

6-21-2011

## The Evolutionary History of the Modern Birth Mechanism: Looking at Skeletal and Cultural Adaptations

Sharon Buck

*The University of Western Ontario*, [Sharon.buck29@gmail.com](mailto:Sharon.buck29@gmail.com)

Follow this and additional works at: <http://ir.lib.uwo.ca/totem>



Part of the [Biological and Physical Anthropology Commons](#)

---

### Recommended Citation

Buck, Sharon (2011) "The Evolutionary History of the Modern Birth Mechanism: Looking at Skeletal and Cultural Adaptations," *Totem: The University of Western Ontario Journal of Anthropology*: Vol. 19: Iss. 1, Article 7.  
Available at: <http://ir.lib.uwo.ca/totem/vol19/iss1/7>

This Article is brought to you for free and open access by Scholarship@Western. It has been accepted for inclusion in Totem: The University of Western Ontario Journal of Anthropology by an authorized administrator of Scholarship@Western. For more information, please contact [kmarsha1@uwo.ca](mailto:kmarsha1@uwo.ca).

---

# The Evolutionary History of the Modern Birth Mechanism: Looking at Skeletal and Cultural Adaptations

## Keywords

evolution, birth, obstetrics, cranial capacity, skeletal, adaptation

## Creative Commons License



This work is licensed under a [Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 License](https://creativecommons.org/licenses/by-nc-nd/3.0/).

## **The Evolutionary History of the Modern Birth Mechanism: Looking at Skeletal and Cultural Adaptations**

Sharon Buck

### ***Introduction***

The development of bipedalism changed the course of hominin evolutionary history. One of the most significant impacts it had, outside of locomotion, was on birth. The advent of bipedalism, combined with later encephalization, has placed many evolutionary constraints on the birth process. As a result of evolutionary pressures, a series of skeletal and cultural adaptations occurred making the modern birth process unique. This paper reviews the literature and fossil evidence and will outline the differences between three forms of birth mechanisms: modern, ancient and non-human primate. A look at the variability within these processes will lead to a more complete understanding of evolutionary history and a more critical analysis of the fossil record. This review of research on the evolution of human birth mechanisms is essential, not only to understand our history but also to apply these insights in a modern context. Knowledge of human and non-human primate birth mechanisms is useful for the biomedical community, primate conservationists and socio-cultural anthropologists trying to understand birthing practices throughout different cultures.

### ***Modern birth mechanism***

The features of the modern birth mechanism have a long evolutionary history that correlates to bipedal locomotion and the process of encephalization. Three main features characterize the modern birth mechanism: rotation, navigation of the three pelvic planes and the emergence of the fetus in the occiput anterior position (Rosenberg

and Trevathan 1995:162). Rotation is necessary because the fetal head is largest in the sagittal dimension. Structurally, the maternal birth canal is comprised of misaligned planes, including the pelvic inlet, midplane, and the pelvic outlet. The largest dimension at the pelvic inlet is the transverse direction and the largest at the pelvic outlet is the sagittal direction (Rosenberg and Trevathan 1995:162). Therefore, the fetus rotates so that the sagittal dimension can line up with the largest diameter of each plane (Wittman and Wall 2007:745). The fetus emerges in the occiput anterior position because of the rotation. This can cause problems which require assisted birth. While the occiput anterior position has problems, it is preferred because it is most favourable for distributing the forces of uterine contraction along the fetal spine, and it leads to the most efficient cervical dilation. Another benefit of this position is that it results in the most efficient fetal drive down the birth canal (Trevathan 1988:674).

The process of birth involves many complicated movements of the fetus through the birth canal. The biomedical community typically describes an eight step process based on the gynecoid shape, known as the cardinal movements (Figure 1) (Trevathan 1988: 675). Although understanding the cardinal movement can assist in understanding the birth process, this process can be different based on natural variability in pelvic morphology and/or fetal presentation. As laid out by Trevathan (1988:676), the first step consists of the fetus engaging the birth canal, typically in the oblique or transverse position; the fetus then descends through the pelvic inlet and begins to enter a position of flexion (Trevathan 1988:675). Flexion is assumed to allow the smallest dimension of the cranium to descend first. Internal rotation, the most recognized feature, occurs so that the head can line up

