Fetal molding examined with transperineal ultrasound and associations with position and delivery mode

Johanne Kolvik IVERSEN[1,2], MD, Birgitte Heiberg KAHRS[3,4], PhD, Erik Andreas TORKILDSEN[5], PhD, Torbjørn Moe EGGEBØ, PhD[3,4]

[1] *Department of Obstetrics and Gynaecology, Oslo University Hospital*

[2] *Institute of clinical medicine, University of Oslo*

[3] *National Center for Fetal Medicine, Trondheim University Hospital (St. Olavs hospital), Trondheim, Norway.*

[4]*Institute of clinical and molecular medicine, Norwegian University of Science and Technology, Trondheim, Norway.*

[5]*Department of Obstetrics and Gynecology, Stavanger University Hospital, Norway*

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Corresponding author:

Torbjørn Moe Eggebø

Torbjorn.eggebo@ntnu.no

mobile phone: +4792699433

National Center for Fetal Medicine, Trondheim University Hospital (St. Olavs hospital), Trondheim, Norway.

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Condensation

Fetal molding can be diagnosed with ultrasound and differentiated into occipito-parietal, fronto-parietal and parieto-parietal molding

Short Title

Fetal molding diagnosed with ultrasound

AJOG at a Glance

A. ***Why was the study conducted***?

- Knowledge of fetal head molding in labor is incomplete and based mainly on old clinical and radiological studies
- The prevalence and clinical implications of fetal molding in a modern population are unknown

B. ***What are the key findings***?

- Ultrasound examination of fetal molding was feasible
- Molding was most commonly seen in occiput anterior positions as occipito-parietal molding along the lambdoidal suture
- 50% of fetuses with occipito-parietal molding delivered spontaneously
- Fronto-parietal (coronal suture) and parieto-parietal molding (sagittal suture) were associated with malpositions and operative deliveries

C. *What does this study add to what is already known*?

- Molding can be diagnosed and classified with ultrasound
- Occipito-parietal molding was not significantly associated with delivery mode
- The prevalence of fronto-parietal and parieto-parietal molding was lower than reported in old studies

Structured abstract

Background

To accommodate passage through the birth canal, the fetal skull is compressed and reshaped, a phenomenon known as molding. The fetal skull bones are separated by membranous sutures which facilitate compression and overlap, resulting in a reduced diameter. This increases the probability of a successful vaginal delivery. Fetal position, presentation, station and attitude can be examined with ultrasound, but fetal head molding has not been previously studied with ultrasound.

Objective

To describe ultrasound assessed fetal head molding in a population of nulliparous women with slow progress in the second stage of labor, and to study associations with fetal position and delivery mode.

Study Design

This was a secondary analysis of a population comprising 150 nulliparous women with a single fetus in cephalic presentation, with slow progress in the active second stage with pushing. Women were eligible for the study when an operative intervention was considered by the clinician. Molding was examined in stored transperineal 2D and 3D acquisitions, and differentiated into occipito-parietal molding along the lambdoidal sutures (Figure 1), fronto-parietal molding along the coronal sutures and parieto-parietal molding at the sagittal suture (molding in the midline). Molding could not be classified if position were unknown, and these cases were excluded. We measured the distance from the molding to the head midline, molding step and overlap of skull bones (Figure 1), and looked for associations with fetal position and delivery mode. The responsible clinicians were blinded to the ultrasound findings.

Results *Six cases with unknown position were excluded, leaving 144 women in the study*

population. Fetal position was anterior in 117 cases, transverse in 12 cases and posterior in 15 cases. Molding was observed in 79/144 (55%) fetuses. Molding was seen significantly more often in occiput anterior (OA) positions than in non-OA positions; 69/117 (59%) vs. 10/27 (37%); p=0.04. In OA positions the molding was seen as occipito-parietal molding in 68/69 cases, and as parieto-parietal molding in one case with deflexed attitude. Molding was seen in 19/38 (50%) of OA positions ending with spontaneous delivery, 42/71(59%) ending with vacuum extraction and in 7/8 (88%) with failed vacuum extraction (p=0.13). In four fetuses with OP positions parieto-parietal molding was diagnosed and successful vacuum extraction occurred in three cases and failed extraction in one. Fronto-parietal molding was seen in two transverse positions and four posterior positions. One delivered spontaneously, vacuum extraction failed in three cases and was successful in one. Only 1/1l fetuses with either parieto-parietal or fronto-parietal molding delivered spontaneously.

