Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/3621
DOI URL: http://dx.doi.org/10.21474/IJAR01/3621

ISSN NO. 2320-5407

RESEARCH ARTICLE

EPISIOTOMY AND THE IMPACT ON THE PELVIC FLOOR: BIOMECHANICAL OVERVIEW.

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Manuscript Info

Manuscript History

Received: 07 January 2017
Final Accepted: 04 February 2017
Published: March 2017

Key words:-
Episiotomy; Pelvic Floor Dysfunctions; biocomputational birth simulator

Abstract

Aim: The aim of this review is to provide a comprehensive overview of the available literature on the use of episiotomy and its impact on the pelvic floor and to compare the current knowledge on the subject with recently developed bioengineer programs which allows us to further understand the labor process.

Method: We performed a literature research in the PubMed database for studies referring to the use of episiotomy published between 1990 and 2016, without restrictions for language and study type. We then assessed that knowledge to the findings of a new developing bioengineer program which simulates the childbirth, measuring the level of pressure on the pelvic floor and the outcomes.

Results: Biomechanical models of childbirth allow the simulation of several incisions on the pelvic floor muscles in order to quantify the effect and consequences of episiotomy. According to the analyzed studies, a mediolateral episiotomy reduces the stress on the muscles and the force required to successfully delivery. These models estimate also that the incision limited muscle injury. There was a strong agreement in the findings of the bioengineering program and the current knowledge about medicine. According to the results of the bioengineering study, a mediolateral episiotomy has a protective effect, reducing the stress on the muscles, and the force required during delivery. The intervention also has benefits on muscle injury, reducing the damage to a small zone.

Conclusion: Although there is a strong evidence that the cut applied mediolateral would have less impact on the pelvic floor and a protective effect during delivery, more studies should be made assessing the damage on the perineum and the consequences that may occur (blood loss, infections and others).

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Introduction:-

The pelvic floor is a muscular structure with an essential role in women's well-being and health. Its integrity is essential in maintaining urological, gynecological, gastroenterological and pulmonary functions. (Neels et al. 2016) There are numerous risk factors that can contribute to Pelvic Floor Dysfunction (PFD) which may lead to consequences such as Urinary Incontinence (UI), Fecal Incontinence (FI), Pelvic Organ Prolapse (POP) and sexual problems, like dyspareunia. These problems often deteriorate a women's quality of life and result in the need of complex surgical procedures, with high ratings of reoperation. Some of the main contributing factors to the occurrence of PFD are obesity, congenital factors, aging, pregnancy, childbirth, menopause and Chronic Obstructive Pulmonary Disease (Fritel 2010; Neels et al. 2016), which increase the pressure applied on the women's pelvic floor leading to muscular dysfunction or tears.

Approximately 54% of women have normal vaginal delivery, 21% instrumental delivery and 25% undergo caesarean section. (De Souza et al. 2015) The first two are responsible for the appliance of a higher degree of pressure on the pelvic floor, leading to a higher prevalence of PFD. It was therefore important to find a way of relieving this pressure.

Episiotomy is a surgical incision performed by the obstetrician during the second stage of labor (that ensues after a fully dilated cervix and ends with childbirth) on the musculature of the pelvic floor. It is the most common procedure in Obstetrics(Carroli and Mignini 2009; Graham et al. 2005), even though its routine practice is not supported by studies(Myers-Helfgott MG 1999) (de Tayrac et al. 2006). Its main aim is to create a wider opening of the vagina preventing the hyperdistention and laceration of the perineum, vagina and, most specially, the muscles and aponeuroses of the pelvic floor, amongst which the levator ani muscle, minimizing post-partum complications. The procedure is done without the previous consent of the patient, being now considered a "obstetric violence" (Melo et al. 2014) (an act in which routine medical or pharmacological procedures are conducted without allowing the women to make the decision). There is controversy regarding when to preform episiotomy as a prophylactic measure amongst professionals. Even without this procedure around 23% of women with vaginal delivery need posterior suture of the perineum. (Leal 2014).