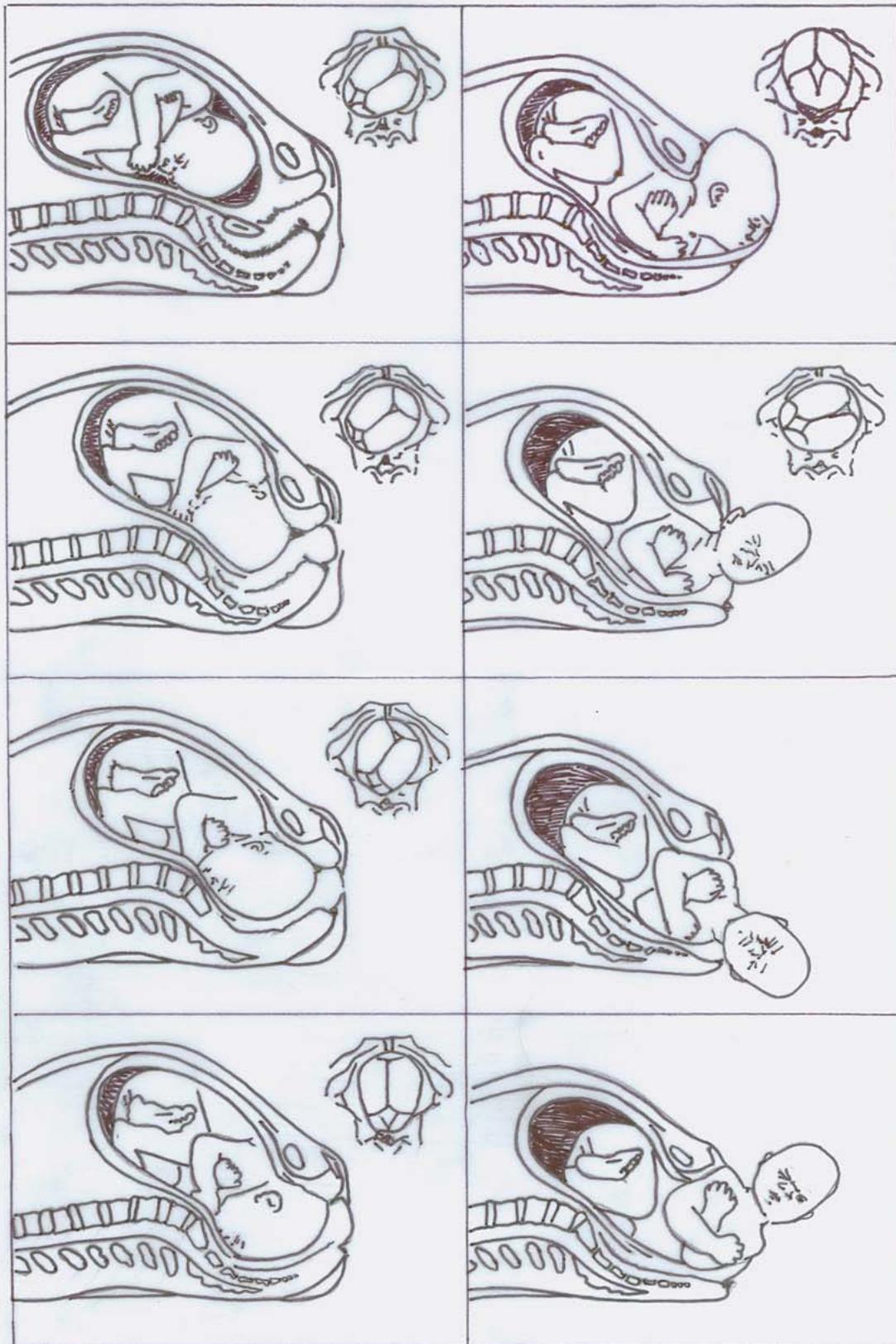


Figure 1: The cardinal movements of birth (redrawn from Walrath 2003: 12)

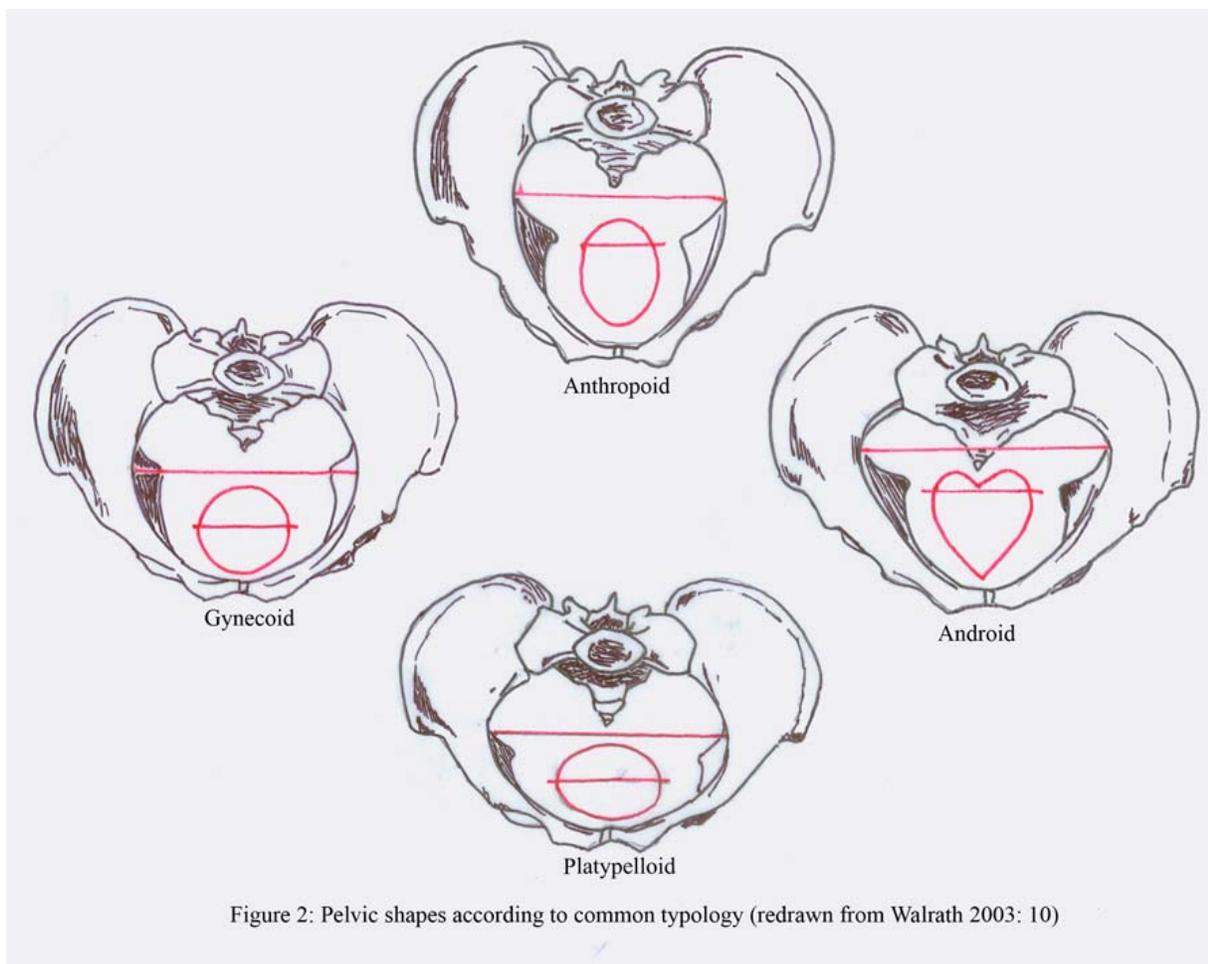
with the largest dimension of the pelvis and to allow the shoulders to pass through the pelvic inlet. After the internal rotation, an extension movement occurs where the fetal head passes under the pubis. The head then returns to the original transverse position after the shoulders pass the pelvic inlet, which is known as restitution (Trevathan 1988:676). Restitution is followed by external rotation of the emerged cranium, which reflects the internal rotation of the shoulders navigating the pelvic outlet. The final step of expulsion is marked by the emergence of the anterior shoulder followed by the posterior shoulder (Trevathan 1988: 676).