Conclusion *The different types of molding can be classified with ultrasound. Occipito-parietal molding was commonly seen in OA positions and not significantly associated with delivery mode. Fronto-parietal and parieto-parietal molding were less frequent than reported in old studies.*

Key words: molding, head sutures, head position, cesarean delivery, vacuum extraction, labor, sonography, transperineal ultrasound

Abbreviations: OA, occiput anterior; OP, occiput posterior; HPD, head-perineum distance

Introduction

To accommodate passage through the birth canal, the fetal skull is compressed and reshaped, a phenomenon known as molding. The fetal skull bones are separated by membranous sutures which facilitate compression and overlap, resulting in a reduced diameter[1, 2]. This increases the probability of a successful vaginal delivery[1-3].

Mild to moderate compression will cause the occipital and frontal bones to slide under the parietal bones, with straightening and elevation of the parietal bones[1-4]. Increased molding is associated with nulliparous women, oxytocin augmentation and operative vaginal deliveries[5-7]. The biparietal diameter is seldom significantly affected by moderate compression, but as compression increases the parietal bones will press against each other, and in some cases overlap. The forces required for the parietal bones to overlap is substantially higher than the force required for other bones to overlap, and is correlated with an increased risk of cephalopelvic disproportion and fetal complications[1]. Parieto-parietal molding was reported to occur in 25% of labors with cesarean delivery due to poor progress in a South African high-risk obstetric unit in 2008[8], and frequencies around 90% were found in arrested labor in old studies[9, 10].

The clinical definition of molding relates to parieto-parietal bone overlap only: Grade 1 is closure of sutures with no overlap; grade 2 is reducible overlap and grade 3 irreducible overlap. Grades 2 and 3 are associated with risk of cephalopelvic disproportion and increased risk in operative vaginal deliveries[1, 2, 11], and fetal complications including cerebral palsy, intracranial hemorrhage and fetal death[12-14]. Assessment of moulding was traditionally central in practical obstetrics for the aforementioned reasons.

Our scientific knowledge of molding comprises a limited selection of anatomical, clinical, computer-simulation and radiological studies, and the results vary greatly [1-7, 15-17.]. The majority of imaging literature on molding is more than 50 years old. One recently

published study used magnetic resonance imaging in the second stage of labor, but included only seven patients[2]. The knowledge about the prevalence and clinical associations of the different type of molding in a contemporary population is limited.

Ultrasound has a potential to improve knowledge about the labor process, and editorials and opinions in scientific journals have promoted increased use of ultrasound in active labor [18-21]. Fetal position[22, 23]; fetal presentation[24, 25], fetal station[26-29], fetal attitude can be measured[30, 31] and the clinical feasibility has been studied in many publications[23, 28, 32-42]. These have resulted in clinical guidelines published by the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) in 2018[43]. A molded fetal head was diagnosed with ultrasound by Carlan et al, in 1991[44] and Barbera et al in 2009[28], but no systematic studies on molding have used ultrasound. We wanted to describe ultrasound assessed fetal head molding in a population of nulliparous women with slow progress in the second stage of labor, and to study associations with fetal position and delivery mode.

Materials and Methods

This study was a secondary analysis of a European multicentre cohort study from November 2013 to July 2016. The primary aim of this project was to investigate associations between ultrasound assessed fetal station and position with duration of vacuum extraction and delivery mode in term nulliparous women, with slow progress in the second stage of labor[35]. Slow progress was diagnosed after at least 45 minutes of active pushing, in accordance with local protocol. If a vacuum extraction was considered, an ultrasound examination was performed.

Fetal head position was diagnosed with transabdominal or transperineal ultrasound, and classified as hours on the clock. Occiput anterior (OA) was classified as ≥10.00 and ≤ 02.00, occiput posterior (OP) as ≥ 04.00 and ≤ 08.00 and occiput transverse (OT) as >02.00 and <4.00 or >08.00 and <10.00[45]. Fetal head station was diagnosed with a transverse

transperineal ultrasound scan of head-perineum distance (HPD), measured as the shortest distance between the outer bony limit of the fetal skull and the perineum[27, 35].