Currently the World Health Organization (WHO) recommends the reduction of episiotomy rate to 10%, encouraging physicians to use their judgement when to perform it. (Melo et al. 2014) The problem remains in establishing a protocol of when and which type to use.
The lack of consensus regarding this practice is an ongoing discussion, therefore the importance of biomechanical studies (Oliveira et al. 2016) to assess the impact on the women's pelvic floor and its capability in preventing PFD.

Methods and Materials:

Using the database of PubMed we acquired studies published from 1990 to 2016 about episiotomy and its diverse effects not only during but also after labor, comparing it to the data obtained by the computational model (simulator).

Results:

General knowledge:

The pelvic floor of women is a complex muscular structure that must be kept intact as to prevent future severe damage, one of the most common being PDF which may in time lead to many other consequences that leave the woman unable to have the same life as before.

Childbirth is an occurrence when the pelvic floor undergoes a large amount of stress, sometimes unable to cope with it, leading to an increase likelihood of developing PDF. The highest point of this pressure is felt on the vaginal birth, leading to a much higher incidence of diseases such as urinary incontinence, organ prolapse, chronic pelvic pain and dyspareunia in vaginal childbirths than in cesarean. (Bertozzi et al. 2011) (Victoria L. Handa 2012).

Perineal injury is the most common obstetrical consequence after vaginal childbirth (18,4% in primiparous women and 24,6% in multiparous). (Bertozzi et al. 2011) (Mellier and Delille 1990) Therefore physicians started applying episiotomy as a mode of decreasing the pressure on the pelvic floor in order to attempt to decrease the negative effects vaginal delivery might have had on the pelvic floor. (Fonti et al. 2009; Memon and Handa 2013)

Its appliance leads to a significate reduction of first and second degree tears of the vagina (Lavesson et al. 2014) and anterior perineal lacerations(de Tayrac et al. 2006). It is also associated with a better outcome in assisted deliveries, since the appliance of forceps or perineal tear without episiotomy were associated with higher PFD prevalence 5 to 10 years after birth, unlike with the usage of episiotomy. The likelihood of developing PFD does not increase with the number of episiotomies performed, unlike those with assisted delivery by forceps. The risk of prolapse is much higher in women who suffer natural tears, due to the extensive stretching of the vaginal hiatus which leads to the avulsion of the levator ani. (Victoria L. Handa 2012) It is also performed to hasten the birth, preventing severe damage in a distressed baby, and to minimize or avoid complications from abnormal presentations.
Its use as a routine prophylactic measure was proved not to reduce perineal trauma or pelvic floor relaxation(Klein et al. 1992), thus leading to a more restricted approach to its use. Although being a constant source of discussion and contrary opinions, there is still to be established a consensus regarding its use.

Pelvic floor changes during childbirth:-
The women's pelvic floor is a complex structure that maintains the organs of the pelvic region in place allowing a normal functioning of different systems. This region undergoes an increased amount of pressure during pregnancy, and most notably, during stage II of childbirth. Therefore, it may result in tears and lead to a malfunctioning pelvic floor.

This pavement contains the perineum, the endopelvic fascia, the arcus tendinous fasciae pelvis, the coccygeus muscle, the levator ani muscles and a supporting layer consisting of the anterior vaginal wall and the connective tissue that attaches to the pelvic bones through the pubovaginal portion of the levator ani muscle, and the uterosacral and cardinal ligaments comprising the tendinous arch of the pelvic fascia.

The levator ani muscle along with its associated fascia make the pelvic diaphragm, responsible for maintaining closure of the urogenital hiatus. The anus hiatus on the other hand is composed by the pubic bones and levator ani muscles, the perineal body and external anal sphincter. (Ashton-Miller and DeLancey 2007).

It is easy to understand that the malfunctioning of one of these structures may lead to various consequences on the pelvic floors functions leading to PFDs.

