

## NARRATIVE REVIEW

### Are all Kristeller maneuver's forbidden?

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**Doi:** 10.36129/jog.2024.196

## ABSTRACT

**Objective.** Kristeller maneuver was first described by Samuel Kristeller in Berlin in 1867, in literature named "Fundal pressure" (FP), because the original maneuver can be performed in the second stage of labor.

The aim of the narrative review is to point out that the FP maneuver isn't prohibited by all the authors even though there are conflicting opinions in clinical practice and in literature.

**Materials and methods.** A literature search of the last 35 years was performed on PUBMED, SCOPUS, EMBASE, MEDLINE, GOOGLE SCHOLAR, with the aim of clarifying the real advantages or disadvantages of this maneuver and at the same time, to identify in which situations it can be done safely due to the lack in literature, taking into account that more complications about maternal and fetal injuries related to FP are not reported in literature, for medical legal problems.

**Results.** These findings highlight the importance of obtaining informed consent from women before administering FP to ensure the protection of women's autonomy during the birthing process. The impact on the maternal perineum remains uncertain based on our findings.

Through a regression analysis model, author determined that only the duration of the second stage, neonatal weight, and the use of episiotomies were significantly associated with the Kristeller maneuver.

**Conclusions.** It is authors' belief that this maneuver should be reported into the international Guidelines with the aim of having strict but clear indication for its application and reducing future legal litigations.

## KEY WORDS

*Kristeller maneuver; vaginal delivery; review.*

## INTRODUCTION

Kristeller maneuver first described by Samuel Kristeller in Berlin in 1867, in literature is named "Fundal pressure" (FP), an original maneuver that could be performed in the second stage of labor. All the maneuvers have a single purpose which is to apply pressure on the fundus of the uterus to allow for the progression of the fetal head into the birth canal [1 – 3]. In the original procedure of Kristeller, the patient lay in the supine position and the operator placed his hands on the fundus and sides of the uterus. Steele described a combine maneuver of downward pressure with the palms on the fundus with lateral pressure using the fingers, the uterus was brought into correct relation with the pelvic axis and the fetus was forced down into the canal of birth [4]. From Kristeller to modern obstetrics practice many FP maneuvers are described in clinical obstetrics practice and the use of a device called "inflatable belt" [5 – 6]. There isn't sufficient evidence to conclude the beneficial or harmful effects of FP, either manually or by inflatable belt.

This narrative review aim is to evidence that the FP maneuver isn't prohibited by all the authors even though there are conflicting opinions and at the same time to identify in which situations in which it can be performed safely [7]. The authors carried out a literature search of the last 35 years on Pubmed, Scopus, Enbase, Medline, Google Scholar, with the aim of looking at the studies for and against [8].

## MATERIALS AND METHODS

A literature search of the last 35 years was performed on PUBMED, SCOPUS, EMBASE, MEDLINE, GOOGLE SCHOLAR, with the aim of clarifying the real advantages or disadvantages of this maneuver and at the same time, to identify in which situations it can be done safely due to the lack in literature, taking into account that more complications about maternal and fetal injuries related to FP are not reported in literature, for medical legal problems. Strength of this study is the very big quantity of data from the cited studies summarized in two distinct tables while limitation of the study is the under-reporting of the maneuver for fear of litigations causing difficulty to generalize findings to population.

## RESULTS

### Negative opinions

In a review of Verheijen EC et al. there is no evidence whether FP is harmful or beneficial. In his study, FP maneuver was practiced using an inflatable belt device applied during the second stage of delivery. This simple device is wrapped around the woman's abdomen above the level of the uterine fundus and secured with Velcro. A sensor on the tocotransducer, which is also fastened around the woman's abdomen, picks up uterine activity during a contraction, and via a microprocessor controller, automatically causes the belt to inflate to a maximum of 200mmHg for 30s. Results showed no increase in vaginal delivery rate when patients were on epidural analgesia. Furthermore, it must be remembered that there are insufficient data about fetal outcomes.

Regarding perineal damage, this author reports inconclusive evidence [9]. In this study, patients were not blinded, and this factor could have influenced outcomes. It seems indeed, that the belt may have been perceived by patients as 'doing the work' so women have pushed more lightly and the midwives have encouraged them less enthusiastically. But this is a real representation of what happens outside a research setting, where there is no blinding either.

