to learn more about oncoplastic surgery?

Table 2.1 – con't.

7. How useful do you think this surgical technique will be in the future and should it be part of the training curriculum for residents?
8. Would you directly recommend this technique to your patients or do you refer your patients to an oncoplastic surgeon for a conversation about it? What's the main criteria you follow for doing either?

Table 2.2. Post-Intervention Interview Guide.

1. Can you tell me about your breast practice in the last few months.
2. Can you tell more about any changes after a period of intra operative mentoring and discussion of various oncoplastic techniques. (impact of intraoperative mentoring).
3. If there are any changes, how would you explain them?
4. What do you think or how do you see oncoplastic surgery now from your prospective?
5. During this period, how frequently did you think oncoplastic techniques were an option for your patients?
6. Can you elaborate more on the techniques you have tried?
7. Can you tell me about the patients' perception and interest in oncoplastic surgery and how did it change their perception of surgery?
8. What do you think were the barriers to adopt these techniques, in your opinion?

Table 2.2 – con't.

9. With the current health system in Canada, what would be the future of oncoplastic surgery?
10. How do you think we can advance our knowledge and skills in oncoplastic surgery and how would this change your future practice?

On the day of the interview and prior to its conduction, the study purpose, requirements and stages were explained in detail to the surgeons. Consent forms were reviewed, and all questions that may have arisen were answered.

2.4.1 Pre-Intervention Interview

Each surgeon was instructed to answer the questions within their comfort level, and to ask for any explanations as necessary. They were also informed of having the right to refuse to answer any of the questions, or request that the recording be stopped if the need was felt. All interviews were recorded with two recording devices. Each interview lasted approximately 45-60 minutes, with questions adjusted according to the flow of the discussion.

2.4.2 After the Pre-Intervention Interview

Following the pre-intervention interview, a 6-week period of mentorship was allocated for all the surgeons. During this period, a detailed discussion and intra-operative illustration of different oncoplastic techniques was carried on. The principal investigator, who is also a mentor, reviewed each surgeon clinic and operation list to find the possible candidates for oncoplastic surgery, then make themselves available at the time booked for the patient to meet with his surgeon to have a more detailed discussion and hands on teaching on the planning required to perform oncoplastic techniques. At the same time, surgeons were advised to contact the principal investigator for any possible cases that may

benefit (in their opinion) from oncoplastic surgery to have further discussion about it.

In the clinic, the principal investigator of the study then discussed the clinical picture of the patients, and the feasibility of certain techniques with the surgeon. After reaching an agreement/consensus about the procedure to be used for the treatment of that patient, the patients themselves would then participate in the discussion and the plans for their surgery. Patients were informed about the planned surgical technique. Once the patient approved and signed the informed consent, all other pre-operative procedures were carried out as usual.

On the day of the operation, the surgeon reviewed the plan with the principal investigator and the patient, including pre-operative markings. The procedure started with a timeout announcement, stating the oncoplastic procedure that was planned (Kozusko, Elkwood et al. 2016). During the surgery, discussions continued with the individual surgeon, providing explanations of different possibilities and options, as well as the intra-operative techniques. Post-operative care of the patient continued as usual, with the post-operative period instructions provided to the patient.

Following the six weeks of mentoring, all surgeons were given a period of two months to apply the different technique and practice to the appropriate patients of their selection in their clinical practice. It is important to note that the principal investigator, who was also the mentor in this study, is fellowship-trained in breast oncology and reconstruction, and an oncoplastic surgeon who

previously attended numerous master classes and courses of oncoplastic surgery in Europe and the United States. The mentor was a fellow in Breast Surgical Oncology in London, Ontario and was working with all the participant surgeons during the time this study was conducted.

2.4.3 Post-Intervention Interview

The second round of interviews was carried out by the principal investigator, as a follow-up to the period of mentoring. As before, the interviews were carried out across all three hospital sites at the times convenient to each surgeon. The interviews had an identical, semi-structured format as before, and lasted approximately 15-30 minutes. The post-interview guide was more focused on the period of mentoring and various oncoplastic surgery techniques.

2.5 DATA ANALYSIS

A professional transcription services centre transcribed the interviews. All interviews were anonymized, to preserve the confidentiality of each study participant. The principal investigator reviewed all transcripts for accuracy, before they were analyzed.

The interview transcripts were analyzed using a coding process with three iterative phases, as described in thematic analysis (section 2.1.5). Based on the first two interviews, the principal investigator used the initial coding to identify the

Themes were applied to the next two transcripts, to refine and expand the developing categories. Following further team discussion, preliminary categories were iteratively developed and refined by analyzing the entire dataset. True to the iterative nature of constant comparative analysis (Charmaz 2006), additional initial codes were also added. Theoretical coding then enabled for more explicitly linking categories, and to theoretically conceptualize findings. As the analysis evolved, the theoretical coding was blended with notions from the diffusion of innovation theory that were used as sensitizing concepts.

The ‘sensitizing concept’ was referred to by the sociologist Charmaz (2006) as “those background ideas that inform the overall research problem”. The concept is normally used as a starting point in qualitative research, where usually there is no hypothesis, but rather a way to discover and understand an experience, or a phenomenon (Bowen 2006).

The principal investigator debriefed with all the team members at each stage of the analytical process (Thurmond 2001), to ensure rigor, credibility, originality, resonance and usefulness of the data generated (Charmaz 2006).

CHAPTER 3

Results

CHAPTER 3. RESULTS

This study was designed to identify and understand factors that contribute to the slow uptake of oncoplastic surgery, both broadly within the Canadian healthcare context and specifically, at the University of Western Ontario in London. The results that emerged from the qualitative analysis of this surgical mentoring intervention, described in the previous chapter, are presented.

The intervention was conducted over a six-week period, and consisted of perioperative mentoring with pre-surgical discussion, intra-operative guidance and post-operative feedback. In order to assess the appropriateness and effectiveness of the intervention as a method for teaching new surgical skills to practicing surgeons, pre-intervention interviews were conducted to assess the prior knowledge of each participant, and to gain an understanding of their specific perceptions and willingness to incorporate oncoplastic techniques into their practice. Post-intervention interviews were conducted two months after the conclusion of the intervention, to assess how surgical mentorship affected participants' knowledge of oncoplastic surgery, their perceptions of its usefulness and their degree to which the new surgical techniques were incorporated into their practice.

3.1 PRE-INTERVENTION INTERVIEWS

The pre-intervention interviews generated significant insights into the pre-existing knowledge that participants held about oncoplastic surgical techniques,

their perceptions of the outcomes and their willingness to incorporate them into their surgical practice. Participants were also asked to reflect generally on their breast cancer practice, as well as on the various surgical techniques they routinely employ. The pre-intervention interviews provided rich descriptions of the ways that the participating general surgeons understand, manage and treat breast disease. The results suggest that there are important differences in the surgical management of benign and malignant breast disease, and that these approaches are, in part, a reflection of the outcomes prioritized by surgeons for each condition. While cosmetic outcome was described as being a central concern in the management of benign breast disease, the outcome was not considered to be as important in the treatment of malignant breast disease. In the case of malignancy, surgeons prioritized an adequate resection with negative margins over cosmetic outcome. Although the appearance of the post-surgical breast was not of primary importance in malignant cases, the surgeons indicated that they used cosmetically appealing incisions whenever possible.

Despite the fact that aesthetics were not of primary importance, the surgeons interviewed in the study consistently described the overall cosmetic outcome in malignant cases as being generally good. However, participants conceded that in the cases of large cancers, standard lumpectomy techniques are not able to yield an acceptable cosmetic outcome; in these cases, mastectomies are often performed. These were the cases that figured centrally in the discussion of the pre-intervention interview, during which the participants were prompted to reflect on the appropriateness and effectiveness of oncoplastic

surgical techniques in cases where the standard procedures cannot yield optimum cosmetic outcomes.

During the pre-intervention interview, it was established that oncoplastic surgery was a term known to all participants. Each surgeon was asked to define oncoplastic surgery, as well as to describe how he/she understood the practice and the techniques with which it is associated. The results indicated that the general surgeons interviewed did not share a single, uniform understanding of oncoplastic surgery. The participants had varying levels of knowledge and different understandings of oncoplastic surgery. Across the various definitions, however, oncoplastic surgery was consistently described as a practice that is associated with improved cosmetic outcomes. Participant 6 defined oncoplastics as an evolving sub-specialty that prioritizes the aesthetic appearance of the breast:

> *"I view it as a blend between general surgery and plastic surgery, sort of an evolving subspecialty of surgical oncology. It's using plastic techniques to try to improve the outcome cosmetically for patients."*

Similarly, participant 1 explained that oncoplastic surgery as a complex surgical practice that is both "oncologically safe" and breast conserving:

> *"Generally, oncoplastic surgery to me means performing an oncologically safe surgery on the breast that generally involves breast conservation using plastic surgery techniques that optimize the cosmetic outcome at the same time, which generally means trading more extensive surgery or scars for a better shaped breast."*

The definition offered by the participant 2 also highlighted the centrality of aesthetic outcomes in oncoplastic surgery, but also emphasized that its scope is

limited to the malignant breast, clearly separating oncoplastic techniques from those associated with plastic surgery:

> "*To me, oncoplasty means techniques of doing a cancer operation with a better cosmetic outcome, but in my mind, this is not talking about reconstruction. This is talking about dealing with the procedures in the native breast."*

The various definitions of oncoplastic surgery provided by the surgeons interviewed in the study were consistent in their acknowledgement of the hybrid nature of the practice, its relationship with plastic surgery, and the cosmetic benefits associated with it. However, the relationship between the elements and the ways that they figured within the definitions was diverse. Our findings indicate that the practice of oncoplastic surgery has yet to be integrated and incorporated into surgical practice in London, Ontario in a meaningful way. Furthermore, the differences between the definitions also provide an important insight into the surgeons' knowledge and perceptions of this nascent sub-specialty.

