Review Article

Prevalence of Pelvic Floor Muscle Injury as an Impact of Operative Vaginal Delivery: A Systematic Review and Meta-Analysis

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ABSTRACT

Objective: Establishing the rates of pelvic floor muscle (levator ani muscle) injury in patients following operational vaginal delivery (OVD) as determined by 3D/4D transperineal ultrasound was the aim of this meta-analysis.

Methodology: Up until December 2023, a thorough search was conducted across the MEDLINE, PubMed, Google Scholar, and Embase databases. Included were studies on primiparous women who had been diagnosed with levator muscle tears after forceps delivery (FD) or ventouse delivery (VD) using 3D/4D transperineal ultrasound.

Results: Of the 1274 studies that satisfied the eligibility requirements, 26 were included in the study as a result of the search. The computed joint odds ratios were 1.93 (95% CI: 1.31–2.86) for VD over normal vaginal delivery (NVD), 5.33 (95% CI: 3.78–8.11) for FD versus NVD, and 2.36 (95% CI: 1.46–3.84) for FD versus VD.

Conclusion: Pelvic floor muscle damage is more common in vaginal deliveries performed with forceps or vacuum. It is impossible to determine if the particular instrument or the delivery method used in the instrumentation itself is to blame for this harm.

Key Words: Forceps, operative birth, pelvic floor, transperineal ultrasound, vacuum.

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INTRODUCTION

The separation of levator muscle fibers from their attachment on the inferior pubic ramus is known as levator ani avulsion in the Pelvic Floor Muscle (PFM)[1]. Following a vaginal delivery, 10–35% of women get it[2]. The vertex being at station + 3 or + 4[3], when the vicinity of the levator hiatus obtains its largest size[4], is the most essential point for the emergence of PFM damage.

Pelvic Floor Muscle (PFM) separation is difficult to diagnose because, while it can occasionally be seen through a vaginal tearing[5], it is typically missed during labor. As a result, diagnostic imaging procedures including magnetic resonance imaging (MRI)[6,7,8] and three-dimensional (3D) ultrasound have become more important for identifying PFM separation. Transperineal or translabial ultrasonography has been linked to the clinical and MRI evaluation of PFM separation among the two three-dimensional ultrasound modalities (introital and transperineal)[5]. Because of their bigger size and superior ergonomics of the perineal structures, the abdominal probes utilized in transperitoneal ultrasonography also clearly outperform vaginal transducers[9]. We believe that transperineal ultrasonography is the best imaging tool for the research of PFM avulsion because MRI is more expensive, less accessible, and requires fewer anatomical postures.

Compared to a normal vaginal delivery (NVD), an instrumented delivery increases the risk factors for PFM separation. However, the frequency of PFM separation during vacuum delivery (VD) and forceps delivery (FD) varied significantly, which may be because the various research methods are not consistent.

Determining the frequencies of PFM separation in patients following instrumented delivery, as determined by 3D/4D transperineal ultrasound imaging, was the aim of this meta-analysis.

METHODS

Research Procedure

Up until December 2023, a thorough search was conducted across the MEDLINE, PubMed, Google Scholar, and Embase databases. Delivery, Obstetric/adverse effects or Vacuum Extraction, or Obstetric Forceps or Delivery,

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Operative Vaginal Delivery) AND (Pelvic Floor Diagnostic imaging & Pelvic Floor injuries) were the medical topic title terms we used in our search.

Research selection

Researches that satisfied the following requirements were enrolled:

1. Trials used VD or FD to assess the rate of PFM tears,
2. 3&4 Dimensional transperineal ultrasound to diagnose PFM avulsion,
3. Only primigravidas,
4. Provided the data so that we could compute the 95% CIs and odds ratios (ORs).

Data Extraction

There were potential differences in the studies' choice and the data taken from them, but the researchers ultimately came to an agreement. To ensure that there was no bias resulting from the mandatory reconsideration of the exact same research, the papers that belonged to the identical group of workers were evaluated for the time periods in which the investigations were conducted.

Data synthesis

Using Review Manager (Revman) software version 5.4 , two authors independently conducted the meta-analysis. A senior author reconciled any differences by conversation after comparing the results' consistency. Continuous data was pooled using the standards mean difference (SMD) with 95% confidence interval (CI). For meta-analyses, we employed the Mantel-Haenszel and Inverse-Variance approaches, respectively. I-square and chi-square tests were used to measure heterogeneity; low heterogeneity was classified as I2 <30%, moderate as 30%-50%, and high as >50%. I2 test >50 and chi-square test $p<0.1$ both showed significant heterogeneity. The fixed-effects and random-effects models were used to assess the homogeneous and heterogeneous outcomes, respectively. A *p-value* of less than 0.05 was considered statistically significant.