During the II stage of labor the contraction of the abdominal wall and the respiratory diaphragm timed with the peak of uterine contraction greatly increase the pressure on the pelvic floor to successfully drive the fetal head through the hiatus. The pubococcygeus muscle, the shortest and most medial levator ani muscle, suffers the largest tissue strain. Tissue stretch ratios are proportional to fetal head size: increased fetal head diameter by 9% increases medial pubococcygeus stretch by the same amount.

It is also important to note that the pudendal nerve is also susceptible to injury during pregnancy and childbirth, suffering stretching and compression. This is a known risk factor for the development of PFDs, since it is responsible for nervous supply of most of the anatomic structures that maintain pelvic support and continence. (Ashton-Miller and DeLancey 2007; Herbert 2009).

Episiotomy - The procedure:
With the mother on the lithotomy position episiotomy should be performed on the second stage of birth at the time of maximum uterine contraction by inserting two fingers in the vaginal opening (protecting the fetus). If the woman has not received epidural beforehand, a local anesthesia should be applied before using the episiotomy scissor, or less commonly the Mayo scissors, to make an incision of 3-5 cm in length, either midline or mediolaterally. (Bettencourt B. 2003).

If the fetus does not descend, pressure should be applied in the incision site between contractions as to reduce the bleeding and the risk of postpartum hemorrhage.

After the delivery, all layers of the wound should be stitched, being the healing period of 4 to 6 weeks (depending on the length of the incision, type of incision, the suture material used and the proper wound care). The area should be assessed for any signs of trauma.

There is a crescent importance given to the procedure since the way the technique and material might have a preponderant impact on the outcome. (Bertozzi et al. 2011)

Types of Episiotomy:
There are two incisions commonly performed during the procedure: either a midline incision (from the vaginal opening towards the anus) or medio-lateral (diagonal cut from the vaginal opening towards the ischial tuberosity). The former is more used in the USA and preferred due mainly to the suture being easier to perform, a quicker healing process, lesser degree of pain, better sexual function, less blood loss and better cosmetic outcomes. The latter is preferred in South America and Europe because, although the cut does not occur in a natural anatomic plane it is associated with less high degree perineal tears (III and IV) (Thacker 2000).

It is important to access which method is better, or weather a different approach should be used in different settings.

Clinical variables of labor:
Situations that either decrease the compliance of the musculature of the pelvic floor, the vaginal opening or increase the pressure on the pavement might be indications for episiotomy. The variables commonly associated with the more frequent use of episiotomy during the vaginal delivery are primiparity, gestational age >41weeks, augmented or induced labor, epidural analgesia use, oxytocin use, lithotomy position during fetal expulsion and instrumentation. On the other hand, maternal age <35 years or a neonatal weight < 2500g are associated with lower episiotomy rates. (Ballesteros-Meseguer et al. 2016)

Consequences and Complications:
Even though the execution of episiotomy is a relatively simple procedure it still can have some consequences or complications of either the procedure or the posterior wound or scar tissue. Although the health of the child does not suffer alteration from this procedure, there are a lot of unwanted events for the woman that may arise.

Episiotomy is associated with higher postpartum perineal pain levels in the immediate postpartum period, more stress urinary incontinence at 6 weeks and dyspareunia, but studies show recovery after 6 weeks and a complete normal function in 12 months after the procedure. (Macleod et al. 2013) A recent study (Bertozzi et al. 2011) also showed that episiotomy served as a protective factor of the pelvic disorders in terms of quality of life seeing they had better psycho-physical health status in the follow-up. It has also been speculated that it may result in an increase rate of clear cell carcinoma on the scar site (Han, Zheng, and Wang 2016) and bacterial vaginoses(Letouzey et al. 2015).

If a midline episiotomy is performed there is a higher risk of third-degree lacerations, with rare complications such as incontinence for stool and flatus and fistula-formation. If a mediolateral episiotomy is performed it is more frequently linked with impaired wound-healing.(Langer and Minetti 2006; Dimitrov, Tsenov, and Ganeva 2000; Hirsch 1997).