The steps outlined above are merely rough guidelines for understanding the birth mechanism. The biomedical concept of a singular mechanism has many flaws. For example, Walrath (2003:13) stated that according to a study where neonates were not actively 'delivered' or manipulated by the birth assistant, the posterior shoulder typically emerges first. Another line of evidence comes from a study showing that in some cases the occiput anterior position does not occur. According to a study of 40,000 births conducted by Walrath (2003: 15), there was a 20% occurrence of malpositions. Clearly, the variability inherent in these cardinal birth movements needs to be studied in depth.

Pelvic morphology is another factor that affects modern birth. There are four main types described: gynecoid, anthropoid, android, and platypelloid (Figure 2). Gynecoid is seen as the ideal pelvic shape for birth even though it occurs in less than 50% of women (Walrath 2003:11). Anthropoid pelves, while differently structured than gynecoid examples, similarly result in an efficient birth mechanism (Walrath 2003: 10). Android is a typically male type pelvis; for this reason, when it is seen in females, it is often associated with hormone imbalances

and hyperandrogenism. Platypelloid-shaped pelves are seen as the least desirable shape for birth as it places the most constraints on fetal head size and shoulder width (Walrath 2003:10). While platypelloid pelves can make birth more difficult, the shape has also been termed "ultra human." This term is used because in modern women a platypelloid shape often correlates to attaining erect posture early in life, and bipedal posture is considered both biologically and culturally to be an important human trait (Abitbol 1996:242). Other factors that can affect pelvic shape include amount of physical activity during childhood, genetic factors, obstetric requirements, environmental factors, cultural factors, and hormone imbalances in females as seen in some women with android-shaped pelves (Abitbol 1996:243). It should be noted that these shapes are broad categories and there can be intermediate pelvic shapes (Figure 3). The pelvic typology just discussed only considers the amount of variability in a minimal sense; this can affect the perception of ancient pelvic shapes by trying to make them fit into one of these categories.

Secondary altriciality is regarded as one of the most important factors of modern birth, as it has vast implications for the evolution of encephalization. Secondary altriciality is defined as the infant emerging in a state of helplessness due to having only a third of the brain size relative to mature adults (Walker and Ruff 1993:227). Within the first year of infancy, their brains develop to more than 2/3 of their adult counterparts as infants have a fetal rate of brain development throughout their first year (Walker and Ruff 1993:227). This rate of brain growth is so substantial that anthropologists have referred to this period as *extero-gestation* or *external gestation* (Rosenberg and Trevathan 1995:166). This adaptation essentially allows encephalization despite the con-



straints of the bony pelvic canal because the fetal rate of brain growth continues for the first year of life. Some anthropologists believe that secondary altriciality only developed in the genus *Homo* around 1.5 mya, although this is hard to establish (Walker and Ruff 1993:233). This adaptation had a large impact on the social structure and life history of our ancestors. The modes of parental care would have consequently changed drastically due to raising such a helpless neonate (Rosenberg and Trevathan 1995:166-67). As with many features of birth, the impact of this evolutionary process has profound implications for our species. Having a basic knowledge of the modern birth process is necessary to understanding the non-human

primate birth mechanism and its similarities and differences.

