

Mechanism of birth in chimpanzees: humans are not unique among primates

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Researchers have argued that the process of human birth is unique among primates and mammals in that the infant emerges with its face oriented in the opposite direction from its mother (occiput anterior) and head rotation occurs in the birth canal. However, this notion of human uniqueness has not been substantiated, because there are few comparative studies of birth in non-human primates. This paper reports the mechanism of birth in chimpanzees (*Pan troglodytes*) based on the first clear, close-up video recordings of three chimpanzee births in captivity. In all three cases, the foetus emerged with an occiput anterior orientation, and the head and body rotated after the head had emerged. Therefore, these characteristics are not uniquely human. Furthermore, in two of the three cases, the chimpanzee newborns landed on the ground without being guided from the birth canal by the mother. The fact that the human newborn emerges with an occiput anterior orientation has thus far been taken as evidence for the necessity of midwifery in modern humans, but this view also needs revision. Our observations raise the need to reconsider the evolutionary scenario of human birth.

Keywords: mechanism of birth; chimpanzee; occiput anterior; foetal rotation; parturition

1. INTRODUCTION

Large brains and bipedal walking in modern humans have made parturition an especially difficult task [1,2]. Researchers have argued that the process of human birth is unique among primates and mammals in three aspects: the mechanism of birth, difficulty of labour, and behaviour during and after labour [3–5].

The mechanism of birth refers to the way the baby adapts itself to and passes through the maternal pelvis [6]. Traditionally, the mechanism of birth in non-human primates has been considered a simple process (e.g. [3,5,7]). The foetus passes through the birth canal without significant changes in orientation, although one report indicated the rotation of monkey foetuses through the birth canal of a different sort from that seen in humans [8]. The head of the foetus emerged from the birth canal with its face oriented towards the anterior side of the mother (occiput posterior, figure 1a). This occiput posterior position is

adaptive because the mother is able to safely lift the infant towards her and clear its breath passage soon after the birth.

In contrast, the mechanism of birth in modern humans involves a number of movements and rotations of the head of the foetus in the birth canal (e.g. [3–5,7]). This is due to the tortuous birth canal and close correspondence of the size of the foetal head with the size of the birth canal in humans, which leads to difficult parturition, the second unique human aspect of birth. Usually, the human foetus emerges from the birth canal ‘facing away’ from the mother, with its face oriented towards the backside of the mother (occiput anterior, figure 1b). This is considered to be disadvantageous because the mother cannot meet the immediate needs of the infant after the head emerges [4]. It has been suggested that the occiput anterior emergence pattern accounts for the third uniquely human aspect of birth, that is, the birth is attended by other individuals, such as midwives, and mothers actively seek assistance in childbirth [4,5,7,9].

However, the above notion about human uniqueness is not entirely confirmed because there are few comparative data on birth in non-human primates [10]. Birth in non-human primates is generally a solitary event, and observers have had few chances to record births in the wild. In addition, the process of parturition is quick, and precise prediction of its timing is difficult. Thus, it is extremely rare that observers are able to witness the event in close enough proximity to determine the mechanism of birth in captive settings. Here, we report the orientation of chimpanzee newborns when they emerge from the maternal birth canal based on the first clear video recordings of the births of chimpanzees.

2. MATERIAL AND METHODS

The chimpanzees (*Pan troglodytes*) in this study were cared for at the Great Ape Research Institute of Hayashibara Biochemical Laboratories, Inc. Three births were observed. In the first case, Tsubaki was the mother and Natsuki was the offspring. In the second case, Misaki was the mother and Hatsuka was the offspring. In the third case, Mizuki was the mother and Iroha was the offspring. The three mothers were all primiparous. The offspring were all females. In all cases, the father was Loi, one of the group’s males; paternity was confirmed by DNA analysis. Based on daily monitoring of urine samples from these female chimpanzees with the use of an ovulation test kit (Check One LH, ARAX Co., Ltd.), the date of ovulation could be determined. Naturalistic observation of their behaviour while they were in the enclosure confirmed mating between females and males on the estimated day of ovulation. Therefore, the date of conception could be estimated to be the day of the female’s last ovulation.

In the first case, Tsubaki was 8 years and eight months old on the day of conception. She was 40 kg at the time and 50 kg just before the parturition. The gestation length was 248 days. In the second case, Misaki was 8 years and nine months old on the day of conception. She was 40 kg at the time and 46 kg just before the parturition. The gestation length was 243 days. In the third case, Mizuki was 11 years and zero month old on the day of conception. She was 52 kg at the time and 55 kg just before the parturition. The gestation length was 235 days. The body weights of the mothers, and the gestation lengths were all within normal ranges of the previous data on captive chimpanzees [11].