Evaluation of Bias Risk

Analysis was done on the study model data, patients comprised, selection procedure, patient features, and the statistical approach. Two separate authors analyzed the results of the systematic review, evaluated the reliability of the research included and the risk of bias, and identified any potential bias brought on by the study's heterogeneity.

RESULTS

26 of the 1274 papers that were initially found through the search were incorporated in the review due to their compliance with the requirements for inclusion (Figure 1). The investigation conducted by Greenbaum *et al*.[10] stands out among all the omitted studies because, while meeting the requirements for inclusion, it was disqualified for failing to specify the kind of apparatus used during vaginal delivery.

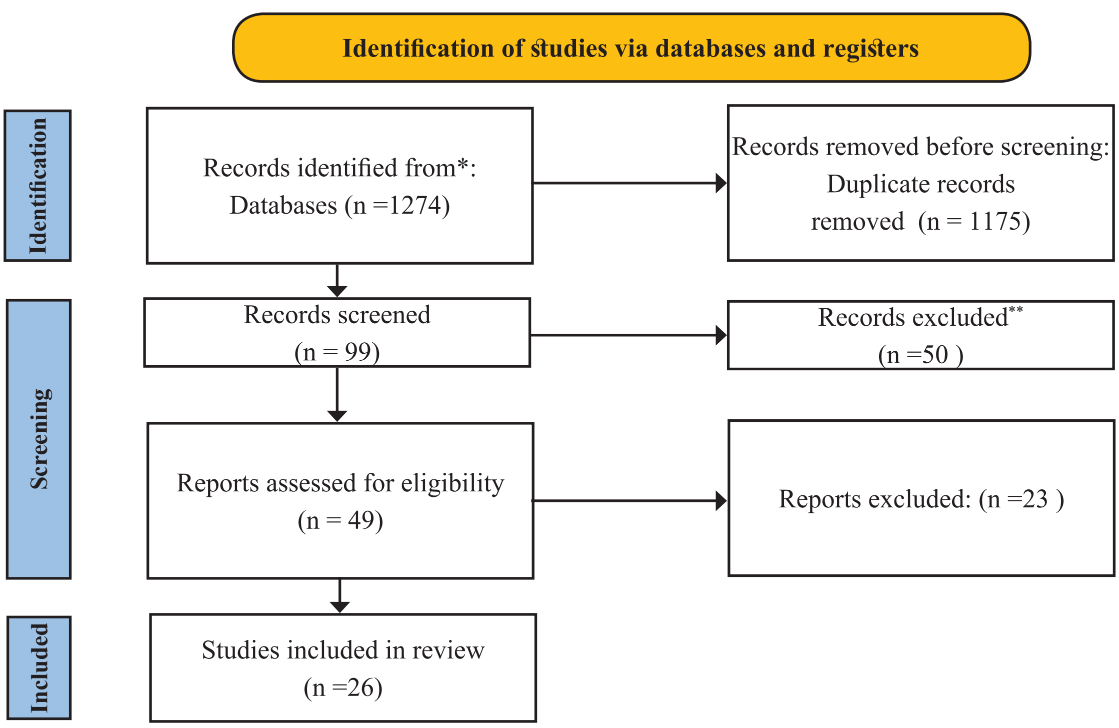

Fig. 1: PRISMA flow chart of the research.

(Table 1) displays the findings taken from the various studies[11–36]. The remaining trials were prospective, while five were retrospective. While some studies conducted ultrasound scans solely or subsequent to this time frame[17,18,21,24,35,36], the majority of studies conducted the examination within 6 months following delivery[11–17,19,20,22,23,25–35]. A tiny number of Forceps Deliveries (12, 13, 14, 27) and Ventouse Deliveries[12,20,27] were mentioned in certain articles, which could have been biased.