In this new study we investigated fetal molding in stored 2D and 3D acquisitions from 150 women included in the two participating Norwegian centers (Stavanger university hospital and Trondheim university hospital). The two-dimensional transverse and sagittal images and 3D volumes were obtained between contractions and stored on the ultrasound device, for later off-line analysis. Molding could not be classified if position was unknown, and these cases were excluded. Vacuum extraction was classified as failed if the attempt was converted to forceps delivery or cesarean delivery.

Molding was diagnosed if a step between two neighbouring skull-bones was observed (Figure 1). The different types of molding are illustrated in Figure 2. In molding at the lambdoidal suture, the occipital bone is sliding under the parietal bones (Figure 1 and 3, and Video 1 and 2). At the coronal suture, molding is seen between the frontal and parietal bones (Figure 4 and video 3) and at the sagittal suture molding occurs between the two parietal bones (Figure 5 and video 4). The distance from molding to midline, the step between two bones and the overlap between bones were measured as illustrated in Figure 1. The measurements were taken at the presenting part of the skull; i.e. where the skull was closest to the ultrasound probe.

The ultrasound devices used were GE Voluson *i* (GE Medical systems, Zipf, Austria). The local ethics committees approved the study with reference numbers REK 2012/1865 and all women gave informed written consent. The study was registered in Clinical Trials with identifier NCT01878591. Data were analysed with the statistical software package SPSS statistics version 25.0 (IBM SPSS, Armonk, NY, IMB Corp, USA).

Statistical analysis

Data were presented descriptively, and groups compared with chi-square test, t-test and

Anova with Bonferroni correction. P-values <0.05 were considered significant. Data were analysed with the statistical software package SPSS statistics version 25.0 (IBM SPSS, Armonk, NY, IBM Corp, USA).

Results

Study population

Six cases with unknown position were excluded leaving 144 women in the study population. Characteristics of the study population are presented in Table 1. A transverse transperineal image was recorded in all 144 women, a sagittal image in 124 women and a 3D volume in 112 women. Fetal occiput position was anterior in 117 cases, transverse in 12 cases and posterior in 15 cases.

Molding characteristics

Molding was observed in 79/144 (55%) fetuses, and was seen significantly more often in OA positions than in non-OA positions; 69/117 (59%) vs. 10/27 (37%); (p=0.04). Parieto-parietal molding was seen in the midline. Occipito-parietal molding was not in the midline and the mean distance from the midline was 16.2 mm (range 3-37 mm). The fronto-parietal molding was best seen in the sagittal view, and therefore not possible to relate to the midline. A molding step could be measured in 74/79 fetuses in OA position, with mean value 4.1 mm, ranging from 1.0 to 8.0 mm, and molding overlap measured in 74/79 of cases with mean value 2.4 mm, ranging from 0 to 9.0 mm. In 20/74 (27%) of cases with a molding step, the bones did not overlap. We did not find any significant association between molding and ultrasound assessed fetal station measured as HPD (p=0.10).

Associations with fetal position and delivery mode

In all, 40/144 (28%) fetuses delivered spontaneously, 90/144 (63%) with successful vacuum extraction, and vacuum attempt was converted to forceps in three cases and to caesarean in 11 cases.

In OA positions the molding was rarely seen in the midline because the molding was caused by the occipital bone sliding under the parietal bones (68/69), i.e. occpito-parietal molding (Figure 3). In one OA position with a deflexed attitude, the molding was seen in the midline as a parieto-parietal overlap. Molding was seen in 19/38 (50%) of OA positions ending with spontaneous delivery, 43/71(61%) ending with successful vacuum extraction and in 7/8 (88%) with failed vacuum extraction, (p=0.13). Distance from the midline, molding step or molding overlap were not associated with delivery mode (Table 2).