#### ***Nonhuman primate birth mechanism***

Nonhuman primate birth is considerably different than the modern human birth mechanism. The main differences in the birth mechanism include the following: that the fetus engages the birth canal anteriorly, that there is no rotation during descent and that the neonate emerges in the occiput posterior position. These differences are a result of the simple cylindrical shape of the quadrupedal pelvis (Walrath 2003:16). It is believed that birth in nonhuman primates is considerably less complex than it is for humans because of pelvic morphology. Walrath (2003:17), however, pointed out that nonhuman

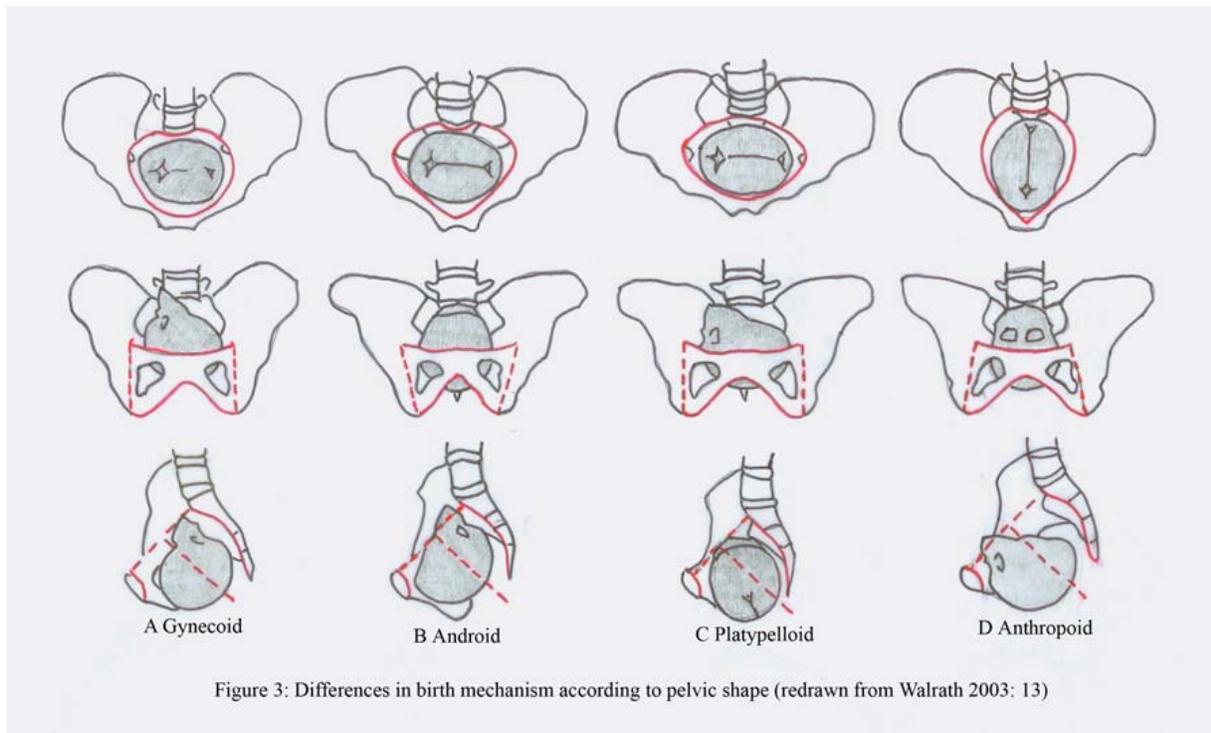


Figure 3: Differences in birth mechanism according to pelvic shape (redrawn from Walrath 2003: 13)

primates have rarely been observed giving birth in the wild. The captive nonhuman primate populations unfortunately cannot answer this question as caesarean sections are typically undertaken. Contrary to this belief in ease of birth, there is some evidence of difficult birth among nonhuman primates. These difficulties may arise from the general encephalization of primates as well as the trend of having closely matched dimensions between the pelvic canal and the fetal head (Walrath 2003:16). Recognizing the possibility of “human”-like difficulty in nonhuman primates is also important in understanding the ease or difficulty of birth in the genera *Australopithecus* and early *Homo*. There is the possibility that birth in nonhuman primates as described in the literature is oversimplified to make the modern birth mechanism seem more complex (Walrath 2003:14). The level of variability seen in nonhuman primates needs to be analyzed in a more systematic manner in order for anthropologists to understand which modern birth features are the result of

evolution occurring after the origin of bipedalism. This analysis of the non-human primate birth mechanism allows for the academic exploration of the ancient birth mechanism in order to recognize how the mechanism changed.

### ***Ancient obstetric mechanism***

The fossil evidence that the ancient birth mechanism is based on is very limited; therefore, the variability may not be fully understood or appreciated. Of the fossil remains, anthropologists can really only use A.L. 288-1 (Lucy) and Sts 14 to understand australopithecine pelvic canals (Tague and Lovejoy 1986:238). Many anthropologists see A.L. 288-1, an *Australopithecus afarensis*, as the best specimen for reconstructing the ancient birth canal because of its remarkable preservation. The pelvis of A.L.288-1 consists of a complete sacrum and left innominate. The entire pelvis was reconstructed using mirror imaging (Tague and Lovejoy 1986:238). According to Tague and Lovejoy (1986:237), A.L.288-1 is

indeed a female but differs in the sexually dimorphic areas found in modern females. There are many features of A.L.288-1 that are interpreted as male-like, such as the angulation of the sacrum, the overall funnel shape, the intermediate subpubic angle and the straight ischiopubic ramus (Tague and Lovejoy 1986:251). The only modern female trait that A.L. 288-1 has is a long iliopectineal line, which, in fact, probably provided no obstetric advantages (Tague and Lovejoy 1986:243). Overall, the morphology of A.L.288-1's pelvis in each plane results in a hyperplatypelloid shape which constricts the bony birth canal (Tague and Lovejoy 1986:244). The authors suggested that the long and extremely curved iliopectineal line greatly influenced the platypelloid shape seen in A.L. 288-1 (Tague and Lovejoy 1986:244).