Other very rare consequences that may result from either the procedure or from the wound described in literature are infection, hematoma, cellulite, dehiscence, abscess formation, pudendal nerve lesion, necrotizing fasciitis and death. (Bettencourt B. 2003)

The Future:
Recent attempts have been made to decrease the need of episiotomy in vaginal birth.
Some studies have shown that exercise for the pelvic floor musculature during birth preparation might facilitate the delivery process and might result in reduced numbers of complications of PFD. (Haddow, Watts, and Robertson 2005) (Klein et al. 1997) Others have tried the appliance of a protecting device on the perineum at time of birth providing a structure to stabilize and prevent the extensive distension of the perineum, which might reduce the likelihood of developing a tear. (Lavesson et al. 2014) A device called EpiNo has also been tested to reduce the rate of episiotomy. (Kavvadias and Hoesli 2016) It consists of a device inserted in the vaginal cavity some time before birth, that will gradually distend the tissues, giving time for the musculature to adjust.
Although some research has been made it is still not clear weather their main goal is achieved and weather it leads to a better outcome than with episiotomy.

Biomechanical Overview (Oliveira et al. 2016):
With the advance in modern technology it is possible to simulate very accurately the human body and to experiment the outcome of different situations. There is a crescent tendency of using this model simulators to assess the outcomes regarding a wider range of variables.

Being that selective episiotomy is still a common procedure from either fetal indication (nonreassuring fetal heart, preterm delivery, breech delivery, macrosomia, shoulder dystocia) or if severe perineal trauma is imminent (instrumental delivery, thick inelastic perineum, previous lacerations, short perineal body), it is important to study the delivery techniques and the different outcomes.

A biomechanical numerical model widely used was applied to investigate the quantitative effects of episiotomy on the pelvic floor. For this model, it is used the pelvic floor muscles (levator ani muscles and coccygeus muscle) with a constant thickness of 2mm and assuming the muscles are fully relaxed due to anesthesia. In this study, we were able to see the resulting effect on the musculature of the pelvic floor of the mediolateral incision, varying the angle (30º, 45º and 60º), degree, length (1cm, 2cm and 3 cm, accounting for the absence of the perineum on the model) and time of incision (after the full descent of the fetal head). All these variables were compared to a delivery without episiotomy.

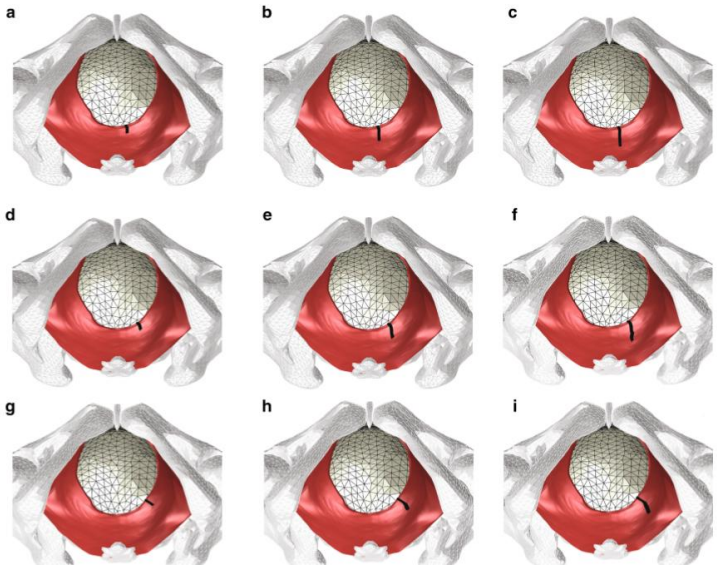

Fig1 – Inferior view of the female pelvic outlet at the moment that medieolateral episiotomy, with different extensions and angles, should be performed, i.e., after the full descent of the fetal head. The elements selected for the different situations are identified in *black color*. The figures on top are related to episiotomies carried out at 30º: **a** 10mm, **b** 20mm and **c** 30mm. The figures in the middle correspond to the episiotomies performed at 45º: **d** 10 mm, **e** 20 mm and **f** 30 mm incision. The last figures are from 60º episiotomies: **g** 10mm, **h** 20mm and **i** 30 mm incision. *(Reprinted with permission from Ref 10).*

It was observed that the distribution of the maximum principal stresses varies when the episiotomy is performed, changing also with the extension of the incision. In the non-episiotomy model the maximum value of stress was seen on the insertion points of the rectal area of the levator ani in the symphysis pubis. When episiotomy is simulated there is a shift of the peak stress observed on the posterior area of the levator ani.