In four fetuses with direct OP positions (occiput between 5 to 7 o'clock) parieto-parietal molding was seen in the midline (Figure 2) and a successful vacuum extraction occurred in three cases and failed extraction in one. Fronto-parietal molding was seen in two transverse positions (occiput at 9 o'clock) and four oblique occiput posterior positions (occiput at 4 to 5 or at 7 to 8 o'clock). One delivered spontaneously, vacuum extraction failed in three cases and was successful in one. An overview over associations between molding, fetal position and delivery mode is presented in Table 3.

Comment

Principal findings

Fetal molding can be examined with transperineal ultrasound and classified as occipito-parietal, fronto-parietal or parieto-parietal molding when the fetal position is known. We observed fetal molding in 55% of nulliparous women with slow progress in the second stage of labor. Occipito-parietal molding was seen in 47% of the fetuses, fronto-parietal molding in

4.1% and parieto-parietal molding in 3.5%. We did not find significant associations between occipito-parietal molding and delivery mode. The prevalence of fronto-parietal and parieto-parietal molding was substantially lower than in previous publications.

Results in context

Molding is described in older articles and textbooks[1, 3, 14, 46], and parieto-parietal molding is considered as a warning sign for cephalo-pelvic disproportion; especially parieto-parietal molding along the posterior aspect of the sagittal suture[1]. In OA positions, the occiput is the presenting part and molding will typically occur between the occipital bone and the parietal bones, followed by the molding between the frontal bones and the parietal bones[10]. OP positions often present with a deflexed attitude, meaning the compression will fall more anteriorly. The parietal bones will overlap more easily in OP position, as the parietal bones overlap more easily at the frontal part than the posterior part[1, 15]. Our finding of no association between occipito-parietal molding and delivery mode is in line with traditional clinical practice, which considers only parieto-parietal molding to be associated with complicated operative deliveries[8, 46]. A previous clinical study found no correlation between cephalo-pelvic disproportion and fronto-parietal or occipito-parietal overlap, but significant correlation with parieto-parietal overlap[8]. We were not able to differentiate between anterior or posterior parieto-parietal molding in our study. This warrants further investigation.

Clinical implications

A largely forgotten prerequisite for operative vaginal delivery is that the widest bony part of the fetal skull must have passed the pelvic inlet. This usually occurs when the leading bony part of the skull is at the level of the ischial spines. As the fetal skull becomes elongated by compression, the distance from the leading bony part and the largest diameter of the skull

increases[3]. This may mislead the clinician to incorrectly conclude that the prerequisites for operative vaginal delivery is met[47], and lead to increased risk of failed operative vaginal delivery with increased complication rates for the neonate[11]. This risk of misdiagnosis increases with increased grade of molding, and hence is of particular importance where parieto-parietal molding is found. Yet molding is paid little attention in modern scientific journals, perhaps because modern clinicians are unaware of its importance, or because they are unaware of the distinction between parieto-parietal molding and other forms of molding.

Even-though occipito-parietal molding was seen in 7/8 fetuses with failed vacuum, it was also commonly seen in successful operative deliveries and spontaneous deliveries. It is likely a physiologic process, which should not be considered as a warning sign. Parieto-parietal overlap was found in only 5/144 patients (3.5%). This is substantially lower than in older publications and could indicate that true cephalo-pelvic disproportion is rare in a modern population[8-10], probably because operative interventions are done earlier but it may also be an indication of a lower prevalence of narrow pelvis.

Research implications

No previous study has systematically examined molding with ultrasound in a large population and studied molding in different fetal head positions. The body of literature on molding is a patchwork of studies using different modalities, usually with small sample sizes[1-7, 15]. The full picture is opaque, but the overall patterns of molding described in previous publications are mainly in accordance with our findings. It would be of great clinical interest to do further studies on the prevalence and clinical consequence of parieto-parietal molding in modern populations, and answer questions still unanswered, such as the pattern of molding in malpresentations. It is unknown if parieto-parietal molding in OP positions holds the same “signal value” for cephalo-pelvic disproportion as parieto-parietal molding in OA

position, because it has not yet been studied. Ultrasound is uniquely suited for dynamic, physiological studies in labor, and our study demonstrates that it is a promising modality with potential to answer open questions in the anatomy and physiology of human labor, some of which may be of great clinical importance. Our study was done in a mainly Caucasian population and new studies should be done in other populations, as our knowledge of labor mechanics and molding in other pelvic types than the gynecoid is virtually non-exciting.