The hyperplatypelloid shape is a result of a compromise between bipedality, birth and support of viscera (Tague and Lovejoy 1986:250). The three skeletal adaptations that result in a platypelloid pelvis include: an elongated ilia which repositions gluteal muscles, decreased distance between the sacroiliac and hip joints, and a ventrally tilted pelvis that aligns the sacroiliac and hip joints and ultimately results in lumbar lordosis (Tague and Lovejoy 1986:250). All of these adaptations, which support viscera and posture, create a short and narrow pelvis. In order to rectify this problem, the ilia are flared laterally and the sacrum is broadened. This combination of adaptations results in the platypelloid pelvis of A.L. 288-1 (Tague and Lovejoy 1986:250).

The birth mechanism of A.L.288-1 would have proceeded with some features of modern birth but without any rotation (Rosenberg and Trevathan 2003:84). Tague and Lovejoy (1986:248) argue that birth in A.L. 288-1 would have been easy despite the platypelloid shape, due to the small

cranial capacity of the fetus. An *Australopithecus* fetus would have engaged the birth canal as *Homo* did, transversely. The australopithecine fetus would have continued descent along the transverse diameter and there would have been no internal rotation (Tague and Lovejoy 1986: 248). Another modern human-like feature that A.L. 288-1 might have displayed was occiput anterior emergence patterns. Based on pelvic morphology, this emergence pattern may have occurred in approximately 50% of australopithecine births. This emergence pattern would have occurred due to the external rotation which allows the shoulders to pass through the pelvic outlet. This possibility of the neonate emerging in the occiput anterior position may have resulted in the social imperative of assisted birth (Rosenberg and Trevathan 2003: 84)

The pelvis of Sts 14, an *Australopithecus africanus*, is not as well preserved as that of A.L.288-1; it is represented by the first two sacral vertebrae, a nearly complete right os coxae, and elements of the left os coxae which were fully reconstructed using extrapolation and mirror imaging (Abitbol 1995:143). The overall morphology of the Sts 14 pelvis was one of platypelloidy, although the shape was less extreme than that of A.L. 288-1 (Abitbol 1995:157). There were some problems with the reconstruction because three of the sacral vertebrae were entirely based on extrapolation. Moreover, the results of the reconstruction showed that the pelvis had a reduced posterior sagittal diameter and a similar sacral angulation to A.L.288-1, which is deemed male-like (Abitbol 1995:156). The overall features of the pelvis in Sts 14 suggest that birth was most likely nonrotational (Abitbol 1995: 157).

Many significant features of modern birth, such as rotational birth and the infant being born in a state of secondary

altriciality, probably developed during the early forms of the genus *Homo* when there was a leap in encephalization (Wittman and Wall 2007:740). Unfortunately, there is only one female *H. erectus* pelvis. Prior to the discovery of this pelvis, the lack of fossil evidence led Walker and Ruff (1993) to postulate an ancient birth mechanism using KNM-WT 15000 (Nariokotome Boy), an adolescent male *Homo erectus*, as the model. The pelvis of KNM-WT 15000 consists of parts of all three pelvic elements. Reconstruction was undertaken using mirror imaging as well as reference to KNM-ER 3228 (male *H. erectus*) and a modern male pelvis (Walker and Ruff 1993:222). The authors use the reconstruction to posit that secondary altriciality had developed by 1.5 mya. They worked under a series of assumptions: that KNM-WT 15000 was male, that he would have grown in a manner similar to modern humans, and that the amount of sexual dimorphism in *H. erectus* is similar to modern humans (Walker and Ruff 1993: 231). They compare the lengths of the curve between the articular surface and the sciatic spine, to other early *Homo* specimens for which sex is known and to modern males and females. The results reinforced the fact that KNM-WT 15000 is male and provided ratios for the degree of sexual dimorphism (Walker and Ruff 1993: 231-32). Using the ratios obtained, Walker and Ruff (1993:232) compared the expected transverse diameter of the female pelvis to the adult cranial capacity of *H. erectus* specimens. These two measurements helped establish whether there were enough pelvic constraints to necessitate a state of secondary altriciality to reach adult cranial capacity (Walker and Ruff 1993:233). The conclusion of the study indicated that an adult cranial capacity of 900 cc or above would require secondary altriciality (Walker and Ruff 1993:233). Therefore, secondary altriciality probably developed around 1.5

mya, just prior to the emergence of *H. erectus*.

The Gona *H. erectus* pelvis was discovered in the Afar region of Ethiopia and has been dated to 0.9 to 1.4 mya (Simpson *et al.* 2008:1089). There is some deformation in the pelvis due to *in situ* fracture and the cementation of some fragments. Despite the reconstruction of the pelvis, some asymmetry was still present though not enough to dismiss the analysis. Pelvic features of the Gona pelvis that are important for birth include an antero-posteriorly broadened birth canal, a greater transverse diameter of both the pelvic mid-plane, and an outlet than is often seen in modern females (Simpson *et al.* 2008: 1090). These features suggest that the Gona *H. erectus* female was able to give birth to a fetus with a cranial capacity up to 315 ml. This cranial capacity would have meant that *H. erectus* could have experienced modern-like prenatal brain growth as well as a postnatal brain development rate intermediate between modern humans and chimpanzees (Simpson *et al.* 2008:1090). This illustrates that by the early Pleistocene, secondary altriciality was necessary to continue the process of encephalization and that the human pelvis was still undergoing changes to accommodate both bipedalism and encephalization.