Takmaz in his study concludes that FP in the second stage of delivery is associated with a doubled risk of LAM (Levator ani muscle) defect whether mono or bilateral and a loss of anterior vaginal wall support. These defects were already visible in patients when a 3D ultrasound was made 36 hours after delivery. Patients indeed showed a higher value of anteroposterior hiatal diameter during the Valsalva maneuver or even rest [10].

Regarding FP, Merhi affirms that physicians should use an alternative method to shorten the second stage of labor because there is poor evidence of the efficacy and safety of this procedure, on the contrary, maternal and fetal adverse effects are well documented and the risk of a potential litigation is always present. One solution could be just waiting for the passive descent of the fetal head even if the fetal status is not reassuring. Episiotomy should be avoided considering post-partum pain and dyspareunia. Epidural analgesia indeed, with its known lengthening action on the second stage duration, should also be used mindfully privileging analgesics rather than anesthetics [11].

Youssef in his prospective case-control study concluded that the FP increased more of the double risk of Levator ani muscle avulsion in primiparous patients. Identifying and preventing LAM avulsion is fundamental considering the role this condition plays in subsequent anterior and central compartment pelvic organ prolapse. The author advises not applying this FP and when applied, should be reported in patients' records [12].

Moiety concludes that FP is a maneuver that should be standardized and reported in a guideline. The author has found a shortening in the second stage of labor in nulliparous patients, this result seems linked, on the other hand, to severe perineal lacerations, given the mechanical resistance perineum can offer to the pushing. Operators should never forget that this maneuver can determine adverse effects on the maternal and fetal side, raising intrauterine pressure and leading to an increase in fetal head compression with subsequent cerebral hypoperfusion and brain edema. Lower Apgar scores found in neonates born with FP seem to confirm this hypothesis. When applied, FP should be concomitant with uterine contractions, so the abdominal muscle tone can protect the uterus and other organs from external damage. In the shoulder dystocia scenario this maneuver should be avoided considering that it can worsen the condition. Post-partum incontinence and dyspareunia seem linked to FP [13].

Abedzadeh-Kalahroudi et al. reported that women under 35 years of age and with a high gestational age have a higher risk of perineal trauma when subjected to FP, reason why episiotomy should be avoided when indications are not strictly met [14].

Elise Farrington affirms that the use of uterine FP on women during vaginal birth in health facilities is widespread but also underestimated and no clear benefit has been demonstrated. The maneuver is often applied at the wrong time without the right indications and it can cause cava compression with subsequent maternal hypotension. An effort to prevent its use when not needed should be done [15].

Hofmeyr affirms in his trial that he will investigate whether upright posture and/or a controlled method of applying gentle assisted FP can improve labor outcomes for women and their babies.

Steady but gentle pressure is applied in the long axis of the uterus during contractions for a maximum of 30 s, with at least 30s rest before the next application.

If FP is found to have a measurable beneficial effect, this gentle approach can be promoted as a replacement for the uncontrolled methods currently in use [16].

In his randomized study indeed, the author affirms that there were no differences in secondary outcomes, except that maternal discomfort was greater for the GAP group, and for some women upright position was uncomfortable. Anyway, he concluded that controlled FP should be used only in research environments and women should choose for delivery position they found most comfortable [7 – 16].

Koji Matsuo affirms that the uterine FP maneuver increases the risk of severe perineal laceration indeed the use of the maneuver must be cautioned, and careful attention must be paid to its application.

The risk of employing the uterine FP maneuver is heightened in women who are giving birth for the first time, have longer a labor duration, and experience significant weight gain during pregnancy. First-time mothers who struggle with effective pushing during labor require coaching and incentives to reduce the likelihood of resorting to the uterine FP by shortening the second stage of labor. The subjects who underwent the uterine FP maneuver exhibited greater weight gain during pregnancy. Authors haven't found a specific hypothesis to explain these results, but one could speculate that the increased pressure or tension in the birth canal, caused by the additional body weight, might impede the descent of the fetus through the birth canal.

The use of the uterine FP maneuver during vaginal delivery has been associated with various complications, including uterine rupture, anal sphincter tears, amniotic fluid embolism, and injuries to the neonatal central nervous system or brachial plexus.

This author found that sphincter tears were associated with nulliparity, postmaturity, FP, midline episiotomy, and fetal weight.