3.1.1 Knowledge of Oncoplastic Surgery

The pre-intervention interviews provided important insights into the level of technical knowledge the general surgeons had about oncoplastic surgery. The knowledge base of participants was varied, and while some surgeons reported a general familiarity with the practice and its basic techniques, others also related specific information about oncoplastic techniques and their clinical applicability. For example, participant 1 demonstrated their knowledge of oncoplastic

techniques through their description of the characteristics of level 1 and level 2 techniques:

> *"I use the nomenclature that I think pretty standard for what we call oncoplastic surgery, which is differentiating breast conserving surgery into small lumpectomies with a volume loss of less than 20%, where if the breast tissue is not too fatty, the skin and chest wall layers can be mobilized so that the intervening gland can be primarily closed to close the defect. And level II where the defect is closed, but additional skin is taken and the nipple is recentralized in order to create a smaller, but balanced and cosmetically pleasing breast mound."*

This participant had a keen interest in oncoplastic surgery, and also reported using specific level 1 techniques such as a 'glandular closure,' in their pre-intervention practice, as well as some more complex level 2 techniques, such as nipple recentralization.

In sharp contrast to the specific knowledge of oncoplastic techniques by participant 1, other participants had very cursory knowledge of oncoplastic surgery and no knowledge of specific techniques. For example, participant 3 described their understanding of oncoplasty in very general terms, stating:

> *"It means respecting the oncologic needs of the surgery, so first and foremost not to compromise your margin. Oncologic safety is the first consideration, but within that parameter, to try to achieve the best cosmetic appearance of the breast along with a safe cancer operation. I know they're divided into different levels. I can't remember if it's A, B, C or 1, 2, 3 and everybody is supposed to be able to do level 1, that's about all I know."*

The precursory nature of this participant's knowledge rendered it challenging for the surgeon to describe the clinical benefits of oncoplastic techniques and how such techniques could be applied within his/her practice. While the majority of participants reported a generally favourable opinion of oncoplasty, other

surgeons, like participant 3, expressed uncertainly about the clinical value of the practice; participant 5 overtly challenged the relevance and clinical advantage of oncoplastic surgery:

> *"People use the oncoplastic techniques, but I find it a fairly rare thing to use, that's all. I just don't identify a ton of patients that I would use it in, that's all, because there's a bunch of limitations to it. In other words, you have to have breast tissue that's reasonable, and so you have to have a patient that has reasonable breast tissue, rather than fat. I don't know, I just… I'm still struggling to understand how I would fit oncoplastic techniques into my practice. I just don't know, in my practice, that there's that many."*

Participant 5 elaborated on their opinion that oncoplastic surgery was of limited value for their practice by drawing on the specific demographics of their patient population:

> *"In other words, you have to have breast tissue that's reasonable, and so you have to have a patient that has reasonable breast tissue, rather than fat. The patients I struggle with are the DCIS patients, in an older woman on a mammogram, they're 70 years old, they got … really, all of their breast tissue is all just fat. You can't move that around."*

In the pre-intervention interview, the surgeons were asked to describe their opinions of oncoplastic breast surgery to generate insight into why the practice has yet to be substantially incorporated into their local practice. Participants were aware that oncoplastic surgery is a well-established practice in Europe, and is emerging as a standard practice. Participant 1 commented that while the speciality is "brand new to Canada," the importance of the practice is becoming apparent:

> *"It's becoming increasingly appropriate to do, but the vast majority of a blade of breast surgeons don't know how to do it and are still at the learning phase about how to modify their surgery in a way that improves*

> *the outcome aesthetically. Most surgeons probably haven't given it as much thought as they should to a good cosmetic result."*

Furthermore, participant 2, a senior surgeon with extensive expertise in breast surgery, communicated the increasing relevancy of the practice in Canada by stating:

> *"If I was training now to be a breast surgeon, I would definitely want to be able to do as much oncoplastics as the European surgeons are doing by myself."*

This view was supported by participant 1, who recently sought out and completed oncoplastic courses, to allow them to incorporate some techniques into their practice. Gaining expertise in this area was described as being important for this participant, so that the surgeon could deliver a high standard of care in their breast practice. To this effect, the surgeon stated:

> *"This procedure really should be done on almost everyone that has breast conserving surgery, barring elderly fatty replaced breasts where a simple lumpectomy of a small amount of disease could be done. But barring that, most people you could approach with either the glandular closure or a more complex type of mound revision to permit for a good breast shape while doing a lumpectomy."*

While the participant 1 and 2 deemed oncoplastic techniques to be both important and relevant for their practice, other surgeons expressed hesitancy about adopting these surgical techniques, in light of their limited knowledge of the practice. For example, participant 3, who reported attending some presentations on oncoplastic techniques, emphasized

> *"I don't consider my knowledge to be anything but superficial, though. I wouldn't like to teach or talk to a resident about oncoplastic techniques because I don't feel I have enough knowledge for that. I know there are*

> *some simple techniques, that sort of bat wing thing which I don't really understand and have never tried."*

This surgeon's reflection demonstrates how constraining are the limited exposure to oncoplastics, as well as opportunities for practicing breast surgeons to learn about and to practice, are to the possibilities for surgeons to incorporate oncoplastic techniques into their practice. This account highlights that, in order for new surgical techniques to be successfully introduced into practice, general surgeons need to have access to training incorporating opportunities to practice, and to receive feedback from experts. The finding supports the appropriateness of mentorship as a surgical intervention for teaching new techniques.

3.2 INTERVENTION: MENTORSHIP PROGRAM

The findings of the study have demonstrated that mentorship is an effective and desirable method to teach new surgical techniques in a manner that supports their adoption and incorporation into practice. Participants in the study consistently described their desire to learn new techniques from a surgeon who had expertise in that particular skillset, and who could support them during their hands-on practice. This method was described as being preferable to self-learning:

> *"When I am doing the simple things, I have looked at doing some of the things that they describe, but I don't feel that I would be happy to go ahead with that without somebody who has done that procedure and is comfortable with it with me. I don't learn very well from a book, for sure. So, I really like to do it with someone. "*

In the post-intervention interview, the surgeons were asked to comment specifically on the mentorship intervention as a method to facilitate their adoption of new techniques. The majority of responses were supportive of the use of this method as useful and efficient to educational intervention. One participant related how the hybrid approach of the mentorship provided them with a valuable, and efficient learning opportunity:

> *"I think I've had a good variety of cases, especially just having started here. When we had talked, I hadn't done very much, I don't think, at that point. I was just starting out. I've done a lot of lumpectomies, a lot of mastectomies, and decision-making around one or the other, and so on. I've had a chance to do some oncoplastic techniques, both with you in the operating room, as well as a few on my own. I think I have a better sense of who to consider for the different procedures, like the Level 1 and the Level 2. In fact, I had one lady whom I did like a therapeutic mammoplasty with Dr. X, which I felt I wouldn't have really been comfortable offering or understanding how that would go if I hadn't had any of the training, or the background I had.* "

Participant 1, who had described their interest and adoption of oncoplastic techniques in their practice during the pre-intervention interview, found that the mentorship experience affirmed their belief in the importance and relevance of oncoplasty for their practice:

> *"I think it validated it. For me, I was pretty convinced, even a bit before the intervention, but I became more certain as a result of the intervention. I really could see clearly the benefit for virtually all patients, and the benefit of discussing it with other people, in terms of coming up with ideas that I hadn't thought of. "*

Given the limited scope of the study, the mentorship intervention offered had some limitations; specifically, the length of the intervention was confined to six weeks. Given the unfamiliarity and complexity of oncoplastic techniques,

study participants reported that the period of mentorship was not sufficient to familiarize themselves with all oncoplastic techniques, particularly those that are used infrequently. Moreover, the incorporation of oncoplastic techniques into surgical practice was complicated by the degree of both knowledge and imagination involved in the clinical decision-making process. Reflecting on the limitations of the intervention, one participant commented:

> *"I suspect that if you were mentoring someone over a period of six months or so, you probably would get a couple of examples of the basic techniques to try, like to practice on during that amount of time. I felt as though I had seen a lot of useful techniques that I could learn, but I didn't quite feel confident in trying them without someone there to say yeah, you're doing it, that's the right way, that kind of thing."*

3.3 POST-INTERVENTION

At the conclusion of six weeks of perioperative mentoring and discussion, participants returned to their own practices, where they incorporated the application of the new techniques they had learned. A second round of interviews was conducted following a two-month interval, to gain an understanding of how the period of mentoring and introduction of oncoplastic surgery affected the practices of the breast surgeons.

The surgeons enrolled in the study reported that mentorship increased their knowledge of oncoplastic surgery, and provided them with an opportunity to familiarize themselves with previously unknown surgical techniques, while also gaining the confidence to apply the new skills in their breast practice.