In Fig2 it is evident that the episiotomy angle affects the amount of force experienced by the muscles, and the difference is even more evident the greater the extent of incision (longer incisions require less force of delivery).

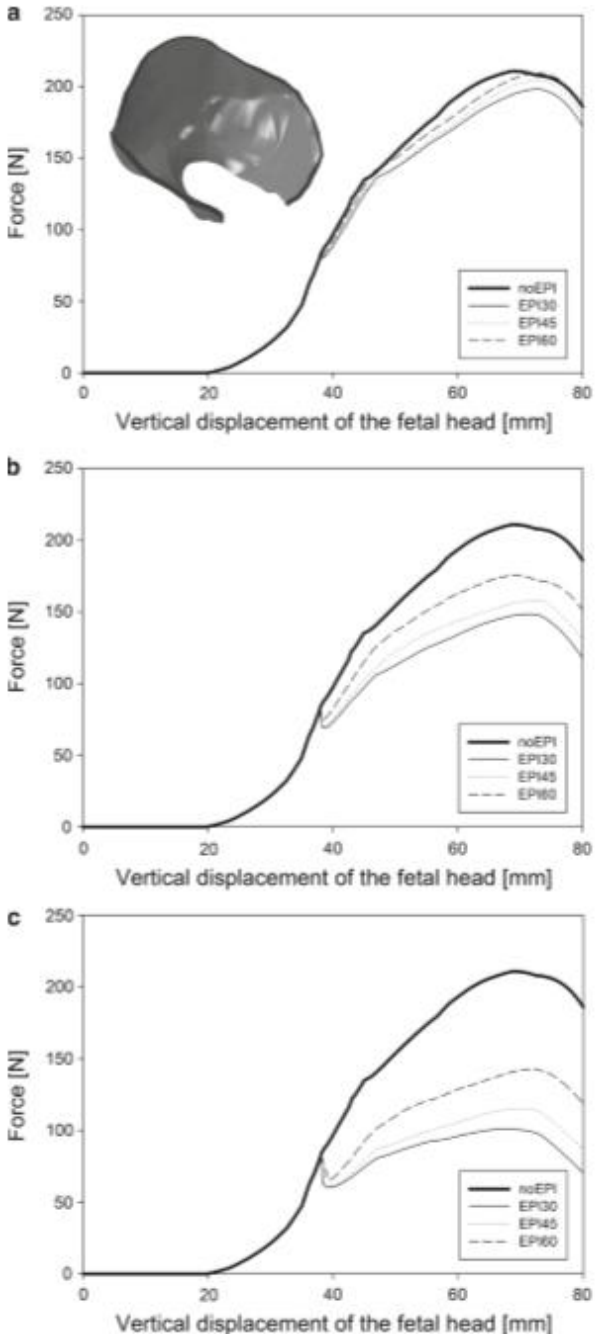

Fig2 – Antero-posterior reaction forces in the pelvic floor muscles during the passage of the fetus, measured in the nodes highlighted in the pelvic floor model, which represents the zone where boundary conditions were applied. noEPI, no episiotomy performed; EPI30, EPI45 and EPI60, episiotomy carried out at 30º, 45º and 60º, respectively. **a** 10 mm incision, **b** 20 mm incision and **c** 30 mm incision *(Reprinted with permission from Ref 10)*

Fig 3 shows us that the extension of the cut affects the amount of muscle damage, no matter which angle of incision is used. The longer the incision, the lower the damage experienced during delivery on the pelvic floor. When comparing the incision angle it is observed that the episiotomy performed at 30º angle is the most protective, since it is the one with less induced muscle damage. In all of the simulated cases, the levator ani is the most affected. If episiotomy is performed the damage is confined to the upper extremity of the incision, without episiotomy the whole muscular portion suffers.