Although the number of cases is limited, the authors reported one instance of shoulder dystocia following the uterine FP maneuver. This case supports previous reports suggesting that the maneuver could exert non-physiological force on the pelvic floor and potentially damage the perineal sphincter. While it has been suggested that the uterine FP maneuver might reduce the need for operative interventions during the second stage of labor under specific circumstances, caution must be exercised, and careful attention should be given to its application [17].

Eijiro Hayata et al. made a retrospective study in 2017 focusing also on FP application in twin pregnancies.

Compared to single pregnancies, twin pregnancies are more prone to developing non-reassuring fetal status (NRFS), leading to a higher likelihood of opting for an expedited delivery. Given the increased chances of having low-birth-weight infants and abnormal rotation, the use of vacuum extraction and forceps delivery may present challenges. Consequently, employing the uterine FP maneuver (UFPM) for the delivery of the first twin can be considered an effective approach to expedite the process.

It has been reported that delivery with UFPM can potentially result in a higher incidence of severe perineal lacerations, with a rate of 10.9%.

Furthermore, obstetricians need to consider the risk factors associated with uterine rupture due to UFPM, which include: grand multiparity, induction of labor in a previously scarred uterus, uterine malformations such as bicornuate uterus or septate uterus, and so on, inappropriate use of oxytocin or prostaglandins, utilization of vacuum extraction or forceps delivery, and excessive or overly forceful application of FP [18].

Wei SC et al. report a case of uterine rupture in two cases of hydropic fetuses with subsequent shoulder dystocia at the second stage after repeated FPs. The author affirms that the severe abdominal pain that escalates to an unbearable level during the Kristeller maneuver or fresh vaginal bleeding can be early signs of uterine rupture.

In the described scenario, an emergency laparotomy was carried out, unveiling a significant hematoma located in the left broad ligament. The hematoma exhibited multiple sites of bleeding, involving several branches uterine artery branches [19].

In a comprehensive analysis utilizing multivariate logistic regression on a dataset comprising 9,743 deliveries carried out by Romana Furrer et al. it was observed that among the 919 deliveries

involving uterine FP, there were associations between UFP and shoulder dystocia in both spontaneous and assisted vaginal deliveries. Furthermore, the implementation of UFP was linked to adverse neonatal outcomes. However, it remains challenging to establish whether the intervention itself is the cause of the adverse outcomes or if the adverse outcomes are the result of an existing pathological condition that necessitated the intervention. One possible explanation for the increased occurrence of fetal acidosis following UFP could be a reduction in placental oxygenation due to the physical pressure exerted on the uterine fundus. The association between UFP and shoulder dystocia may be attributed to the effects of external pressure, leading to faster descent of the fetus through the birth canal, thereby altering the physiological process and dynamics of fetal rotation and descent through the maternal pelvis. Women who underwent FP reported a significantly higher frequency of dyspareunia and perineal pain [20].

Rajiv Mahendru affirms that, if the primary purpose of utilizing uterine FP in common practice is to expedite the second stage of labor, this statement is contradicted by the findings of his study. Nonetheless, in cases of delayed progress in the second stage of labor, efforts should be made to identify the underlying causes and implement appropriate corrective measures. Considering the numerous complications associated with FP, both conventional and alternative healthcare providers should refrain from its application.

Uterine rupture, a rare yet severe complication in obstetric practice that poses risks to both the mother and fetus, occurs less frequently in unscarred uteruses, estimated to be around one in 8,000 to 15,000 deliveries. However, the incidence of uterine rupture increases when FP is exerted on the uterus during active labor. Even Gynaecological complications that could arise should be considered like utero-vaginal prolapse [21].

Pan HS shows a case report about a spontaneous uterine rupture in G3 P0 patient with the only risk factor being the uterine FP applied at delivery.

The occurrence of spontaneous rupture in an unscarred uterus during labor is infrequent, as an author have documented only one case at our facility over ten years. Risk factors that contribute to this condition involve the weakening of the uterine muscle and the utilization of FP. Detecting the rupture at an early stage and promptly undertaking surgical intervention are the primary approaches for managing this situation [22].

S J Gross affirms that FP, when applied in the absence of other maneuvers, resulted in a 77% complication rate. The combination of FP and traction has been linked to complications affecting the neurological and orthopedic domains. Considering the mechanism of FP, which exerts additional force on the anterior shoulder, pushing it against the pubic bone, it is not surprising to observe the heightened risk of brachial plexus injury and the need for increased traction to facilitate delivery [23].