Strengths and limitations

The main strength of our study was a well-defined population comprising nulliparous women with slow progress in the second stage of labor. Important limitations are that the study design was retrospective and that the ultrasound examiners did not focus on molding during the examinations. The molding was investigated off-line from stored acquisitions. Only molding at the presenting part close to the ultrasound probe could be examined with ultrasound, and other types of molding not seen on the ultrasound images may have been present, especially in transverse positions. We found some cases with fronto-parietal overlap, which is in accordance with previous anatomical and clinical studies, where molding in the transverse positions was typically between the frontal bone and the parietal bone[1, 15]. We do not know if parieto-parietal molding occurs in transverse positions, and it would have been of great interest to compare ultrasound findings with clinical assessments of molding in new studies. We found that 10/11 fetuses with either fronto-parital or parieto-parietal molding ended with an operative delivery, but the subgroups were too small to analyse further in this study.

Conclusions

The different types of molding can be classified with ultrasound. Occipito-parietal molding was commonly seen in OA positions and not significantly associated with delivery mode.

Fronto-parietal and parieto-parietal molding were less frequent than reported in old studies.

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References

1. Baxter J. Moulding of the foetal head; a compensatory mechanism. J Obstet Gynaecol Br Emp 1946;53:212-8.
2. Ami O, Maran JC, Gabor P, et al. Three-dimensional magnetic resonance imaging of fetal head molding and brain shape changes during the second stage of labor. PLoS One 2019;14:e0215721.
3. Moloy HC. Studies on fetal head molding during labor. Am J Obstet Gynecol 1942;44:763.
4. Borell U, Fernstrom I. The mechanism of labour in face and brow presentation. A radiological study. Acta Obstet Gynecol Scand 1960;39:626-44.
5. Lindgren L. The causes of foetal head moulding in labour. Acta Obstet Gynecol Scand 1960;39:46-62.
6. Borell U, Fernstrom I. Shape and course of the birth canal; a radiographic study in the human. Acta Obstet Gynecol Scand 1957;36:166-78.
7. Sorbe B, Dahlgren S. Some important factors in the molding of the fetal head during vaginal delivery--a photographic study. Int J Gynaecol Obstet 1983;21:205-12.
8. Buchmann EJ, Libhaber E. Sagittal suture overlap in cephalopelvic disproportion: blinded and non-participant assessment. Acta Obstet Gynecol Scand 2008;87:731-7.
9. Knight D, Newnham JP, McKenna M, Evans S. A comparison of abdominal and vaginal examinations for the diagnosis of engagement of the fetal head. Aust N Z J Obstet Gynaecol 1993;33:154-8.
10. Stewart KS, Philpott RH. Fetal response to cephalopelvic disproportion. Br J Obstet Gynaecol 1980;87:641-9.
11. Mola GD, Amoa AB, Edilyong J. Factors associated with success or failure in trials of vacuum extraction. Aust N Z J Obstet Gynaecol 2002;42:35-9.
12. Kriewall TJ, Stys SJ, McPherson GK. Neonatal head shape after delivery: an index of molding. J Perinat Med 1977;5:260-7.
13. Bylski DI, Kriewall TJ, Akkas N, Melvin JW. Mechanical behavior of fetal dura mater under large deformation biaxial tension. J Biomech 1986;19:19-26.
14. E H. Cranial Stress in the Fetus during Labour and on the effects of Excessive Stress on the Intracranial Contents ; with an analysis of eighty-one cases of Torn Tentorium