Participant 2, for example, described how they incorporated skin excision and measurement techniques introduced to them during mentorship into their practice in the eight weeks following the intervention:

> *"So, before that, I had not had a lot of experience doing anything that involved removing skin. I had done some moving breast flaps underneath and closing dead space, but I had not done measurements or skin excision. So, in the last two months, I did several cases where I did a circumareolar excision of the skin, so basically a reduced volume of the breast. And I did some with a wing excising some of the lateral breast, and then actually doing elliptical incision around the nipple to move the nipple and adjust for the shape and the volume reduction."*

For this participant, the period of mentorship was an effective intervention because it increased their knowledge of oncoplastic surgery, as well as the advanced technical skills required to successfully implement their new knowledge. Similarly, participant 6 described implementing sophisticated oncoplastic techniques during the post-intervention period that they had not previously used in their breast practice:

> *"I had done a couple racket-type incisions or racket-type procedures for tumors in the upper outer and lateral, like lateral aspect of the breast."*

The results of the study also suggest that surgical mentorship was an effective intervention for improving surgeons' knowledge of the clinical advantages of oncoplastic surgery and the specific clinical contexts in which the techniques can be optimally applied. Participant 2 reflected that during the period of mentorship, their understanding of relevance of oncoplastic surgery in their breast practice improved:

> *"I think it offers advantages that I did not see in the past, and it would involve a greater percentage of women than I thought in the past. So, my*

> *general feeling is that a surgeon who does breast surgery in a reasonably large volume would be motivated enough to do this surgery to see the good results."*

In addition to recognizing the broad applicability of the techniques for the general patient population, participant 2 also described how the surgeon had come to see oncoplastic surgery as worthwhile practice for busy breast surgeon's practice, and more importantly, as a set of techniques that could increase the satisfaction of both patients and surgeons:

> *"I think that, basically, a lumpectomy is not a very rewarding operation for a surgeon. There's no nice anatomy. There are no nice landmarks. It's not a beautiful procedure, so oncoplasty does offer a little bit more of a challenge to the procedure, and a little more of the person's input into the operation, so that can be rewarding."*

Participant 6 reflected that, as a result of the mentorship and their increased knowledge of oncoplastic techniques, they have incorporated more breast conserving techniques into their practice, reducing the number of mastectomies they perform:

> *"Now I know what other possibilities I can offer a patient, or at least I've got more possibilities, anyway. It will, for sure, change my practice because I will be continuing to think about ways that, if I have to do a very large lumpectomy, I will feel like 'well, it's not necessary, how can we avoid a mastectomy for this patient'. And so, I don't know that I would have necessarily always gone that route in my thinking before having had this period of a little bit of learning, both with the material given and the one-on-one, and the feedback and things like that."*

Participant 5, who had reported in the pre-intervention interview that they did not see the relevance of oncoplastic surgery for their practice, described post-intervention how their increased knowledge of the techniques enabled them

to identify specific cases in their practice for which oncoplastic surgery would be beneficial. The participant described how the surgeon successfully incorporated the techniques into the treatment of a younger patient:

> *"Well, I tried one of the oncoplastic techniques. I think it was a racket… well, I was happy with the way it turned out. I could see the benefit in that particular young woman. I still think it has limited applicability, but just to identify the cases that it would work in is fine. I still think there's just a small proportion of the women that would really benefit from it."*

However, despite the account of their successful application of oncoplastic techniques in their practice, the opinion of participant 5 was not fundamentally transformed in terms of relevance of oncoplastic surgery to their practice.

3.3.1 Effect

In the post-intervention interviews, participants were asked to reflect on how the intervention and their training in oncoplastic techniques might affect their breast surgery practice in the future. The results indicate that the mentorship intervention enabled surgeons to identify cases where oncoplastic techniques could improve cosmetic outcomes, enabling them to optimally incorporate the new techniques into their surgical plans. Participant 6 described how the perioperative discussions and surgical mentorship during the intervention provided them with an opportunity to confidently incorporate the new knowledge into their practice and consultations with patients. The surgeon related that before the intervention:

> *"I wouldn't have really been comfortable offering or understanding how that would go, if I hadn't had any of the training, or the background I had. Which is not extensive, but at least I'm thinking about it in a different way*

> *because, otherwise, this woman would have had a mastectomy for sure, no questions asked, had we had not gone that other route."*

Participant 3 described how the surgical intervention and their increased knowledge of oncoplastic surgery had made breast conservation as more central consideration in their preoperative planning. In particular, the surgeon related how their clinical decision-making practices altered for patients presenting with large cancers who may benefit from oncoplastic techniques:

> *"I think it probably increased my willingness to try to, for instance to preserve the nipple area where a complex one, that something was a little bit close. And as I said for lower, not just lower poles six o'clock lesions but anything in the lower half of the breast I've changed my way of looking at those. I used to say 'well, if it's too small a breast it's just going to be a disaster and I should just do a mastectomy' and now I'm thinking I should at least talk to somebody about whether an oncoplastic technique could be used to do a breast-conserving operation."*

While the mentoring intervention increased the surgeons' knowledge of level 1 and 2 oncoplastic techniques, the findings suggest that continued mentorship and support are required for the successful integration of these into practice. For example, participant 1 was hesitant to complete advanced procedures by themselves, and adopted the strategy of combining their more complex surgical cases with the plastic surgery team in order to access continued support:

> "*I still don't feel comfortable doing what I would call level 3 cases by myself. I think I now feel comfortable to do a variety of level 2 oncoplastic procedures, where you are reducing some of the skin envelope as well as the lumpectomy. But the reduction by myself, I don't feel comfortable yet with the markings, I don't have enough experience to really do it totally by myself. Because I have a plastic surgery backup, I've been really making all of those cases be combined cases, and it has worked out really well, I think."*

Participant 1 further reflected on the challenges the surgeon experienced incorporating oncoplastic techniques, and identified moments where continued mentorship would have provided them with both, the support to be 'brave' in the operating room and the assistance they needed to work through the difficulties that arose during the surgical procedure:

> *"I found sometimes that it was more challenging than I thought, where I would rotate the glandular rotation and it doesn't quite fill the defect. Or it fills it, but it's still rumpley-looking and I just don't have the volume experience to be comfortable that it will settle out, and so I worry that there's going to be excess fat necrosis or volume loss or contour deformity, and I worry that I haven't done it right or sufficiently well. Those things made me hesitate probably more than I should. I don't feel brave necessarily to embark on big contour changing procedures and, for that reason, I haven't been brave enough to do my own breast reductions on the affected cancer side fully alone. I still want the outcome to be optimal. I have slowly increased my experience over time and it's becoming a larger portion of my practice."*

The long-term effects of the mentorship cannot be evaluated, given the limited scope of the study. The nature of breast surgery and the long recovery process for patients also render it difficult to assess the implications of the intervention for the surgeons' future practice. The post-intervention interviews were conducted before the surgeons had an opportunity to follow-up with the patients who had received oncoplastic surgery, and thus could not comment on the potential positive cosmetic outcomes. While the feedback about the outcomes of the cases where the participating surgeons tried oncoplastic techniques was generally good, all participants agreed that cosmetic result could

not be accurately assessed until after the patients finish their radiation treatment, which is a major contributor to the less desirable cosmetic outcome after surgery.

Reflecting on one of their cases, participant 2 mentioned that

> *from a shape point of view, I was very pleased. I'd have to say it was very good",*

but also emphasized that they

> *"…have not seen these cases after the radiation, which I would be very anxious to see, and they probably will be about ready to see that now, but I was pleased with the healing. I did not have any issues with unusual pain. I did not have any infection, and it did not feel there was fat necrosis or any other problems with the healing."*

Similar to participant 2, another surgeon emphasized that the potential benefits of oncoplastic surgery are not yet visible, affirming that surgeons need to look to the long-term results in order to assess the usefulness of the techniques:

> *"As I said, I think that the real benefits are what we're seeing in the long-term, not what we're seeing in our immediate post-op visits. It's after the radiation that you can really feel that you made a difference for the patient."*

Thus, the currently unknown long-term cosmetic outcome and satisfaction of patients remain unknown, and may have an effect on how participants perceive the clinical value of oncoplastic surgery.

3.4 WORKING WITH THE PLASTICS TEAM

Oncoplastic surgery, as the term suggests, combines techniques from plastic surgery with oncological surgical techniques. Given the centrality of

techniques derived from plastic surgery in this practice, the plastic surgery team are integral to the adoption of oncoplastic surgery in a general surgery breast practice. In the post-intervention interview, we asked the surgeons to describe their relationship with the plastic surgery team, and to reflect on the possibilities for collaboration between the two specialities in the future, in order to promote oncoplastic surgery.

During the course of the intervention and in the post-intervention period, participant 2 reported that the plastic surgery team had been very willing to collaborate during oncoplastic procedures. They remarked:

> *"In our centre, I think we are very fortunate. I have never had any kind of response other than enthusiasm for anything that I wanted to do, including booking with them if we were doing a major lumpectomy, an adjustment of the other side, or a lumpectomy combined with a full reduction."*

Another surgeon reflected that while they anticipated tensions to arise around the division of labour in oncoplastic procedures, these had not materialized in the local setting:

> *"I think, in general, maybe it's an area of contention about who does the reduction, and who does the other side, and who does the major oncoplastic procedures for large lesions. However, I think here, our plastic surgeons are so overwhelmingly busy with the work they already have, and we have a good working relationship that I have never detected any issue related to who does what, or working together, or trying to accommodate."*

While the surgeons interviewed for the study reported experiencing productive, collaborative relationships with plastic surgeons in their local hospital context, participants acknowledged the potential for the adoption of oncoplastic techniques to cause conflict between plastic and breast surgeons. For example,

participant 4 highlighted the potential for oncoplastic procedures to cause political problems between specialties:

> *"I would say, like every other hybrid specialty or subspecialty that is evolving in medicine, [it] depends where you are. There will be areas where it's very collaborative, and people are very happy to share it, but politically, in other areas, it would be very difficult. There would be, I'm certain, centres where general surgeons would view it as their domain, and plastic surgeons would see it as their domain, and there would be conflict."*

Another surgeon described plastic surgeons, particularly those with prominent practices, to be the "greatest challenge" to the acceptance of oncoplasty in Canada, but was optimistic about the potential for collaboration between the two specialties in the future:

> *"With regard to other specialties, the plastic surgeons, I think, are the greatest challenge in terms of acceptance of the procedure. Especially older, well-established plastic surgeons are fearful that it will be a turf battle between specialties over cosmetic elective breast cases, if we start doing these procedures increasingly. There's a lot of underlying tension still, about that. I think it will take time, but I think it will ultimately resolve. Because in Canada, where resources are constrained, it works best to work in combination, rather than in isolation, and so I think it will end up staying a shared field."*

3.5 BARRIERS FOR ADOPTION OF ONCOPLASTIC SURGERY

3.5.1 Outcome Satisfaction

The findings of the study illuminate a number of important factors that hinder the adoption of oncoplastic techniques in the breast general surgical practices in London, Ontario. One important and unexpected barrier identified was the high level of satisfaction reported by surgeons and patients with their

current surgical practices. Superficially, the surgeons interviewed in the study consistently stated that they were satisfied with the oncological and cosmetic outcomes of their current standard practice. Participant 6 described how professional satisfaction with current practices poses a barrier to the incorporation of breast-conserving techniques:

> *"There are a lot of general surgeons both in academic centres and community centres that just don't really believe that this is something that needs to be improved upon. They don't see this as a problem that needs to be solved but the thing is you can change minds when you show people the results of like you don't have to do a mastectomy. You can actually take out this much breast tissue. And if you use these techniques you do not have to do a mastectomy and you save that patient reconstruction and big surgery and so on. It's hard though. I don't know how to do that without, like you know, there is a lot of I think prejudice about it. I think that people feel like, again like it's a problem that doesn't need to be solved."*

Given the challenges of incorporating new surgical techniques, particularly those that draw on techniques from other specialities, it is unlikely that surgeons will be motivated to change their practice to incorporate oncoplastic surgery, if their current surgical outcomes are deemed to be satisfactory. As indicated by participant 2:

> *"In order to adopt a new technique, you have to think that it's substantially better than what you're doing at the present time. And probably that the proportion of lumpectomy cases, that would benefit from an oncoplastic approach, are small enough that people think oh I'm doing fine."*

To counteract this barrier, participant 6 suggested that surgeons need to be shown 'the results' of oncoplastic interventions, and to be exposed to cases where the use of oncoplastic surgery enabled the surgeon to avoid both mastectomy and reconstruction, and instead perform a smaller, breast

conserving surgery. This participant emphasized that while breast surgeons with well-established practices may be unlikely to adopt oncoplastic techniques, early career surgeons would likely be both interested in and receptive to oncoplastic surgery:

> *"I think you'd have to start with people at the beginning of their careers rather than the ones at the end who may be less likely to want to learn any new tricks, so getting residents exposed to it and maybe residents who are interested in doing breast surgery or breast fellowships. Showing them what is possible because that might influence their interest in doing these extra courses or, doing an extra six months of their fellowship or year or what have you to get that experience, so maybe just picking the right people who are receptive to it. I mean, like I said, you may not change minds of people who are already set in their ways and are happy with their practice the way it is."*

In addition to experiencing a high level of satisfaction with their current surgical practices, participants reported receiving little negative feedback from their patients about their cosmetic outcomes of their breast surgeries. Participant 6 reflected that

> *"women don't complain to me about this. They're happy to have the mastectomy. Their cancer is gone, I feel like I've done a good job and they tell me I've done a good job, but when they don't know the alternative then it's not a completely […] it's not the best outcome necessarily."*

Another barrier to the widespread adoption of oncoplastic surgery is the fact that patients are largely unfamiliar with oncoplastic surgery and do not have an understanding of its cosmetic benefits. Participant 1 remarked that a number of patients that had been approached about oncoplastic surgery did not express an interest in the procedure or a desire for improved cosmetic outcome:

> *"I think probably half of the patients that we offer oncoplastic surgery to probably don't care, or they say they don't care, at the time of the surgery,*

> *and maybe they'll be happier later. But they probably don't have a huge vested interest, and probably the other half are completely delighted to have a breast reduction built into a cancer operation, so they see it as a bonus. They probably don't appreciate that it's so much better long term, from a cosmetic perspective, because they don't know what it would have looked like if they hadn't had it done. They probably never really even appreciate how bad it would have been if we had just left the contour deformity."*

Given the overwhelming experience of the disease and its treatments, patients often prioritized good oncological outcomes, and considered cosmetic outcomes to be less important. Patient perceptions of their surgical outcomes are further complicated by their limited knowledge of the cosmetic outcomes of various surgical practices. For example, participants commented that patients are often unaware that their cosmetic outcome would have been different if oncoplastic surgical techniques were not used:

> *"You know, I must say it's the same as … I don't think they know the difference, so on an individual patient basis they don't know that the procedure was done differently than it could have been done. They just assume that's the way it was done. Generally, people are happy with it. They're typically overwhelmed with the cancer diagnosis, and are most interested in getting on with the next steps of their treatment. But, it's, I think, down the road my impression is that once people get through the initial cancer treatment and they're starting to feel more like themselves again, that's when at least they raise concerns about whether cosmetically you can do something about their breasts. So, I think the benefit will be down the road. You won't have people wondering should I go see a plastic surgeon and can I have something done to this lumpectomy site."*

In the example above, participant 4 speculated that the cosmetic benefits of oncoplastic surgery may not be appreciated by patients until after the first post-surgical year when patients have completed their primary treatments. The experience of breast cancer and the prolonged nature of the treatments delay

patient feedback about their surgical satisfaction, and in the case of surgical innovations, may make it challenging for surgeons to assess the benefits of oncoplastic surgery in their practice in the short term.

3.5.2 Canadian Healthcare System

The introduction of new techniques and technologies into healthcare practice do not occur in a vacuum, but rather are negotiated within the complex context of the Canadian healthcare system. The structure of the Canadian healthcare system both shapes and constrains the possibilities for the adoption of new techniques. Techniques that fit seamlessly into the existing structure are adopted at a much greater rate than those that challenge one or more practices within the structure. In the case of oncoplastic surgery, the results of the study suggest that the structure of the Canadian healthcare system is largely perceived to be a barrier to uptake.

Participant 1 identified a number of structural barriers that make the adoption of oncoplastic surgery in Canada challenging, including the need for ongoing mentorship, billing limitations and the increased resources required to complete more complex surgeries:

> *"For practicing surgeons, the first barrier is having people to discuss this with, or to bounce this off, after the intervention period. I think we would need regular discussion opportunities of cases, just to increase the confidence. Because every tumor and every patient and every contour is different. I think there are still remuneration barriers, so there is no billing code for that procedure, and I think that's a barrier to the community surgeon in terms of income, and that they don't want challenges around billing and repayment. And time: it takes more time, which is sort of linked to income, but we are resource-constrained, and so I could see how, if you had a number of cases to do, that you would feel like you can't spend an*

> *extra two hours on this one patient, when that's whole other cancer patient that has to wait longer."*

Other participants identified the increased human resources required for oncoplastic surgery as a significant barrier. Participant 4 noted that each oncoplastic procedure would require additional clinical time, to explain the complexity of the procedures to patients, as well as additional operative time. In the Canadian context, where there are increasing concerns about the length of patient wait times and the overburdened publicly funded health care system, introducing new procedures that increase waiting times and decrease the number of patients seen by surgeons are politically difficult. Given this, participant 4 reflected that introducing oncoplastic surgery in Canada in a meaningful way is seen as

> *"challenge, for sure. Anything that's going to increase resources and decrease productivity is harder to swallow for sure, it means that you treat less patients."*

Given the limited human resources available within the Canadian healthcare system, participant 3 speculated that oncoplastic procedures, if introduced, would be limited to procedures that are less the complex and require less operating time:

> *"In the simpler ones, I think people will readily do just what I did, the mobilization of the breast tissue and use an extra layer of closure. That doesn't take very long, but the pre-op planning and the extra… the more complex stuff probably adds an hour or so to your operating time. And that might be rate-limiting if you're in a place where you have barely enough operating time to look after the pressure of cancer cases.*"

While human resources may pose a significant barrier for surgeons located at academic hospitals, community practices were thought to be potentially enabling environments for oncoplastic surgery, depending of the local culture of the community hospital:

> *"It might be easier for community general surgeons to accommodate a breast case that was a bit longer because they can trade, maybe do one less hernia on their list and devote that extra bit of O.R. time to the oncoplastic planning and that part of the procedure. That said a lot of people, who are doing a lot of breast cancer in the community, are under the same sort of pressure to use their O.R. time for cancer cases."*

In contrast to the various human resource constraints identified above, the cosmetic benefits of oncoplastic surgery were described as being enabling for the adoption of the practice, because of the potential for the practice to minimize the costs associated with mastectomies. In this regard, participant 6 remarked that she is

> *"hopeful that it actually will be a very good thing for the system because it would ideally minimize the amount of reconstruction that we need to do."*

Participant 5 echoed this optimistic view and stated that he did not think that

> *"oncoplasty would pose any significant problems for the Canadian health care system."*

3.5.3 Courses

While the mentorship intervention piloted in this study demonstrated a useful method for effectively and efficiently introducing new surgical techniques, participants reported a clear need for ongoing mentorship and training in the area of oncoplastic surgery. In the context of Canada, there is a distinct lack of training

opportunities and courses in the oncoplastic surgery. Moreover, the number of international courses that are offered in the specialty are limited, highly competitive, and require surgeons to take time off from their busy practices to travel to Europe or the United States. Several participants spoke about the challenges that they had faced accessing appropriate oncoplastic surgery courses. Participant 1, for example, stated:

> *"The courses are very competitive and very difficult to get into because it is becoming an international gold standard and will, at some point. So, it's quite competitive to get to and they're very expensive, and it's difficult to put your practice on hold and travel to attend these courses, but it's absolutely worthwhile."*

While participants generally described oncoplastic surgery courses as desirable learning opportunities, it was clear that the time and money required to attend them were often a significant barrier. Additionally, the usefulness of the courses was called into question, as it was acknowledged that the majority of courses available did not offer a hands-on component or wet lab; when wet-labs were incorporated, they often were not comprehensive enough to provide sufficient training:

> *"And the other thing is simply that it's costly and you only have a few opportunities a year to go to a meeting where you might be able to do a wet lab. I don't really think the wet lab is enough to give you the confidence that you need; well, for me, anyway."*

Mentorship and one-on-one training, like the intervention piloted in the study, were described by the surgeons as alternatives to courses, while being one of more effective ways to learn and implement new techniques. The lack of

opportunities to mentorship in this area, particularly for busy practicing surgeons, was lamented:

> *"I think, it's just learning how to do it, like most surgical procedures you learn it during your residency or fellowship. So, you watch somebody do it, you're mentored through it, then you get to do it and you get to see the results. The barrier really is adopting or learning new techniques when you're in practice where you're not necessarily going to have that same opportunity. It would be great to go away and do a course or travel to another site. I think those are the best ways to learn it. The challenge is finding time. Holding a meeting like we're doing is I think the best to locally disseminate it but you're not going to be able to get everybody because of our crazy schedules."*