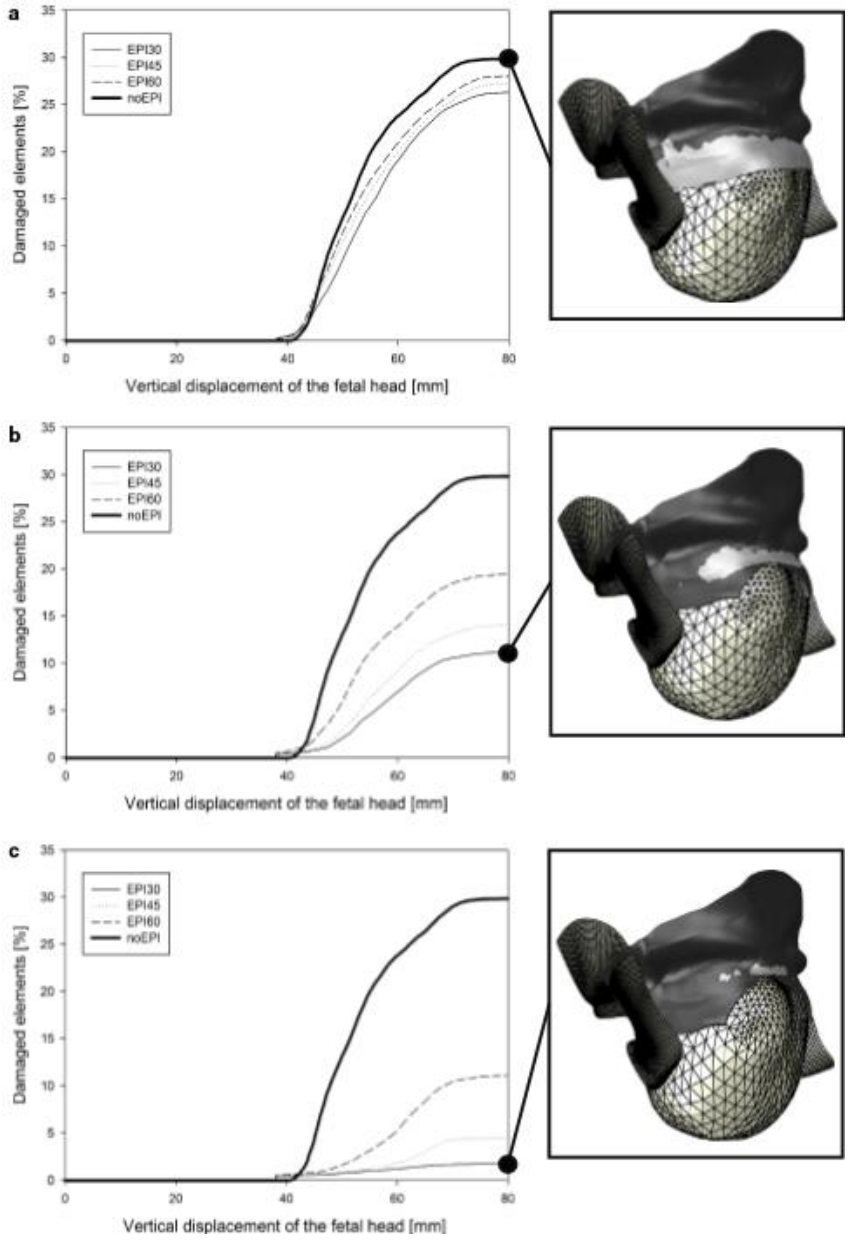

Fig3 – Evolution of the percentage of elements with fiber damage during normal vaginal delivery, and identification of the damaged region in the pelvic floor muscles, represented in light gray, at a vertical displacement of the fetal head of 80mm. noEPI, no episiotomy performed; EPI30, EPI45, EPI60, episiotomies carried out at 30º, 45º and 60º, respectively. **a** 10mm incisions and highlight of the damaged region in the pelvic floor muscles without episiotomy, **b** 20 mm incisions and highlight of the damaged region in the pelvic floor muscles with 30º episiotomy, **c** 30mm incisions and highlight of the damaged region in the pelvic floor muscles with 30º episiotomy. To simplify the images, only fetal head is showing *(Reprinted with permission from Ref 10)*