Cerebelli and Subdural Cerebral Hamorrhage. J Obstet Gynaecol Br Emp 1922;29:549-71.
15. Cox L. The Diagnosis of the Position of the Foetal Skull. Aust N Z J Obstet Gynaecol 1961;1:40.
16. Lapeer RJ, Prager RW. Fetal head moulding: finite element analysis of a fetal skull subjected to uterine pressures during the first stage of labour. J Biomech 2001;34:1125-33.
17. McPherson GK, Kriewall TJ. The elastic modulus of fetal cranial bone: a first step towards an understanding of the biomechanics of fetal head molding. J Biomech 1980;13:9-16.
18. Ville Y. From obstetric ultrasound to ultrasonographic obstetrics. Ultrasound Obstet Gynecol 2006;27:1-5.
19. Yeo L, Romero R. Sonographic evaluation in the second stage of labor to improve the assessment of labor progress and its outcome. Ultrasound Obstet Gynecol 2009;33:253-8.
20. Ugwumadu A. The role of ultrasound scanning on the labor ward. Ultrasound Obstet Gynecol 2002;19:222-4.
21. Eggebo TM. Ultrasound is the future diagnostic tool in active labor. Ultrasound Obstet Gynecol 2013;41:361-3.
22. Akmal S, Tsoi E, Kametas N, Howard R, Nicolaides KH. Intrapartum sonography to determine fetal head position. J Matern Fetal Neonatal Med 2002;12:172-7.
23. Ghi T, Farina A, Pedrazzi A, Rizzo N, Pelusi G, Pilu G. Diagnosis of station and rotation of the fetal head in the second stage of labor with intrapartum translabial ultrasound. Ultrasound Obstet Gynecol 2009;33:331-6.
24. Bellussi F, Ghi T, Youssef GS, Giorgetta F, Parma D, Simonazzi G, Pilu G. The use of intrapartum ultrasound to diagnose malpositions and cephalic malpresentations. Am J Obstet Gynecol 2017;217:633-41.
25. Malvasi A, Giacci F, Gustapane S, Sparic R, Barbera A, Tinelli A. Intrapartum sonographic signs: new diagnostic tools in malposition and malrotation. J Matern Fetal Neonatal Med 2016;29:2408-13.
26. Dietz HP, Lanzarone V. Measuring engagement of the fetal head: validity and reproducibility of a new ultrasound technique. Ultrasound Obstet Gynecol 2005;25:165-8.
27. Eggebo TM, Gjessing LK, Heien C, et al. Prediction of labor and delivery by transperineal ultrasound in pregnancies with prelabor rupture of membranes at term. Ultrasound Obstet Gynecol 2006;27:387-91.
28. Barbera AF, Pombar X, Perugino G, Lezotte DC, Hobbins JC. A new method to assess fetal head descent in labor with transperineal ultrasound. Ultrasound Obstet Gynecol 2009;33:313-9.
29. Tutschek B, Braun T, Chantraine F, Henrich W. A study of progress of labour using intrapartum translabial ultrasound, assessing head station, direction, and angle of descent. BJOG 2011;118:62-9.
30. Ghi T, Bellussi F, Azzarone C, et al. The "occiput-spine angle": a new sonographic index of fetal head deflexion during the first stage of labor. Am J Obstet Gynecol 2016;215:84 e1-7.