3.6 FUTURE OF ONCOPLASTIC SURGERY

Despite the barriers to adoption, identified by the study participants, the findings suggest that surgeons are hopeful about the future of oncoplastic breast surgery in Canada. For some participants, the adoption of oncoplastic techniques was understood to be an inevitable outcome in the evolution of breast surgery practices. While participant 2 expressed hesitancy at the widespread acceptance of advanced oncoplastic techniques, they felt that basic oncoplastic techniques will be incorporated into general breast surgery in Canada in the coming years:

> *"I think it will slowly percolate, and it will slowly become part of main surgical practice. Like all new techniques, they sort of take a while to be adopted, but they generally find their way into practice. I don't think all of them; I think the most complex reconstructive techniques will only be done by a few, small, specially trained surgeons. Most of the basic techniques I think will easily be adopted.*

Participant 1 was optimistic about the future of oncoplastic surgery and predicted that the techniques will become as prominent and ubiquitous in Canada as it is in Europe:

> *"Ultimately, I think oncoplasty will become the standard of care in Canada. I think for level 1, it's fairly already well accepted to do glandular closure, and that doesn't take too much time, and so the Canadian system, there's no big down side to that. I think the level 2 is challenging, because it takes a bit more time, and so there might be some resistance until finally patient demand makes it become the standard of care, when other patients hear about it, and then they won't go to the people that have worse cosmetic outcomes. Then the level 3 is going to remain a problem because not every hospital and not every city has a plastic surgeon to do reductions with."*

Given the numerous barriers identified in this study that hinder the uptake of oncoplastic surgery, participant 2 asserted that increased public and medical awareness of the benefits associated with the practice are integral for the wide-spread adoption of practice:

> *"Well, I think that as patients and other physicians, such as, the treating oncologists, as they become more aware of it and the benefits of it, the demand will come, and I think that really, it's how it happened for reconstruction too. It wasn't really until the patients and the political climate around it demanded that we provide that for patients, that's when it really started to happen, and it will probably be the same. It would probably be women who recognize this is an important part of their care that will force the system to adapt to it."*

Thus, our results suggest that surgical mentorship was an effective way to introduce new surgical techniques to practicing surgeons. The results of the study demonstrate that mentorship increased surgeons' knowledge of oncoplasty, their comfort and skill in performing new techniques, and their

perception of its benefits for their practice. This method was described as being preferable to formal learning opportunities and more accessible for busy clinicians.

CHAPTER 4

Discussion

CHAPTER 4. DISCUSSION

Oncoplastic breast-conserving surgery is increasingly accepted as the standard of care for women with early-stage breast cancer across European countries. While oncoplastic techniques have been shown to produce better cosmetic outcomes than traditional surgical techniques without impacting oncological outcomes, the practice has not been widely integrated in Canada. Despite the mounting evidence that oncoplastic surgical (OPS) techniques reduce mastectomy and re-excision rates while producing a cosmetically superior result, Canada lags behind the rest of the international medical community in its uptake of oncoplastic surgery. Previous research has identified the lack of Canadian formal training opportunities for surgical residents and fellows as a significant factor contributing to the slow uptake of OPS (Maxwell, Roberts et al. 2016). OPS are currently not incorporated into Canadian general surgery residency curriculum and are not a formal component of Canadian surgical fellowship training for breast or oncology surgeons. The basic breast fellowship training in Canada consists of different rotations in breast surgical oncology, medical oncology, radiation oncology, breast imaging and pathology. During the fellowship, the trainees are exposed to different reconstruction techniques carried out by plastic surgery team during combined cases. As such, the trainees have no exposure to any OPS techniques during the standard breast fellowship program.

This study emerged out of an ablative and reconstructive breast surgery fellowship in 2013, at which time oncoplastic surgery was not routinely being used at London Health Sciences Centre and St. Joseph's Healthcare Centre by the practicing breast cancer surgeons. While ablative and reconstructive breast surgery fellowships are intended to enable surgeons to develop expertise in the multidisciplinary management of breast disease, the fellows are not really exposed to OPS cases during their training. Given the standardization of OPS techniques globally, developing an OPS skill set is imperative for breast surgeons to provide excellent patient care. Acknowledging the specialized training is required in order to gain expertise in OPS. Given the paucity of formal educational opportunities in Canada, this study was designed to test the effectiveness and appropriateness of a six-week intra-operative surgical mentorship as a strategy for integrating OPS into already-established surgical practice. In addition to testing the effectiveness of inter-operative mentorship as an educational innovation, this study sought to identify and examine the barriers and opportunities for adopting OPS as a new technique at the University of Western Ontario.

4.1 SUMMARY OF THE OUTCOME OF MENTORSHIP

The participants' perceptions of the intra-operative mentorship program implemented in this study and its effects on their surgical practice were described in Chapter 3. The results of the study suggest that surgical mentorship is an

efficient way to introduce new techniques to practicing surgeons that facilitates their adoption into their routine surgical practice. This model of surgical mentorship is broadly applicable, and can be used widely throughout the surgical community to support the introduction of various innovative techniques. Such an approach enhances the utilization of the expertise within the field, and encourages local surgeons pioneering novel techniques to share their experiences with those willing to learn. In addition, mentoring provides a way to overcome the unnecessary burdens (both financial and in terms of the time commitment required) associated with travel to attend a hands-on course at another location. The burdens were identified by participants as significant barriers to accessing formal OPS educational opportunities. In contrast to formal courses, the surgeons who participated in this study described inter-operative mentorship as an accessible, flexible and affordable educational opportunity that supported their ability to develop new expertise.

Furthermore, in combining pre-operative planning with intra-operative discussion and application, the hybrid approach of the mentorship program enabled participants to achieve their learning objectives. The surgeons reported that this method was superior to self-study and other formal courses (with or without a wet lab). The efficacy of the mentorship program was highly visible in the post-intervention interviews, in which most surgeons described how they had incorporated different levels of oncoplastic techniques into their standard practice. The increasing awareness of OPS and its benefits are also visible at the intuitional level, as oncoplastics has recently become a part of the formal

fellowship training at London Health Sciences Centre (LHSC) and St. Joseph's Healthcare Centre (SJHC) in London, Ontario. These changes to fellowship training, in part, are a response to the diffusion of the surgical innovation piloted in this study.

There are indications that the broader landscape of OPS is changing across Ontario. Recently, an oncoplastic partnership program was introduced by academic and community surgeons in Ontario, who are considered local experts in the emerging Canadian field. The surgeons initiated a hands-on oncoplastic surgery course, offered several times a year, with locations in Toronto, Ottawa and London. Additionally, oncoplastic breast rounds were created by the same group; these are now offered on a monthly basis, via teleconferencing, to all the hospitals in Ontario.

To support the integration of OPS into breast surgical practices in Ontario, it is imperative to foster good relationships between the plastic surgeons and general breast surgeons. Oncoplastic surgery requires an immense amount of collaboration between plastic and breast oncology surgeons, in order to plan the proper therapeutic approach and to achieve the best possible surgical outcome for the patient. Collaboration between these surgical sub-specialties is of vital importance.

4.2 DIFFUSION OF INNOVATION

As described in Chapter 2, the design of this study was informed by Rogers' theory of Diffusion of Innovation (Rogers 1983). This conceptual framework enables in-depth exploration of the multiple factors that affect, shape or impede the adoption of new clinical behaviours and techniques. OPS as a surgical innovation is described here, evaluating its success in relation to the four elements affecting diffusion identified by Rogers.

While oncoplastic surgery is a well-established practice in other areas of the world, especially in Europe, it is still considered an innovation in the Canadian healthcare system (Khayat, Brackstone et al. 2017). In 2013, intra-operative mentorship training was introduced at LHSC and SJHC to provide practicing breast surgeons with an opportunity to gain expertise in OPS techniques. The surgeons who participated in the mentorship program reported a more favourable perception of OPS and increased knowledge of its advantages for their breast practices. In the period following the intervention, participants indicated that they had incorporated OPS into their practices and could provide patients, who would otherwise be offered a mastectomy, with new breast-conserving options. Interestingly, some surgeons also commented that the integration of oncoplastic surgical techniques increased their surgical satisfaction.

According to Rogers, there are five crucial elements that affect the adoption of surgical innovations: relative advantage, compatibility, complexity, trialability and observability.

4.2.1 Relative Advantage

Rogers described the ‘relative advantage’ of an innovation as the degree to which it is perceived to be superior to the current practice. There is a considerable body of research that demonstrates the advantages of OPS, particularly with regards to the cosmetic outcome. While all participants reported having some knowledge of OPS prior to the mentorship intervention, many were unable to describe the benefits of such techniques for patients clearly. After the completion of intra-operative mentorship, several participants reported offering oncoplastic surgery to selected patients who would otherwise need a mastectomy, and reflected that the outcome of these cases was optimal. These findings indicate that the mentorship program enabled participants to understand the ‘relative advantage’ of OPS better, assisting with integration of the techniques into their practice.

1.4.2 Compatibility

‘Compatibility’ is a measure that refers to the degree to which a new surgical technique is viewed as being reconcilable or consistent with current values, practices, and the needs of potential adopters. Rogers argued that innovations that address current issues or problems identified by clinicians have an increased probability of adoption. As described in Chapter 3, many practicing breast surgeons and their patients are satisfied with current surgical techniques. This hinders the adoption of OPS, as currently there is not a widespread surgeon-identified need for technical innovation. However, the results of this

study suggest that intra-operative mentorship may be an effective technique to communicate the compatibility of OPS with the current standard in the treatment of breast cancer, and highlight the ways in which these techniques address previously unacknowledged unmet needs.

1.4.3 Complexity

The complexity of new surgical techniques and the level of skill required to adopt them affect their diffusion effectivity. Techniques that are perceived to be difficult to understand and onerous to learn are less likely to be adopted, particularly without addressing a clear and pressing unmet need. Oncoplastic surgical techniques are divided into three levels according to the extent of training and skill that are required to perform each technique. At present, the amount of training required for competency in each skill level has not yet been standardized. The results of this study suggest that a six-week mentorship period may provide sufficient training for surgeons to perform level 1 and 2 procedures, while level 3 procedures may require additional training.