The body weights of the newborns could not be measured on the day of their birth because the mothers held the newborns, and we did not intend to intervene in the natural maternal behaviours. The body weights were measured at later times (electronic supplementary material), and these data were within normal ranges for captive chimpanzees [11].

On the day of delivery, the mother was separated from her group mates after a staff member noticed signs of labour, and she was introduced to a booth prepared for parturition. Researchers who were familiar with the chimpanzees stayed in the same space and recorded

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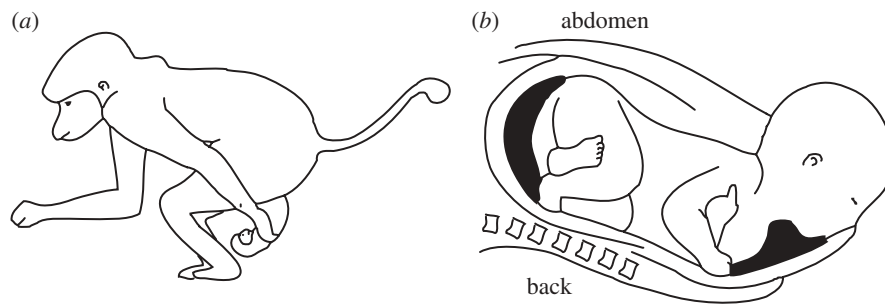


Figure 1. Schematic drawings of the emergence of newborn. (a) Occiput posterior orientation in monkeys. (b) Occiput anterior orientation in humans. The drawings are based on Trevathan [3], Rosenberg [5] and Rosenberg & Trevathan [7].

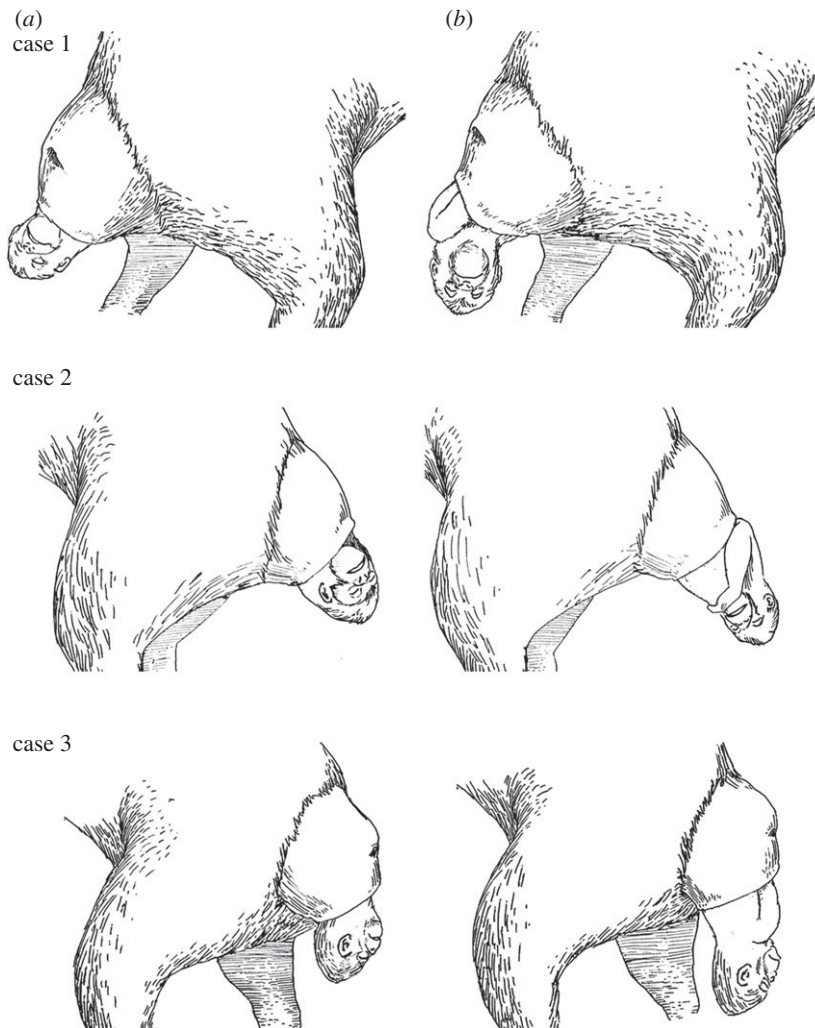


Figure 2. Schematic drawings of the orientation of the face and shoulders when the newborn chimpanzees emerged from the maternal birth canal. The drawings are based on the video recordings. Case 1: Tsubaki was the mother and Natsuki was the newborn. Case 2: Misaki was the mother and Hatsuka was the newborn. Case 3: Mizuki was the mother and Iroha was the newborn. (a) Emergence of the face and (b) the shoulders.