31. Eggebo TM, Heien C, Okland I, et al. Prediction of labour and delivery by ascertaining the fetal head position with transabdominal ultrasound in pregnancies with prelabour rupture of membranes after 37 weeks. Ultraschall Med 2008;29:179-83.
32. Usman S, Kahrs BH, Wilhelm-Benartzi C, et al. Prediction of mode of delivery using the first ultrasound-based "intrapartum app". Am J Obstet Gynecol 2019;221:163-66.
33. Sainz JA, Borrero C, Aquise A, Serrano R, Gutierrez L, Fernandez-Palacin A. Utility of intrapartum transperineal ultrasound to predict cases of failure in vacuum extraction attempt and need of cesarean section to complete delivery. J Matern Fetal Neonatal Med 2016;29:1348-52.
34. Ramphul M, Ooi PV, Burke G, et al. Instrumental delivery and ultrasound : a multicentre randomised controlled trial of ultrasound assessment of the fetal head position versus standard care as an approach to prevent morbidity at instrumental delivery. BJOG 2014;121:1029-38.
35. Kahrs BH, Usman S, Ghi T, et al. Sonographic prediction of outcome of vacuum deliveries: a multicenter, prospective cohort study. Am J Obstet Gynecol 2017;217:69 e1-69 e10.
36. Eggebo TM, Wilhelm-Benartzi C, Hassan WA, Usman S, Salvesen KA, Lees CC. A model to predict vaginal delivery in nulliparous women based on maternal characteristics and intrapartum ultrasound. Am J Obstet Gynecol 2015;213:362 e1-6.
37. Dall'Asta A, Angeli L, Masturzo B, et al. Prediction of spontaneous vaginal delivery in nulliparous women with a prolonged second stage of labor: the value of intrapartum ultrasound. Am J Obstet Gynecol 2019;221:642 e1-42 e13.
38. Cuerva MJ, Bamberg C, Tobias P, Gil MM, De La Calle M, Bartha JL. Use of intrapartum ultrasound in the prediction of complicated operative forceps delivery of fetuses in non-occiput posterior position. Ultrasound Obstet Gynecol 2014;43:687-92.
39. Bellussi F, Ghi T, Youssef A, et al. The use of intrapartum ultrasound to diagnose malpositions and cephalic malpresentations. Am J Obstet Gynecol 2017;217:633-41.
40. Kahrs BH, Usman S, Ghi T, et al. Descent of fetal head during active pushing: secondary analysis of prospective cohort study investigating ultrasound examination before operative vaginal delivery. Ultrasound Obstet Gynecol 2019;54:524-29.
41. Kahrs BH, Usman S, Ghi T, et al. Fetal rotation during vacuum extractions for prolonged labor: a prospective cohort study. Acta Obstet Gynecol Scand 2018.
42. Sainz JA, Garcia-Mejido JA, Aquise A, Borrero C, Bonomi MJ, Fernandez-Palacin A. A simple model to predict the complicated operative vaginal deliveries using vacuum or forceps. Am J Obstet Gynecol 2019;220:193 e1-93 e12.
43. Ghi T, Eggebo T, Lees C, et al. ISUOG Practice Guidelines: intrapartum ultrasound. Ultrasound Obstet Gynecol 2018;52:128-39.
44. Carlan SJ, Wyble L, Lense J, Mastrogiannis DS, Parsons MT. Fetal head molding. Diagnosis by ultrasound and a review of the literature. J Perinatol 1991;11:105-11.
45. Akmal S, Tsoi E, Howard R, Osei E, Nicolaides KH. Investigation of occiput posterior delivery by intrapartum sonography. Ultrasound Obstet Gynecol 2004;24:425-8.
46. Kerr JMM. *Operative Midwifery.* [S.l.]: Bailliere, Tindall and Cox.
47. van den Akker T. Vacuum extraction for non-rotational and rotational assisted vaginal birth. Best Pract Res Clin Obstet Gynaecol 2019;56:47-54.

Legends

Figure 1
The drawing to the left illustrates molding characteristics. The transverse transperineal image to the right shows a fetus in an oblique occiput anterior position (occiput at 11o'clock) with occipito-parietal molding. A molding step is seen, but with no overlap. The observed molding is not in the midline.

Figure 2
The three types of molding. Occipito-parietal molding (occipital bone under the parietal bone at the lambdoidal suture), fronto-parietal molding (the frontal bone under parietal bone at the coronal suture) and parieto-parietal molding (overlap at the sagittal suture)

Figure 3
Transverse transperineal image of a fetus in direct occiput anterior position (occiput at 12 o'clock) showing molding between the occipital bone and both parietal bones.

Figure 4
Parasagittal image of a fetus in occiput posterior position with fronto-parietal molding

Figure 5
Transverse transperineal image of a fetus in direct occiput posterior position (occiput at 6 o'clock) showing parieto-parietal molding in the midline

Video 1
Transverse transperineal videoclip of a fetus in an oblique occiput anterior position (occiput at 11o'clock) with occipito-parietal molding. A molding step is seen, but with no overlap. The observed molding is not in the midline.

Video 2
Transverse transperineal videoclip of a fetus in direct occiput anterior position (occiput at 12 o'clock) showing molding between the occipital bone and both parietal bones.

Video 3
Sagittal image of a fetus in occiput posterior position with fronto-parietal molding

Video 4
Transverse transperineal videoclip of a fetus in direct occiput posterior position (occiput at 6 o'clock) showing parieto-parietal molding.