1.4.4 Trialability

Rogers described ‘trialability’ as the degree to which the surgical innovation is amenable to trial and modification. Innovations that can be appraised on a trial basis are more likely to be adopted because it affords clinicians the opportunity to assess the feasibility of the procedures, its acceptability to patients, and the potential outcomes before committing to its full

adoption. The collaborative nature of the mentorship program provided the participants with the opportunity to observe, test out and assess the post-surgical outcomes of OPS without having to commit themselves to extensive or expensive formal training. Their exposure to a variety of techniques enabled the surgeons to ‘trial’ a variety of OPS procedures with a range of different patients, and to assess which techniques they would like to adopt and practice, and what techniques they would omit and never use. Thus, surgical mentorship may provide an ideal opportunity to practicing surgeons to ‘trial’ new techniques without committing extensive resources to formal training or courses.

4.2.5 Observability

Rogers defined ‘observability’ as the degree to which the superior outcome of the innovation can be readily perceived by other clinicians and patients. The more ‘visible’ the favourable results are, the more discussion is stimulated between clinicians and the more knowledge about the innovation circulates among communities of practice. Highly observable outcomes facilitate the adoption of new surgical techniques. As an innovation, oncoplastic surgery is hindered by the fact that the final cosmetic outcome is not visible until after the patient has completed radiation therapy. However, the preliminary results of the surgical technique were described by participants as being promising. The extensive length of time between surgery and final result are not conducive for facilitating rapid adoption of the practice, but over time, as the superior cosmetic

results of this practice reveal themselves, the ‘observability’ of the innovation may improve.

4.3 COMMUNICATION CHANNEL

The channels, or modes by which information about new clinical techniques is communicated, influence its diffusion. Face-to-face exchange of information has been shown to be an effective and persuasive communication strategy as it provides the opportunity for knowledge to be tailored to the recipient and their specific clinical context (Bero, Grilli et al. 1998). Moreover, this mode of communication is particularly effective in instances where there is a high degree of professional resemblance between individual introducing the innovation and the recipient of the knowledge (Bero, Grilli et al. 1998). The results of our study support this claim, as the surgical mentorship was well received by the participants of our study. As described in Chapter 3, the surgeons report that the presence of a skilled surgical mentor facilitated their learning and increased their comfort experimenting with OPS techniques.

4.4 SOCIAL SYSTEM

For any surgical innovation to be adopted, there has to be a harmony and smooth transition within the social system involved in the adoption of this innovation. In our study, there was an active collaboration between breast

oncology surgeons and plastic surgery team; these surgical sub-specialties are the cornerstone in the adoption of oncoplastic techniques. The high-degree of teamwork at LHSC and SJHC facilitated the smooth transition and the acceptance of oncoplastic surgery as an alternative to the previous practice. Excellent communication and advanced planning through a pre-set agreement between both groups enabled the smooth integration of the techniques into surgical practice.

When examined through the conceptual framework of diffusion of innovation, the results of our study are promising. The intra-surgical mentorship program piloted in this study improved the participants' perceptions of OPS across the five elements. In particular, the program improved the participants' knowledge of the relative advantages of OPS, demonstrated the compatibility of the techniques with current practices, provided an opportunity for surgeons to implement and assess the techniques, and made visible the superior cosmetic outcomes of the procedures.

The theory of surgical innovation has been used by several other scholars to describe and predict the diffusion of surgical innovations Many examples exist in the history of surgical innovation, where the same theory was used and applied successfully to adopt new innovations (McMasters, Wong et al. 2001, Simunovic, Coates et al. 2013, RoyalCollegeofSurgeonsofEngland 2018). The best example is the adoption of sentinel lymph node biopsy (SLNB), where it came to replace the standard of full axillary dissection for regional staging in every patient with breast cancer (McMasters, Wong et al. 2001): originally, SLNB

as a technique was rejected by many surgeons in England, since they did not think it would improve the outcomes. However, a few surgeons opted to test this different approach, demonstrating that with the adoption of proper training methods, SLNB could be done as a day surgery, thus reducing the cost, and eliminating the financial barrier to adoption. Although the lack of infrastructure within the nuclear medicine was initially a factor, the surgeons were able to overcome this. As a result, when the new guidelines for axillae treatment in England were issued, SLNB was added as a standard. Other successful example is the introduction of laparoscopic colorectal surgery and robotic-assisted radical prostatectomy in the UK (RoyalCollegeofSurgeonsofEngland 2018).

Another example where the same theory was used is the Cluster-Randomized Quality Initiative in Rectal Cancer (QIRC) Trial (Simunovic, Coates et al. 2013): the new, total mesorectal excision technique was found to be superior to that of the previously-used standard, resulting in similar rates of adoption between early and late adopters. This occurred despite the fact that the late adopters were still satisfied with the outcomes obtained by the use of traditional technique. As such, our study shows some similarities to the above, since participating surgeons identified self-satisfaction of their surgical outcomes as a barrier to the adoption of new techniques.

Comparison of the early versus late adopters in the QIRC study found no differences among the surgeons' median year of graduation, availability and interest in attendance at meetings (either local or international), resource availability, interest and willingness to learn and adopt new techniques, or their

positive attitude towards their surgical community. As such, these findings were very similar to those of our study, in terms of our participant characteristics.

4.5 BARRIERS TO OVERCOME

This study identified several barriers to the acceptance of oncoplastic surgical techniques in London, Ontario. The first and most unexpected barrier was the degree of surgeon satisfaction with the cosmetic and oncological outcome of current surgical procedures. This poses a significant barrier to the adoption of OPS techniques because it indicates a low degree of 'compatibility' and 'relative advantage' of the practice. In part, the problem is a product of the lack of feedback from patients regarding the satisfaction with the cosmetic outcome of their breast surgeries. Feedback from patients is hindered by both the long recovery period and the overwhelming experience of breast cancer. Given these factors, cosmetic outcome is often not at the forefront of patients' minds. Unfortunately, there is no good formal method of evaluating the patient-surgeon satisfaction with the surgical outcome, due to the disparity in the definitions of 'success' by the surgeon versus that of the patient (Jagsi, Li et al. 2015).

Currently, novel assessment tools are being developed to address the evaluation that would include cosmetic outcome. For example, the BREAST-Q module, developed by the Memorial Sloan-Kettering Institute for Cancer Research (qportfolio.org), is designed to provide essential information about the

impact and effectiveness of breast surgery via the patient-reported outcome measure (PROM). This promising module can now be applied to validate the effectiveness of the outcomes of oncoplastic surgeries in comparison to the traditional oncological procedures. This tool holds great potential for assisting the diffusion of OPS because it spreads knowledge about procedure and its outcomes. It may raise patients' awareness about the availability of OPS surgical procedures and facilitate the adoption of oncoplastic techniques by breast surgeons.

One of the most critical barriers to the adoption of oncoplastic surgery into routine surgical practice is the lack of available and easily accessible training that include the real patient case scenarios. Given the complexity of OPS, this type of training is necessary for the integration of new surgical techniques into practice. In order to overcome this barrier, the emerging oncoplastic partnership in Ontario needs to be supported by Health Canada and the Royal College of Physicians and Surgeons in their continuing efforts to offer regular hands-on training in various locations within the country.

In particular, the lack of formal training during surgical residency and fellowship pose another significant barrier. As mentioned by one of the study participants, current breast fellowships do not offer trainees any exposure to oncoplastic procedures, despite the fact that trainees desire this type of training. To overcome this, oncoplastic surgery should be incorporated during surgical fellowship training, and general surgery residents should be exposed to basic level 1 procedures during their formal training. As oncoplastic surgery

increasingly becomes the standard of care replacing the traditional lumpectomy procedures, it is of vital importance that surgical trainees develop competencies in these techniques. In response to this need, the University of Western Ontario, in collaboration with the University of Ottawa, has started a 1 to 2-year oncoplastic breast surgery fellowship, tailored to the educational needs of the fellows and the existing program requirements.

The final barrier to adoption of any new surgical techniques is the acceptance by the Canadian healthcare system. The oncological and cosmetic advantages of oncoplastic surgery need to be explicitly communicated, to encourage its uptake and overcome resistance within the healthcare system. To advance its adoption, the benefits of oncoplastic surgery must clearly address both the issue of patient satisfaction with the cosmetic outcome and the cost-effectiveness of the procedures employed. One possible solution to this problem is the formation of a Canada-wide oncoplastic surgery case registry (or, to begin with, even just a provincial or local registry); every surgeon would report his/her cases, including all complications and utilization of the operating room time. The registry would allow for objective feedback and a robust cost-benefit analysis. Given that Canada lags behind (in comparison to other leading countries) in the field, access to the registry might also facilitate the number of pertinent publications in the field of breast cancer surgery.

While there is an excellent working relationship between plastic and breast oncology surgeons at our institution (i.e. LHSC/SJHC), this relationship may not exist at other institutions or community hospitals. The experience from our

mentorship program may offer an insight into how to bring the two teams together and foster collaboration between the groups. Drawing on our experience, we suggest the following guidelines to promote collaborative working relationships: level 1 oncoplastic surgical planning and the actual oncoplastic surgical excision procedure should be performed by the oncology surgeon; level 2 oncoplastic surgical planning and the actual oncoplastic surgical excision procedure should also be done by the oncology surgeons, except when the need for symmetrization arises, in which case plastic surgery expertise is required; and level 3 oncoplastic surgery procedures should be planned by the plastic surgeons: the oncology surgeon should do the procedures on the diseased breast as planned by the plastics team, with the plastics working simultaneously to symmetrize the contralateral side. We found that following these guidelines will provide for a smooth transition to the adoption of oncoplastic techniques in any community.

4.6 STUDY LIMITATIONS

While the outcome of our study looks promising, the study evaluated the role of mentorship in adopting oncoplastics only at the institutions in one city: that of LHSC and SJHC in London, Ontario. The outcomes may differ at other institutions, or within smaller community hospitals.