Table 1: Prevalence for PFM tears in operative vaginal delivery

Reference, year	Total no.	NVD no.	% full avulsion NVD	VD no.	% full avulsion VD	FD no.	% full avulsion FD	VD vs. NVD OR (95% CI)	FD vs. NVD OR(95% CI)	VD vs. FD OR(95% CI)
Shek and Dietz[11]	367	186	13%	32	9%	20	35%	0.66 (0.18–2.39)	3.60 (1.32–9.97)	5.42 (1.19–24.78)
Albrich *et al*[12]	157	70	38.5%	10	40%	1	100%	1.06 (0.28–4.14)	4.76 (0.19–121.51)	4.35 (0.14–132.95)
Chan *et al*.[13]	339	201	15.4	48	33.3%	14	71.4%	2.75 (1.35–5.58)	13.74 (4.06–46.53)	5.00 (1.35–18.36)
Araujo *et al*[14]	35	16	6.3%	-	-	9	22%	-	4.18 (0.32–54.05)	6.17 (1.58–24.29)
Van Deft *et al*[15]	191	92	9.8%	30	13%	21	48%	1.38 (0.39–4.90)	8.50 (2.83–25.53)	2.94 (0.96–8.94)
Thibault.Gagnon *et al*[16]	294	160	14.4%	47	19.1%	22	40.9%	1.40 (0.6–3.29)	4.10 (1.58–10.70)	-
Michalec *et al*[17]	103	52	7.7%	51	11.8%	--1.60	(0.42–6.05)	--1.60	(0.42–6.05)	4.39 (1.42–13.60)
Memon *et al*[18]	73	-	-	28	18%	45 49%	--4.39 (1.42–13.60)	- 49%	--4.39 (1.42–13.60)	3.42 (1.70–6.89)
Chung *et al*[19]	289	-	-	247	16.6%	42	40.5%	-	-	-
Guedea *et al*[20]	82	11	0%	14	50%	-	-	23.10 (1.14–464.05)	-	-
Durnea *et al*[21]	202		6%		18%		55%	-	-	-
Michalec *et al*[22]	184	92	10%	92	12%	-	-	1.22 (0.49–3.10)	-	1.99 (0.11–35.87)
Caudwell-Hall *et al*[23]	844	452	13%	102	13%	55	44%	1.00 (0.53–1.90)	5.26 (2.89–9.58)	-
García-Mejido *et al*[24]	105	51	9.8%	54	35.2%	-	-	6.00 (1.7–14.73)	-	0.89 (0.54–1.48)
García-Mejido *et al*[25]	146	73	9.6%	73	34.2%	-	-	4.90 (1.95–12.18)	-	0.54 (0.19–1.54)
García-Mejido *et al*[26]	79	-	-	79	34.1%	-	-	-	-	-
Abdool *et al*[27]	84	51	11.8%	4	25%	5	40%	2.48 (0.22–27.94)	5.00 (0.68–36.23)	-
García-Mejido *et al*[28]	89	-	-	-	-	89	38.2%	-	-	2.03(1.36–3.03)
García-Mejido *et al*[29]	263	-	-	162	41.4%	101	38.6%	-	-	0.89 (0.39–1.99)
García-Mejido *et al*[30]	97	-	-	69	33.3%	28	21.4%	-	-	-
Sainz *et al*[31]	255	-	-	-	-	255	40.4%	-	-	-
González-Díaz *et al*[32]	184	-	-	184	32.1%	-	-	-	-	2.03(1.36–3.03)
García-Mejido *et al*[33]	414	-	-	212	32.5%	202	49.5%	-	-	0.89 (0.39–1.99)
García-Mejido *et al*[34]	100	-	14.9%	56	39.3%	44	36.4%	-	-	-
Halle *et al*[35]	212	168	7.1%	40	20%	165	41.8%	2.02 (1.34-3.03)	-	-
Ortega *et al*[36]	165	-	-	-	-	1118	22% to 71%	1.93 (1.31–2.86)	5.33 (3.78–8.11)	-

The PFM separation rate was found in 23 investigations following VD and 19 following FD. PFM separation rates varied from 22% to 71% in the FD cohort and from 9% to 50% in the VD cohort. Since Albrich *et al*.[12] reported a single instance of PFM separation in a sole FD patient, they were disqualified.

Analyses of findings of the included studies

Vaccum delivery (VD) versus normal vaginal delivery (NVD)

When contrasting Vaccum delivery (VD) versus normal vaginal delivery (NVD), 13 studies were evaluated. Using random effects model with inverse variance method to contrast the hazard rate (HR), there is a statistical difference, the summarized hazard rate (HR) is 1.88 with a 95% confidence interval of 1.39 - 2.55. The test for overall effect shows a significance at p<0.05. A significant heterogeneity was found (p= 0.07), suggesting inconsistent effects in magnitude and/or direction. The I2 value indicates that 39% of the variability among studies originates from heterogeneity and not a random chance (Figure 2).