the behaviour with a video camera. The birth was natural, and there was no human intervention. The newborns began to breathe and move soon after birth. Neither health nor physical problems of the mother or newborn were detected in any case. Further details are presented in the electronic supplementary material.

3. RESULTS

In each of the three cases, the foetus emerged in an occiput anterior position (figure 2; electronic supplementary material, videos S1–S3). The sagittal dimension of the foetal face was oriented approximately 30° rightwards in

case 1, about 15° leftwards in case 2, and almost 0° in case 3 to the sagittal dimension of the mother's perineum. In each of the three cases, the coronal dimension at the shoulders of the foetus was aligned in a sagittal dimension to the mother's perineum when it emerged (figure 2; electronic supplementary material, videos S1–S3). The left shoulder was oriented towards the posterior top of the outlet of the mother's perineum in cases 1 and 3, and the right shoulder was oriented towards the posterior top of the outlet of the mother's perineum in case 2. This indicates that the head of the foetus is obliquely

twisted in relation to its body in the birth canal, and the head is rotated outside the birth canal (external rotation), so that it is in a normal relationship to the shoulders. After the entire body emerged, the newborn was immediately lifted up by the mother in case 2, and it dropped onto a straw layer on the floor in cases 1 and 3.

4. DISCUSSION

Our observations contradict the traditional view that the occiput anterior position and head rotation are unique to human birth. Observations in the early twentieth century, which were based on direct observation without videos, have indicated the presence of the occiput anterior position in captive chimpanzees [12], but recent discussions have rarely referred to this observation. We cannot generalize from just three cases, which may involve idiosyncratic exceptions to general rules, but it is more plausible to assume that the pattern we observed is a result of regulating factors, because the three cases were similar in terms of the direction of the face and shoulders when they emerged. In general, the sagittal and transverse diameters of the maternal pelvis and foetal head, as well as the size of the foetal shoulders, are considered to be determinant factors of foetal orientation in both humans and non-human primates [3,5,13]. However, pelvic size constraints on foetal orientation have been overlooked in great apes. Anthropologists have assumed that the mechanism of birth in great apes is not affected by the relationship between the size of the foetal head and body and the size of the maternal birth canal, because the birth canal is much more spacious relative to the foetal head and body in great apes (e.g. [3,13]).

The neonatal head is largest in the sagittal dimension in all primates, including great apes and humans [7]. In addition, great apes and humans have broad, rigid shoulders [13]. As for the maternal birth canal, the outlet of the maternal pelvis is larger in the sagittal than in the transverse dimension in great apes [14,15]. The chimpanzee birth patterns that we observed can be efficiently explained if we assume that the long axis of the head and body, particularly the shoulders, is aligned with the long axis of the maternal birth canal. Therefore, our observation suggests that the mechanism of birth in chimpanzees is affected by the relationship between the size of the foetal head and body and the size of the maternal birth canal, contrary to the long-held assumption. One aspect that needs additional explanation is the occiput anterior orientation. Further investigation is needed to determine whether this is the typical mechanism of birth in chimpanzees and also whether it can be deduced by the metrics of foetal and maternal morphology. Comparative information on bonobos, the other species of the genus *Pan*, is also needed.

Our observations also indicate that the fact that the newborn emerges facing away from the mother does not necessarily pose the need for a 'midwife' to assist with the delivery. In two of the three cases, the newborns were dropped onto the floor. This may be a result of the captive setting, but it is likely that there are at least some cases in which wild chimpanzee mothers deliver their baby by dropping it, without immediate lifting. Wild chimpanzees make nests, and

parturition has been observed to take place in their nests (e.g. [16]). Therefore, it is not dangerous to drop the newborn into the nest. Our observations show that the newborns that emerged in the occiput anterior position were successfully laid down in a supine position. Researchers have speculated that the occiput anterior birth mechanism in modern humans evolved after the split of *Australopithecus* and *Homo* [5,7]. The evolutionary scenario regarding the uniqueness of human childbirth needs reconsideration.

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