Cost-benefit analysis of oncoplastic surgery was not performed. In order to evaluate the effectiveness of oncoplastic surgery, a thorough assessment of all

variables must be undertaken. Although the benefit of oncoplastic techniques to the patient outcomes cannot be refuted, the additional increase in procedure time versus long-term benefits (e.g. shortened disability period, improved rate of return to workforce) must also be weighed.

In terms of sample size, our study consisted of six surgeons. This was a sample of convenience. Although thematic saturation was reached in the study, the small participant group size can also be considered as a study limitation.

Long-term outcome of the mentorship in our study cannot be assessed, given the timeframe and the scope of the program. As such, an additional study, of a different design would be required to evaluate the long-term effects and acceptance of oncoplastic surgery by practicing surgeons.

The final limitation of the study was the length of the intervention. The mentorship took place over six weeks, which was considered not enough by some of the surgeons involved in the study. This was mainly due to the wide range of techniques and the need for case per case judgment, which may not be easy to cover within this period. The surgeon may need to wait for many clinic visits to find a suitable patient for specific procedure.

4.4 FUTURE DIRECTIONS

To facilitate better awareness and acceptance of oncoplastic surgery into the routine breast cancer surgical practice, feedback from both the patient and the surgeon reporting on the satisfaction with the outcome should be obtained.

This can be implemented by using the patient satisfaction tools already employed in the United States.

To adopt the techniques of oncoplastic surgery into routine surgical practice, the breast cancer surgery residency and fellowship curricula need to be updated, to include training in the methodology. Mentorship programs can be of great value, and can also be applied to other institutions or settings.

It would be of great benefit to create a nationwide oncoplastic surgery registry, providing better visibility of these novel surgical procedures. The registry could be modelled on the one available in the United States; it would not only allow for the evaluation of the surgical outcomes, but also offer an additional research tool into various modern surgical approaches.

Finally, in order to include oncoplastic surgery within the standard Canadian healthcare system, a thorough cost-benefit analysis must be performed. The analysis must not only demonstrate that oncoplastic techniques and procedures do not dramatically increase the cost of patient care, but they provide for a significantly better patient outcome (with much less disability), perhaps even saving money in the long term. Finally, it needs to be conveyed to the administration that out of all advanced countries in the world, Canada really lags behind in the field, given that oncoplastic surgery is now considered a standard of care elsewhere in the world.

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APPENDICES

APPENDIX I. HUMAN RESEARCH ETHICS BOARD APPROVAL LETTER

Western Research

Research Ethics

Western University Health Science Research Ethics Board
HSREB Delegated Initial Approval Notice

Principal Investigator: Dr. Muriel Brackstone
Department & Institution: Schulich School of Medicine and Dentistry\Oncology,

Review Type: Delegated
HSREB File Number: 107844
Study Title: When Student Becomes Teacher: Does the Implementation of a Breast Surgery Fellowship Program Change Knowledge Dissemination Amongst Staff Surgeons?

HSREB Initial Approval Date: February 13, 2017
HSREB Expiry Date: February 13, 2018

Documents Approved and/or Received for Information:

Document Name	Comments	Version Date
Western University Protocol		2017/02/09
Letter of Information & Consent	Resident	2017/02/09
Letter of Information & Consent	Staff	2017/02/09
Recruitment Items	Survey invitation	2017/02/09
Instruments	Resident survey - Received 2017/02/10	
Instruments	Staff 3 month survey	2017/02/09
Instruments	Staff 6 month survey	2017/02/09
Instruments	Staff post exposure survey - Received 2017/02/10	
Instruments	Staff pre-exposure survey - Received 2017/02/10	

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above named study, as of the HSREB Initial Approval Date noted above.

HSREB approval for this study remains valid until the HSREB Expiry Date noted above, conditional to timely submission and acceptance of HSREB Continuing Ethics Review.

The Western University HSREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use Guideline for Good Clinical Practice Practices (ICH E6 R1), the Ontario Personal Health Information Protection Act (PHIPA, 2004), Part 4 of the Natural Health Product Regulations, Health Canada Medical Device Regulations and Part C, Division 5, of the Food and Drug Regulations of Health Canada.

Members of the HSREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB.

The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

[redacted]

Ethics Officer, on behalf of Dr. Joseph Gilbert, HSREB Chair
EO: Erika Basile ___ Nicole Kaniki ___ Grace Kelly ___ Katelyn Harris___ Nicola Morphet ___ Karen Gopaul ___

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APPENDIX II. LETTER OF INFORMATION: CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Principal Investigator:
Dr. Muriel Brackstone, MD, PhD, FRCSC
Tel: [redacted]

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Full Study Title: When Student Becomes Teacher: Does Implementation of a Breast Surgery Fellowship Improve Knowledge Dissemination Amongst Surgical Staff?

Principal Investigator: Dr. Muriel Brackstone, Surgical Oncologist

INTRODUCTION

This study will identify a novel technique in breast surgical oncology (oncoplastic breast conservation). The educating clinical fellow in the Ablative and Reconstructive Breast Surgery program has been trained through the American Society of Breast Surgeons Annual Oncoplastic Course. As an attending staff, you will be asked to rate your use of the specific technique, as well as your comfort level and understanding pre- and post-exposure to the educated clinical fellow.

You will also be asked to participate in an open-ended interview where you will be asked to outline your understanding of these procedures and your perceived barriers to implementation of these techniques. Exposure to these procedures will include having the fellows pre-screen the operative lists and suggest oncoplastic procedures to each staff surgeon for each patient periodically over a one to three month period. Afterwards, you will undergo a debriefing open-ended interview where you will be asked to outline your comfort with these procedures, the likelihood that you will use them independently in the future, and any barriers to ongoing use of oncoplastic surgery where indicated.

This study aims to determine the level of knowledge dissemination from fellow to attending surgeon in a clinical fellowship setting.

As a general surgeon performing breast surgery at Western University, we value your opinion on this matter and ask for your participation in our research. Your

participation in this study is completely voluntary and may be withdrawn at any time. Take the time you need to read over and fully understand this information prior to completing the consent form. Feel free to discuss this information and participation in this study with anyone you wish or contact us for additional information.

PURPOSE

Knowledge translation (KT) is a “dynamic and iterative process that includes the synthesis, dissemination, exchange, and ethically sound application of knowledge to improve the health of patients, provide more effective health services and products, and strengthen health care systems”. Many methods of KT exist, including continuing medical education, clinical practice guidelines and systematic reviews, audit, feedback, and reminders, educational outreach, reward and punishment programs, and operative demonstrations. Previous studies have demonstrated that the majority of the above methods have done little to change physician practice. This has led to the conclusion that physicians are reluctant to change their practice, and that improved KT interventions are necessary.

An exhaustive search of the literature fails to identify any studies examining the effect of clinical fellowship implementation on knowledge translation to attending staff. As more general surgery graduates choose to pursue additional fellowship training, studies have consistently demonstrated improved patient outcomes in centres with affiliated fellowship programs. Furthermore, clinical fellowship programs have not been shown to compromise resident experience. Western University has trained breast surgery fellows intermittently and informally over the past 7 years; however, 2016 will mark the first year of a formal breast ablative and reconstructive surgery fellowship. Fellowship goals and objectives have been developed in accordance to the CanMEDS roles and fellows will be formally evaluated for the first time.

This study aims to examine the dissemination of surgical knowledge from clinical fellow to attending staff, as well as the trickle down effect from staff to general surgery residents in the setting of a new formal breast surgery fellowship. In order to assess this phenomenon, clinical fellows will first pursue course-based training in oncoplastic breast surgery. Oncoplastic breast surgery is the combination of oncologic breast conservation with volume displacement techniques. Its goal is complete removal of the lesion with clear margins and excellent cosmesis, while performing a single definitive operative procedure. This approach has gained wide acceptance in Europe, but is less utilized in North America, despite studies that have demonstrated the oncologic safety of this technique.

Attending surgeons’ use of oncoplastic techniques, as well as their perceived understanding and comfort level with these techniques, will be assessed pre- and

post- clinical fellow education. This will include an open-ended interview with Dr. Eman Khayat, a breast oncology fellow, following her training and 3 month exposure period where she will pre-screen each operative list and propose oncoplastic techniques for each of these patients. This will allow for an examination of the uptake of new knowledge from clinical fellow to attending surgeon. Beyond this, general surgery residents on their breast oncology rotation will also be surveyed on the use of these techniques in the operating room and the oncoplastic specific teaching in order to determine if the new knowledge trickles down to resident education. Furthermore, the longevity of knowledge uptake will be assessed by surveying attending surgeons at six months and one year from initial exposure. This will allow us to determine if the oncoplastic techniques taught by the clinical fellow are still in use and provide a measure of project impact.

RESEARCH INTERVENTION

Participation in this study will involve completion of pre- and post-exposure surveys, as well as three and six month follow-up surveys. It will also involve two audio-recorded one-on-one interviews. Surveys will be available online via SurveyMonkey. Participants will receive invitation e-mails for survey completion and can be completed at your convenience. Each survey should take no more than ten minutes. Each interview should take no more than 30 minutes and will be conducted at the breast care centre at a date and time convenient for you. All surveys and interviews must be completed in order to complete this study.

PARTICIPANT SELECTION

You have been invited to participate in this research because you are an attending general surgeon practicing breast surgical oncology at Western University. We believe that your experience in this field and opinion on this matter can help us understand the patterns of knowledge translation in the setting of a breast surgery fellowship. Approximately 25-30 physicians will participate in this study.

PARTICIPATION

Your participation in this study is completely voluntary. You may withdraw from this study at any time with no consequences. Your decision will have no effect on employment or salary. You have the right to request the withdrawal of your data from the study at any time.

RISKS

The risks associated with breast of confidentiality for the attending staff are minimal. They include questions related to surgeon practice in comparison to

colleagues (i.e., use or non-use of oncoplastic techniques) and potential embarrassment.