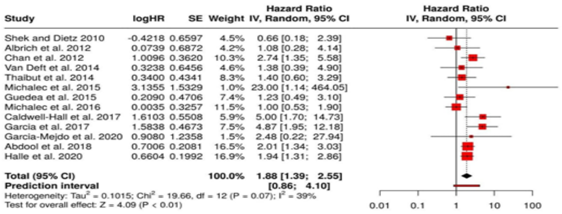

Fig. 2: Evaluation of the pelvic floor muscle (PFM) avulsion rates between vacuum delivery and normal vaginal delivery.

Forceps delivery (FD) versus normal vaginal delivery (NVD)

Contrasting forceps delivery (FD) versus normal vaginal delivery (NVD), 8 studies were analyzed. Using random effects model with inverse variance method to contrast the hazard rate (HR), there is a statistical difference, the summarized hazard rate (HR) is 5.54 with a 95% confidence interval of 3.78 - 8.11. The test for overall effect shows a significance at p<0.05. We did not find notable variability, implying that the effect sizes across studies were uniform in both size and direction (Figure 3).

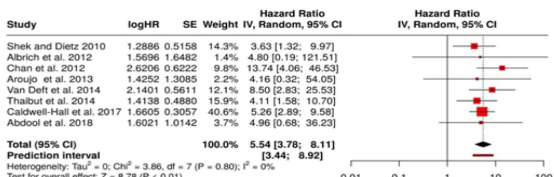

Fig. 3: Evaluation of Pelvic floor muscle (PFM) tears rates between forceps delivery and normal vaginal delivery.

Vaccum delivery (VD) versus Forceps delivery (FD)

When it comes to Vaccum delivery (VD) versus Forceps delivery (FD), 13 studies were tested. Using random effects model with inverse variance method to contrast the hazard rate (HR), there is a statistical difference, the summarized hazard rate (HR) is 2.23 with a 95% confidence interval of 1.43 - 3.47. The test for overall effect shows a significance at p<0.05. A significant heterogeneity was found (p<0.01), suggesting inconsistent effects in magnitude and/or direction. The I2 value indicates that 62% of the variability among studies comes from heterogeneity and not a random chance (Figure 4).

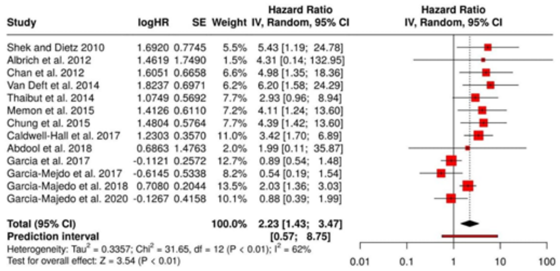

Fig. 4: evaluation of pelvic floor muscle (PFM) tears rates between forceps delivery and vacuum delivery

The type of instrument used during delivery

Thirteen research investigations with VD[11,12,13,15,16,17,18,20,21,22,23,27,35] and ten with FD[11,12,13,14,15,16,18,21,23,27] did not describe the sort of instruments used for delivery. A metal vacuum bird's cup was 50 mm, according to most articles that described the type of vacuum used in the RV[19,24,25,26,29,30,32,33,34]. However, one article also evaluated PFM avulsion following the use of a Kiwi vacuum[32]. While one study examined Anderson and Wrigley forceps, most FD research used Kielland's forceps to explain PFM separation rates[28,29,30,31,33,34,36].

DISCUSSION

With a combined OR for FD vs. VD of 2.36 (95% CI: 1.46–3.84), different rates of PFM separation are reported in VD (between 9% and 50%) and FD (ranging from 22% to 71%). Our results are consistent with those of a prior systematic review[37], which found that FD was linked to a greater incidence rate and degree of PFM separation than NVD[37]. Whether FD exhibits greater rates of PFM separation than VD is up for debate, though. Indeed, a recent meta-analysis supported the use of Kielland's forceps over vacuum-assisted delivery and concluded that they were safe[38]. Nevertheless, PFM was not examined in that meta-analysis.

The inclusion and comparison of various imaging modalities for the investigation of PFM avulsion[39,40], including MRI and 3D introital ultrasonography, is one of the primary issues we discovered in the earlier evaluations. Furthermore, the overwhelming majority of the studies that were part of those analyses did not define the kind of device (such as suction or forceps) or how it was utilized during delivery.