Known, identifiable fossils are incredibly important for understanding the ancient birth mechanism. However, problems with the fossil record include its limited nature, the integrity of the fossils, and the lack of soft tissue preservation. As discussed previously, there are truly only two fossils on which to base australopithecine birth mechanisms. For early *Homo*, there are only Nariokotome Boy (which has problems in terms of accuracy of reconstruction) and the recently discovered Gona specimen. There are additional problems with the Nariokotome Boy

analysis, specifically in terms of the assumptions made by Walker and Ruff (1993). In their study, Thompson and Nelson (2000) questioned a central assumption about the growth and development of Nariokotome Boy suggesting that he would not have grown in a manner similar to modern humans but rather in a manner similar to gorillas (486). This growth pattern invalidates most of the obstetric data gained from Nariokotome Boy. There are also disagreements in the anthropological realm regarding the usefulness of both A.L. 288-1 and Sts 14. Many anthropologists argue that A.L. 288-1 is not a good specimen for reconstruction because of the amount of post mortem deformation. Some academics even postulate that A.L.288-1 may in fact be a male, which obviously invalidates any reconstruction of the birth canal (Rosenberg and Trevathan 1995:166). Finally, the lack of soft tissue preservation hinders reconstruction efforts. The placenta determines the physiology of the birth mechanism, and despite all the calculations based on the bony birth canal, if the placenta was significantly different than modern humans, the anthropological conception of the ancient birth mechanism may be fundamentally flawed (Walrath 2003:15). Comprehending the three types of birth mechanism illustrated above permit an examination of the cultural and skeletal adaptations as well the complications that can occur in the modern birth mechanism.

### ***Assisted birth***

Seeking assistance during birth is a uniquely human behaviour. Many anthropologists believe that assisted birth is a social evolutionary adaptation that occurred to decrease the mortality associated with birth. The importance of this social behaviour is demonstrated through the term 'obligate midwifery' and Rosenberg and Trevathan (1995:164) deemed it almost a

"cultural universal". Assisted birth is significant because of the difficulties associated with the occiput anterior position. When modern females attempt to self-deliver, they run the risk of bending the neonate against the natural curvature of the spine. This pull force can damage the neonate's spinal cord, brachial plexus and other muscles and bones (Rosenberg and Trevathan 1995:163). Another difficulty is that a self-delivering modern mother cannot efficiently clear the airways of the neonate. Additionally, if there are complications such as the umbilical cord being tangled or wrapped around the neonate, the mother often does not have enough leverage to remedy these problems (Rosenberg and Trevathan 1995:163). These complications do not mean that modern women cannot self-deliver, but even a slight reduction in infant and maternal mortality is important enough for this behaviour to be evolutionarily adaptive (Trevathan 1988: 679). Having examined assisted birth, a look at the skeletal adaptations impacting the birthing process is warranted.

### ***Skeletal adaptations***

Since the advent of obligate bipedalism, a whole set of skeletal adaptations have had to occur for it to be an efficient means of locomotion. Some of the changes necessary included anterior movement of the foramen magnum, anterior displacement of the sacrum (which created cervical and lumbar curves), lengthening of the lower extremities, development of valgus knees, development of stable planter foot, loss of the divergent big toe, and the alteration of the pelvis from a simple cylinder to misaligned planes (Wittman and Wall 2007:740). The changes in the pelvis have had great significance for birth mechanisms.

The changes in the female pelvis are incredibly important because there has to be

a compromise between the functions of locomotion, posture, support of viscera, and birth (Tague and Lovejoy 1986:237). The two largest requirements for successful birth throughout hominin evolution have been the accommodation of encephalization and broad rigid shoulders. The changes in the pelvis that result from birth requirements are not as significant as one might expect. This may be due to the malleability of the fetal head and the fact that the fetus is born in a state of secondary altriciality (Wittman and Wall 2007:740). There are, however, a few important pelvic changes resulting from bipedalism that affect birth. One such change is the broadening of the sacrum and its movement caudally. While this change relates strictly to bipedalism and is not a sexually dimorphic trait, a broader sacrum increases the transverse diameter of the birth canal (Wittman and Wall 2007:742). The ischial spines are more prominent for greater muscle attachment to stabilize viscera during erect posture which constricts the midplane of the pelvis (Wittman and Wall 2007:743).

Another significant skeletal adaptation was lumbar lordosis, which relates to maternal health and the accommodation of fetal load. The modern human skeleton shows an adaptation to bipedalism in the lumbar region of the spine. This modification manifests itself as a derived concavity in the lumbar region (Whitcome *et al.* 2007:1075). This concavity developed because there are a different number of vertebrae, different lengths of vertebrae and wedged vertebrae in bipeds when compared to quadrupeds. Lordosis is necessary to stabilize the upper body and to place the center of mass over the hips (Whitcome *et al.* 2007:1075). The lumbar region is a very sexually dimorphic region of the skeleton because females need additional curvature to center their weight when carrying fetal load (Figure 4). Modern females have three