BENEFITS

There is no remuneration associated with participation in this study. There are no direct benefits; however, participation in this study will help to determine the patterns of knowledge dissemination associated with implementation of a formal breast surgery fellowship program. This in turn will contribute to the Canadian surgical education data and may aid in the future development of breast surgical oncology training programs and oncoplastic surgery teaching across the province.

ALTERNATIVES

You may choose not to participate in this study. Your choice will have no effect on your employment, salary, academic standing, or evaluations.

CONFIDENTIALITY

We will not be sharing information about you to anyone outside of the research team. Data will be collected in a fashion that precludes identification of subjects directly. Study data will be de-identified upon collection. Each response will be assigned a unique sequential ID number. No other identifying data will be included in the response. One master log will exist that correlates the participant name to the sequential ID number. This log will be kept and stored separately from the data. All data will be password protected and kept for a minimum of 15 years, after which it will be destroyed according to Western University policy. Access to all records and data will be limited to authorized persons. The UWO Health Sciences Research Ethics Board may require access to study records for quality assurance and auditing purposes.

No identifying information will be used in publications or presentations of the results of this study.

COSTS

There will be no cost to you to participate in this research study.

PARTICIPANT RIGHTS

By completing this survey, you do not give up any of your legal rights against the investigators, sponsor, or involved institutions for compensation, nor does this form relieve the investigators, sponsor, or involved institutions of their legal and professional responsibilities.

CONFLICTS OF INTEREST

None to declare.

COMMERCIALIZATION

None.

SPONSOR/SUPPLIER

N/A

QUESTIONS ABOUT THE RESEARCH STUDY

Please contact Dr. Eman Khayat, MD if you have any questions about this study.

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APPENDIX III. PERMISSIONS TO USE COPYRIGHTED MATERIALS

III.1 British Journal of Surgery 2012; 99(10): 1389-95.

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Author: K. B. Clough, T. Ihrai, S. Oden, et al

Publication: British Journal of Surgery

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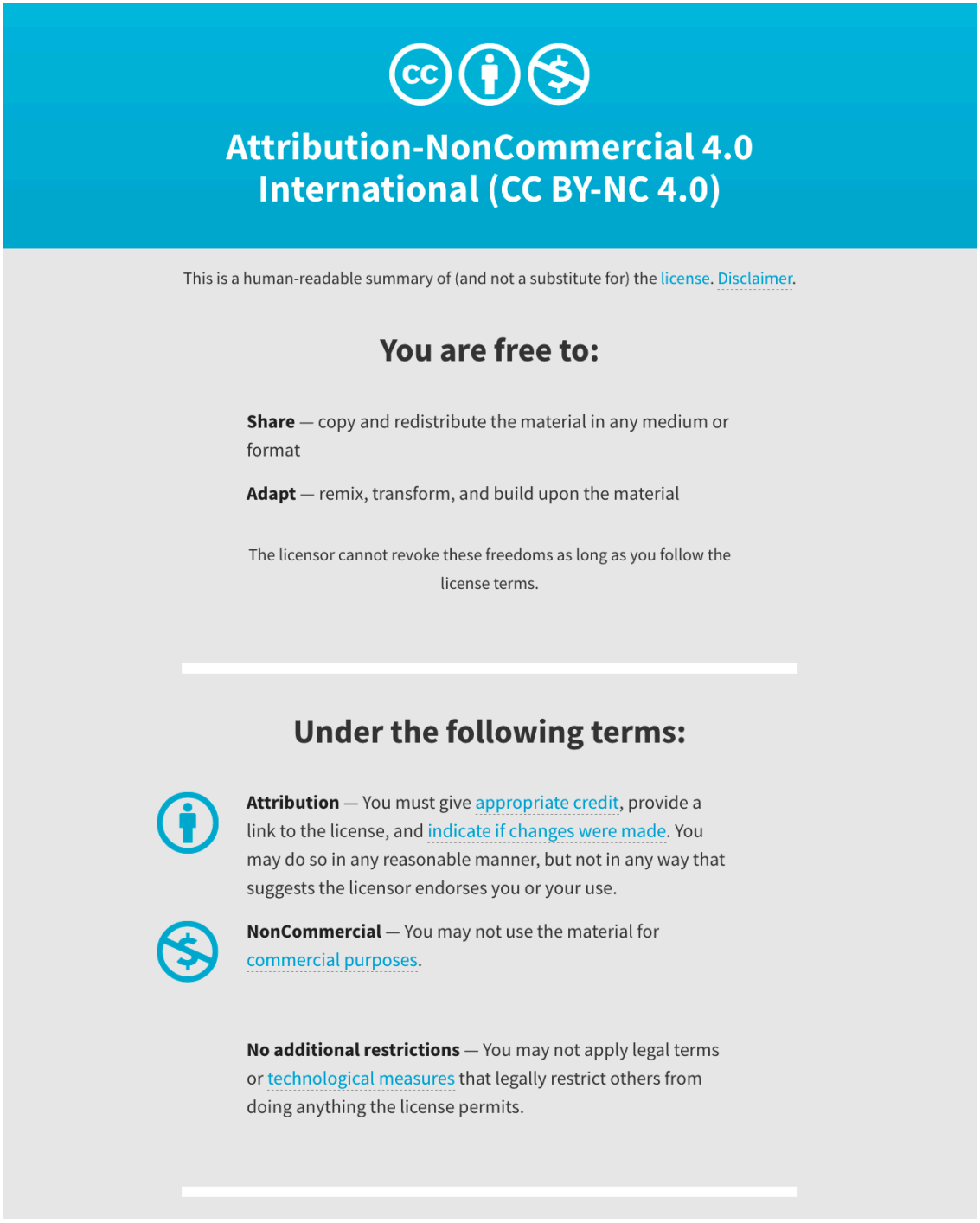

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APPENDIX IV. THEMES IDENTIFIED DURING THEMATIC ANALYSIS OF QUALITATIVE DATA

IV.1 Pre-Intervention

(1) Perception of Oncoplastic Surgery by Practicing Surgeons

These were the perceived ideas defining how much the participating surgeons generally knew about the term 'oncoplastic surgery' and what it entails.

(2) Knowledge of Oncoplastic Surgery

This was defined as the knowledge of technical details the participating surgeons had about oncoplastic surgery.

(3) Opinion of Practicing Surgeons about Oncoplastic Surgery

The initial opinion of the participating surgeons was explored about oncoplastic breast surgery, as reflected by their general knowledge and perceived ideas.

IV.2 Mentorship

(1) Pre-Intervention

The surgeons' opinions about different methods of adopting new techniques and their incorporation into practice were gathered. Mentorship was highlighted as the main purpose of the study.

(2) Post-Intervention

The feedback from the participating surgeons about the period of mentorship, as well as its validity in facilitating the adoption of new techniques was outlined.

IV.3 Post-Intervention

(1) Knowledge

The participating surgeons' knowledge of oncoplastic surgery after the mentorship intervention was evaluated.

(2) Opinion

The opinion of oncoplastic surgery after the intervention was expressed.

(3) Effect

The effect of the mentorship program in the participating surgeon's future practice was assessed.

IV.4 Working with Plastics Surgical Team

The relationship between the participating general surgeons and plastic surgery team, as well as its effect on the process of adopting oncoplastic surgery was explored.

IV.5 Barriers to Adoption of Oncoplastic Surgery

The following barriers were identified by the participating surgeons:

(1) Surgeon's self-satisfaction;

(2) Lack of availability of formal training or accessible courses;

(3) The Canadian Healthcare System, in the context for the adoption.

IV.6 Future of Oncoplastic Surgery

(1) Increase surgeons'/patients' awareness;

(2) Collaboration between teams;

(3) Feedback.

APPENDIX V. CODES GENERATED DURING THEMATIC ANALYSIS OF QUALITATIVE DATA

The following codes were identified in thematic analysis of qualitative data:

1. Background
2. Training
3. Practice
4. Collaboration or relation between plastic and general surgery
5. Discussion
6. The interest in breast surgery
7. Popularity
8. Training
9. Techniques
10. Judgment
11. Barriers
12. Practice
13. Advanced techniques
14. Oncoplastic surgery
15. Cosmesis
16. Opinion on cosmesis
17. Outcome
18. Procedure
19. Time

20. Fellowship
21. Reasoning
22. Fellows
23. Mentorship
24. Experience
25. Adoption
26. Learning from fellows
27. Difficulties
28. Cultural barriers
29. Lack of knowledge
30. Sexual discrimination
31. Prospective about the procedure
32. Level of comfort
33. Patient selection
34. Quality of courses.
35. Fellows and spread of knowledge
36. Instituting effect in spreading the knowledge
37. Limitations of learning
38. Belief in the technique
39. Fellow character can affect learning
40. Needs imagination
41. Extra time
42. Central breast centres

43. Oncological priority
44. Low interest in reconstruction
45. Barriers to adopt oncoplasty
46. Spectrum of oncoplastic surgery
47. Plastic restriction
48. Plastic opinion
49. Availability of fellows
50. Mentorship
51. Importance of fellowship
52. Fellows as a source of knowledge
53. More subspecialized
54. Changing spectrum of breast surgery
55. Limited access to hands-on
56. Good acceptance for learning
57. International courses
58. Traditional ways of learning
59. Difficult techniques with no experience – need more training
60. Methods of learning
61. Level of confidence related to the level of experience
62. Senior restriction
63. Extra training in Europe
64. Information on training
65. Good oncological outcome

66. Recent change in practice
67. Superior result in first surgery
68. Plastic team interest
69. Good collaboration, limited availability
70. Different sources of referral to plastic surgeons
71. Late complaints about cosmesis
72. Surgeons mention cosmesis to patients.
73. Patient satisfaction
74. Patients overwhelmed with cancer
75. Opinion of cosmesis in first visit
76. Options for defects correction
77. Factors affecting patient’s decision
78. Discuss scar pre-op
79. Post-op cosmetic problem
80. Anatomical discussion with radiologist
81. Radiologist and surgical planning
82. Getting second opinion
83. Opportunity to discuss reconstruction
84. Multiple visits

VITA

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King Abdul Aziz University
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1998 – 2003 Bachelor of Medicine

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