We examined the kind of instrument mentioned in the paper in this meta-analysis. The 50 mm bird's cup was the most widely used vacuum[19,24,25,26,29,30,32,33,34]. With an OR of 0.977 (0.426; 2.241; $p = 0.957$) and an adjusted OR of 2.90 (0.691; 12.20; $p = 0.146$), there were no differences in the PFM avulsion rates when compared to those produced by Malmstrom's vacuum, as only one study mentioned the rate of PFM avulsion in deliveries using another type of vacuum (Kiwi vacuum)[32]. Similar findings were found in the studies that described the forceps type used during the FD; the majority of these studies indicate the rate of PFM avulsion produced by a single forceps type (Kielland's forceps)[28,29,30,31,33,34,36]. There was just one research that used distinct forceps[19], had only 20 subjects (20 using Anderson forceps and 22 using Wrigley forceps), and did not compare the two types' rates of PFM separation.

Just five research[26,28,29,33,36] examined the rate of PFM separation in relation to the instrument's use during instrumented delivery. It was found that neither the location of the fetal head (anterior, posterior, or transverse) at the point of vacuum usage[26], nor the number of vacuum tractions required to finish the fetal extraction, were linked to a higher rate of PFM avulsion. There are disagreements regarding FD. In accordance to reports, the application of rotating forceps (OR: 1.5 [0.6–3.6]; p: not significant), asynclitism correction (OR: 0.8 [0.3–1.9]; *p:* not significant), or the station of the fetal head at the point of forceps positioning (OR: 2.0 [0.8–5.1]; *p*: not significant) does not increase the rate of PFM separation[28]. Nevertheless, with an OR of 2.45 (95% CI 1.22–4.93), a different study found a correlation between rotational forceps and avulsion[36].

A crude OR (without disengagement vs. disengagement) for avulsion was 0.90 (95% CI 0.49–1.67; $p = 0.757$) in one study that examined whether disarticulating the forceps prior to fetal head delivery could increase the rate of PFM. The adjusted OR (adjusted for maternal age, induced labor, epidural period, second stage of labor, perineal tear, and fetal head circumference) was 0.82 (95% CI 0.40–1.69; $p = 0.603$)[31]. Nevertheless, no differences were observed in the frequencies of PFM avulsion between VD and FD when taking into account the fetal head's position (anterior or other) and station (low or medium instrumentation) at the time of instrument placement[29,33].

The duration of transperineal ultrasonography used to diagnose PFM separation is another significant feature of the present research. In order to prevent diagnostic errors, it is recommended that PFM separation be diagnosed three months after delivery[41]. However, a recent meta-analysis authorized this suggestion, suggesting that PFM separation should be diagnosed six months shortly after delivery, or twelve months after FD (Rusavy *et al*.,[37]). However, PFM avulsion may eventually go away, according to many writers[42,43,44,45].

Indeed, we recently found that within nine months after giving birth, partial avulsions can show signs of recovery toward an intact PFM[46]. Avulsions come in two varieties: type II levator muscle separation is irreversible, while type I PFM avulsion is a lesion that may heal with time[47]. This aspect has been proven in anatomy research and by MRI[48], in addition to being reported by transperineal ultrasonography[47]. Although the great majority of the investigations included in this meta-analysis conducted ultrasound exams up to six months following birth[11-17,19, 20,22,23,25-35], they did not evaluate how the ultrasounds changed over time.

The option to carry out a delivery should not be influenced by the fact that PFM avulsion results in a change in the pelvic floor structures' support. Indeed, according to a recent Cochrane study, there is no equipment that can ensure the safety of both the mother and the fetus. However, the clinical environment, the choice of readily accessible instruments, and the operator's skill level will all affect the instrumentation during delivery[49].

The eligibility requirements of this meta-analysis are its primary advantage: only studies involving primiparous women following instrumented births have been considered, and 3D/4D transperineal ultrasound was the sole method used to identify PFM separation. One drawback is that different articles employed different ultrasound exam times, and the majority of research don't say what kind of apparatus or methods were used. Furthermore, no clinical trials exist that may offer reliable proof for the query that prompted this meta-analysis.

CONCLUSIONS

PFM tearing is favored by delivery instruments that use vacuum or forceps. It is now unable to determine if this harm is related to the particular instrument or the delivery method used in the instrumentation.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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