wedged vertebrae while males only have two (Whitcome *et al.* 2007:1076). The third wedged vertebra allows an increase in lordosis without dangerous intervertebral rotation. This is extremely important because women compensate for fetal load by extending the lower back by as much as 28° (Whitcome *et al.* 2007:1075-76). This is significant since, during pregnancy, the mass of the abdomen increases up to 31% (Whitcome *et al.* 2007:1075). If there was no increased reinforcement in the lumbar region of females, there would be associated problems including shearing forces along the spine, increased risk of forward displacement of lumbar vertebrae and greater lower back pain during pregnancy (Whitcome *et al.* 2007:1075). The fact that females have three wedged vertebrae reduces the shearing forces along the lumbar region up to 30% (Whitcome *et al.* 2007:1076). The lumbar region is clearly integral to the health of pregnant females so it undergoes strong selective pressure and a similar degree of sexual dimorphism in this area is seen as early as the australopithecines (Whitcome *et al.* 2007:1076). Despite this suite of impressive skeletal adaptations allowing for bipedalism and successful birth, there are still some problems that bipedal locomotion introduced into the birthing process.

### ***Complications***

Complications in the birthing process occur as a result of the evolution of large brained offspring and a small, narrow birth canal. Two serious complications result from the constraints of the pelvic canal. Cephalopelvic disproportion is a complication when the fetal head is too large to enter the birth canal. The fetus becomes blocked and birth cannot progress (Rosenberg and Trevathan 1995:161). The second serious complication is shoulder dystocia which occurs when the fetal head

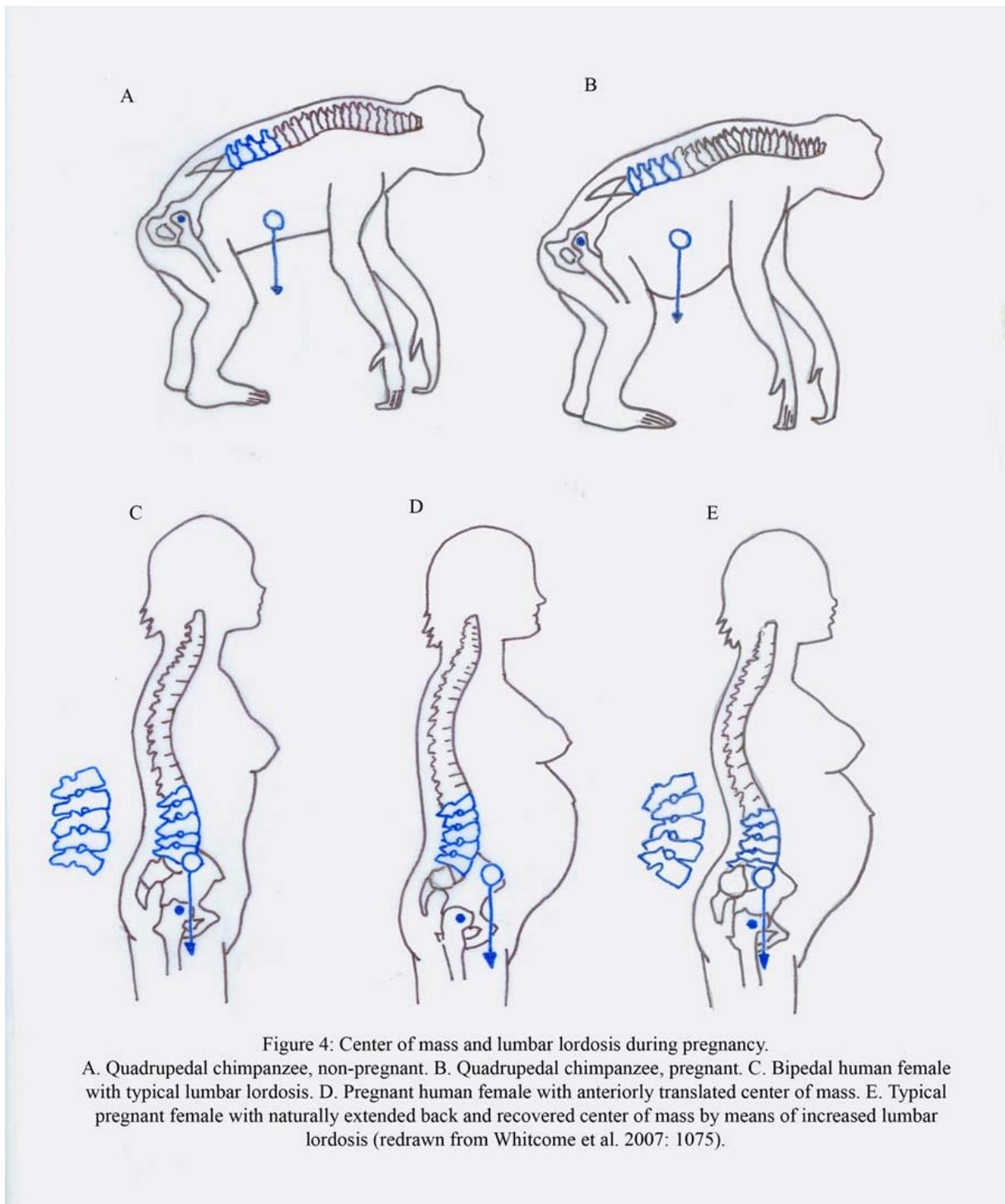


Figure 4: Center of mass and lumbar lordosis during pregnancy.