Nicholas Rubashkin affirms that the normal birth policy has failed to achieve its objectives and also patients' ability to refuse the Kristeller maneuver is limited [24].

Loïc Sentilhes et al. affirm in their international guideline that the FP (grade C) is avoided especially in the shoulder dystocia scenario [25].

### **Positive opinions**

Kanninen affirms that the second stage of labor is associated with a 20-minute decrease in the time of labor and a small decrease in artery PH in the neonatal umbilical artery. FP in the second stage of labor was associated also with a 0.03 decrease in umbilical artery pH, and a 3.5 non-significantly higher chance (4.9% vs 0.7%) of Apgars < 7 at 5 min, with no effect on maternal lacerations, neonatal trauma or admission to the neonatal intensive care unit, compared to no FP. This Author, in examining data between patients who received FP or not, hasn't found a difference

in risk of having perineal or cervical laceration. FP was applied manually or with a belt device. However, none of the included RCTs of this systematic review were blinded, as the intervention is difficult to blind or to have a feasible sham intervention [26].

As said by Sagi-Dain L et al. standardized guidelines are needed to prevent incorrect FP application and assist the obstetricians in medical-legal cases. Application of FP in deliveries when is not strictly needed, as well as avoidance of this maneuver in cases that could benefit from manual pressure with the right timing and execution, avoiding operative delivery, might contribute to adverse effects, making it impossible to draw any solid conclusion [27]. Pinar affirms that FP is commonly applied without a specific indication, but rather in situations where the woman faced difficulties in bearing down effectively, encountered bradycardia in the infant, experienced prolonged second stage of labor, or encountered shoulder dystocia and when applied is more frequently associated with episiotomy, but at the same time, this technique does not have an adverse impact on maternal overall labor satisfaction and does not seem to have consequences on mother or baby health status.

In his study, FP was administered using various techniques such as the front arm, fist, elbow, and hands, typically for approximately 20 seconds, repeated 4 to 5 times. Some women who received FP reported experiencing pain during the procedure, while an almost equal number stated that it eased their labor and assisted in the birthing process. Similarly, there was no association observed between infant body weight and the use of FP.

These findings highlight the importance of obtaining informed consent from women before administering FP to ensure the protection of women's autonomy during the birthing process.

To reduce the frequency of FP application, healthcare professionals may be advised, particularly when dealing with fully dilated primiparous women, to exercise patience and allocate sufficient time for spontaneous bearing down, allowing the fetus to progress forward and the perineum to stretch. Additionally, pregnant women should not be kept in a supine position for extended periods based on the belief that an upright position aids the internal rotation of the infant and facilitates its movement [28]. Öncü in his study shows that FP in the second stage of labor doesn't cause and increase in obstetric anal sphincter injury (OASI). It seems also that mediolateral episiotomy has a highly protective effect on the incidence of OASI during operative vaginal delivery. This data was found at 3D transperineal ultrasound. Numerous techniques have been explored to mitigate the risk of perineal tears during childbirth. These techniques encompass perineal massage, manual perineal support, warm compresses and delayed straining.

The utilization of 45° mediolateral episiotomy has also been shown to significantly decrease the occurrence of obstetric anal sphincter injury (OASI) during operative vaginal deliveries [29].

Catalin S Buhimschi using a sensor-tip intrauterine catheter has found that not in every woman FP causes an intrauterine pressure rise. Myometrium that is relatively thinner and more advanced gestational age is indicative of effective transmission. Nevertheless, it is also plausible that the rate of complications reflects a pre-existing abnormal labor and is not directly linked to the utilization of FP.

Monitor used in this study can help in practicing a controlled FP being the specialist always aware of the intrauterine conditions [30].

Petra Bukovec affirms that FP is not related to anal sphincter injury and it can be used safely also in combination with instrumental delivery [31].

Karin Sturzenegger advice caution with the use of FP in patients with uterine rupture risk factors, such as age at the delivery >40 years, multiparity, abnormal placentation and previous uterine surgery [32].

Shunji Suzuki affirm that There was no evidence that selective uterine FP is unsafe for both mother and two babies during the second stage of the first twin delivery. No association was found between UFP and neonatal complications. While the use of UFPM did not demonstrate any apparent links to neonatal complications, it could potentially lead to maternal complications such as postpartum hemorrhage, severe perineal lacerations, and cervical lacerations.