Episiotomy was associated with a decrease in the opposite forces against the fetal descent, suggesting that mediolateral episiotomy may facilitate birth, protecting the pelvic floor. This study also supports current knowledge that the pubovisceral muscles suffer greater damage and pressure than any other component of the pelvic floor.
Some of the limitations for this study are the need to evaluate the long-term implications of intrapartum care (since this procedure is related to a slower recovery), the evaluation of the muscles of the pelvic floor with distinct characteristics (such as thickness and the need to include the perineum), the fact that the fetal head is rigid hindering fetal head modeling.

Discussion:

Episiotomy is still a controversial subject amongst physicians and the main aim of this study is to clarify some aspects of this procedure, contemplating the different biomechanical effects it has on the pelvic floor. The importance of such simulations is undeniable, and its clinical use has become more regular amongst investigators.
It was clearly proved the role of episiotomy in reducing the stress forces on the pelvic floor. This leads to less strain for the muscles, which is a known risk factor for the development of PFDs. (Bozkurt, Yumru, and Sahin 2014; Chitra and Panicker 2011) As stated in previous studies, it should be seen as a protective measure when certain characteristics, either maternal or fetal, lead to a disproportional pressure of the fetal head on the pelvic floor. (Ballesteros-Meseguer et al. 2016; Fritel et al. 2008) Still, more studies and clinical trials should be made to establish clear guidelines when to perform this procedure.

Regarding the type of episiotomy (midline or mediolateral), due to the lack of representation of the perineum in this model, it was not possible to simulate the midline cut. Still, three different cut angles were performed (30º, 45º and 60º) and the model suggests that a more midline-like cut would be to greater advantage, since it would result in smaller forces against the musculature of the pelvic floor. This is not supported by current studies, that refer the mediolateral cut as the preferred approach, being that it leads to less complications and less risk of secondary tears or lacerations. (Carroli and Mignini 2009; Myers-Helfgott MG 1999; Necesalova et al. 2016; Thacker 2000) It is also known that the healing process occurs more naturally along the midline (due mainly to anatomical reasons). It would be therefore interesting to use a model with the inclusion of the perineum, and to study the post-cut effects on the pelvic floor and the healing process on both methods.

There aren't many known studies that compare the length of the cut used in episiotomy. In a recent study, *M Stedenfeldt et al (Kalis et al. 2012)* proved that scarred episiotomies with depth > 16 mm, length > 17 mm, incision point > 9 mm lateral of midpoint and angle range 30–60° are significantly associated with less risk of injury. The risk for injury decreased by 70% for each 5.5-mm increase in episiotomy depth, 56% for each 4.5-mm increase in the distance from the midline to the incision point of the episiotomy, and 75% for each 5.5-mm increase in episiotomy length. The biomechanical simulator showed a clear lessening of the force suffered by the pelvic floor structures with the increase of the length. But with longer cuts may arise more complications. A trial comparing the outcomes of the healing process with different episiotomies length would be important.

The effect of the timing of application of this procedure was not studied in this model, but according to recent studies (Rusavy, Karbanova, and Kalis 2016) there might be some advantage in applying the cut only when the head reaches it full descent in terms of additional vaginal trauma and blood loss.

Some limitations and prospective for future studies are the lack of consideration of tissue stresses, the simplified fetal head geometry and the lack of consideration of the difference that exists between the different components of the pelvic floor.

Conclusion:

Although it is clear the use of episiotomy is a contributing factor to the decrease of pressure on the pelvic floor during vaginal childbirth, leading to less PFD, it is still unclear the specific guidelines that should be used to apply this procedure, neither which technique should be used.

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