A. Quadrupedal chimpanzee, non-pregnant. B. Quadrupedal chimpanzee, pregnant. C. Bipedal human female with typical lumbar lordosis. D. Pregnant human female with anteriorly translated center of mass. E. Typical pregnant female with naturally extended back and recovered center of mass by means of increased lumbar lordosis (redrawn from Whitcome et al. 2007: 1075).

enters the birth canal, but the shoulders become lodged at some point during the navigation of the pelvic planes (Trevathan 1988:677). These complications have typically led to death for both the infant and the mother in the past, but the invention of

the cesarean section has allowed for greater survival rates (Weiner *et al.* 2008: 469).

Some anthropologists believe that difficulty during birth is merely a myth perpetuated by the biomedical community (Walrath 2003:14). The notion that birth is a

“scar of evolution” or that an obstetrical dilemma is a prevalent idea since birth now takes place in a hospital setting (Walrath 2003:14). The idea of difficult birth also comes from the singular birth mechanism. Evolutionary theory typically focuses on the variability in humans; however, for this particular topic, a monotypic birth mechanism is postulated. It is possible that complications are merely misinterpretations of variability (Walrath 2003:15). There are different birth mechanisms prevalent in other cultures. One such example of an alternate birth mechanism is women from other cultures who deliver in a squatting position rather than in a hospital bed (Rosenberg and Trevathan 1995:163). Walrath (2003) also points out that tolerance for birth variability is steadily decreasing. This lack of tolerance is seen in length of birth; if females do not deliver within 14 hours, operative delivery is undertaken. This has decreased from 24 hours (Walrath 2003: 9). In addition, physicians often measure the maternal pelvis to decide if vaginal labour will be allowed or if operative delivery should be undertaken (Walrath 2003:13). The “normal” birth mechanism is contested through changing definitions of normal fetal presentation in the medical community and debate on which shoulder should be delivered first (Walrath 2003:13). Walrath (2003:18) states that in order to understand how birth progressed in the past, a greater understanding of modern day biological and cultural variability must be undertaken first, as well as a closer examination of nonhuman primate birth mechanisms.

### **Conclusion**

The development of bipedalism had many effects on human evolution but one of the more significant impacts was on the birth process. An array of skeletal adaptations took place which have had had

long lasting impacts. The consequent process of encephalization placed conflicting pressures on the birth process. The evolution of the ancient obstetric mechanism to the modern obstetric mechanism is fascinating, as conflicting pressures existed with regards to bipedalism and the continuation of our genus. The compromises made in the female body have resulted in a unique human birth mechanism. Understanding the suite of biological and cultural adaptations in the most complete sense is essential for anthropologists to comprehend and critically analyze the fossil record. The evolution of birth is critical because it has the first and most direct impact on natural selection as any serious complications may result in death for mother and fetus. Due to this immediate effect on the gene pool, it has shaped human evolution more than any other skeletal or cultural adaptation.

### **Acknowledgements**

I would like to thank my family for their endless support in everything I strive for, as well as Samantha Gordon for being my faithful editor. Finally, I would like to thank Professor Andrew Nelson for encouraging me to submit my paper to Totem in the first place.

### **Works Cited**

- Abitbol, Maurice M. 1995. Reconstruction of the STS 14 (*Australopithecus africanus*) Pelvis. *American Journal of Physical Anthropology* 96:143-158.
- . 1996. The Shapes of the Female Pelvis: Contributing Factors. *Journal of Reproductive Medicine* 41:242-250.

- Rosenberg, Karen and Wenda R. Trevathan. 1995. Bipedalism and Human Birth: The Obstetrical Dilemma Revisited. *Evolutionary Anthropology* 4:161-168.
- . 2003. The Evolution of Human Birth. *Scientific American* 13:80-85.
- Simpson, Scott W., Jay Quade, Naomie Levin, Robert Butler, Guillaume Dupont-Nivet, Melanie Everett, and Sileshi Semaw. 2008. A Female *Homo erectus* Pelvis from Gona, Ethiopia. *Science* 322:1089-1092.
- Tague, Robert G. and C. Owen Lovejoy. 1986. The Obstetric Pelvis of A.L. 288-1 (Lucy). *Journal of Human Evolution* 15:237-255.
- Thompson, Jennifer L. and Andrew J. Nelson. 2000. The Place of Neandertals in the Evolution of Hominid Patterns of Growth and Development. *Journal of Human Evolution* 38:475-495.
- Trevathan, Wenda R. 1988. Fetal Emergence Patterns in Evolutionary Perspective. *American Anthropologist* 90:674-681.
- Walker, A. and Christopher B. Ruff. 1993. The Reconstruction of the Pelvis, in *The Nariokotome Homo Erectus Skeleton*. Edited by A. Walker and R. Leakey, 221-233. Cambridge, Massachusetts: Harvard University Press.
- Walrath, Dana. 2003. Rethinking Pelvic Typologies and the Human Birth Mechanism. *Current Anthropology* 44:5-31.
- Weiner Stuart, Janet Monge and Alan Mann. 2008. Bipedalism and Parturition: an Evolutionary Imperative for Cesarean Delivery? *Clinics in Perinatology* 35:466-478.
- Whitcome, Katherine K., Liza J. Shapiro and Daniel E. Lieberman. 2007. Fetal Load and the Evolution of Lumbar Lordosis in Bipedal Hominins. *Nature* 450:1075-1080.
- Wittman, Anna Blackburn and L. Lewis Wall. 2007. The Evolutionary Origins of Obstructed Labor: Bipedalism, Encephalization, and the Human Obstetric Dilemma. *Obstetrical and Gynecological Survey* 62:739-748.