This maneuver seems to be used more often in monochorionic twin pregnancies maybe because operators tend to be more cautious in these scenarios. Improper utilization of the maneuver during the delivery of the first twin may also result in elevated intrauterine pressure, intracranial pressure, and placental circulatory disruptions in the second twin, such as acute fetofetal hemorrhage. Nevertheless, in the present study, the selective implementation of UFPM appears to be not associated with neonatal complications [33].

Ching-Hsing Hsieh in his study explains the technique to apply a correct FP. The operator should apply pressure on the fundus longitudinally keeping an angle of 30° or 40° to the maternal spine but at the same time he explains that caution is recommended in the application of uterine FP.

Uterine FP involves manually exerting pressure on the uterine fundus using the practitioner's forearms, elbows, or palms, applying it at an angle of 30° to 45° relative to the maternal spine, directed towards the pelvis. The pressure is administered ilongitudinally, and it is recommended to apply gentle, firm, and consistent pressure. The application of uterine FP can lead to various adverse effects, including uterine rupture, postpartum urinary retention, severe perineal trauma and pain, rib fracture, postpartum dyspareunia, as well as the potential for neonatal distress or trauma, furthermore in some situations [34 – 36].

Andrea Sartore affirms that the Kristeller maneuver does not modify puerperal pelvic floor function when examined at three months after delivery but increases episiotomy rates to 76,9%. The impact on the maternal perineum remains uncertain based on our findings. There was no discernible difference observed between mothers who underwent the Kristeller maneuver and those who did not undergo the maneuver. Through a regression analysis model, the author determined that only the duration of the second stage, neonatal weight, and the use of episiotomies were significantly associated with the Kristeller maneuver. Furthermore, our study revealed that the group subjected to uterine FP exhibited a notably higher incidence of dyspareunia [37].

### **Uncertain opinion**

Olus Api affirms that the application of FP on a delivering woman was ineffective in shortening the second stage of labor. There was no difference in the second stage duration between the intervention and control groups. It must be remembered indeed that it presents a challenge to precisely determine the second stage effective start. The outcomes for newborns were favorable in both groups, with no instances of cord blood pH falling below 7.2. The mean values of HCO<sub>3</sub> and base excess were also within the expected ranges. As a result, in this study, the utilization of FP does not appear to negatively impact the immediate neonatal outcomes [38 – 39].

## **DISCUSSION**

There is no standardized approach in managing the second stage of delivery. [40]

In cases of non-reassuring fetal status, failure to progress, maternal exhaustion, and conditions that preclude maternal Valsalva, there are several different approaches to shorten the second stage of labor. These include the use of traditional operative delivery methods such as the vacuum, forceps and, also controversial Fundal Pressure (FP) which still have a place nowadays in the

delivery room. Fundal pressure (FP) is an ancient practice that has been studied in modern obstetrics for possible maternal and fetal complications. Invented by Samuel Kristeller in the late 19th century, it consists of an attempt to assist spontaneous vaginal delivery by applying pressure on the maternal abdomen.

In the cited studies it seems that having a real indication of this maneuver is fundamental for a successful and damage-free delivery being the FP related to some complications on the maternal and fetal side. Between maternal complications most frightening is the uterine rupture often consequent to incorrect execution or wrong timing of the pressure applied. Between fetal complications shoulder dystocia is the most dangerous one but we must not forget that FP is related for some authors to worse neonatal blood pH values after birth. One explanation could be that the fetal head compression in fetuses without good reserves can cause a rise in intracranial pressure activating peripheral baroreceptors and increasing consequently fetal heart rate provoking after many responses of this type, acidemia. [41] Given all those implications and the different opinions on this subject authors have nowadays, one must not be surprised by the great number of legal litigations this maneuver causes.

## **CONCLUSIONS**

Kristeller maneuver application is one of the most controversial topics in second-stage delivery management. Authors feel to say that if needed, the patient must be informed about what the operator is trying to achieve with this maneuver and when applied, it should be written in the clinical report. Specialists should be trained to apply uterine fundal pressure correctly at the right moment. Avoiding most dangerous complications that should be prevented. Another thing that can be done to shorten the second stage of delivery and to reduce damage is combining this maneuver with the use of traditional devices for vaginal operative delivery. Furthermore, it's the Author belief that this maneuver should be reported to international Guidelines to have strict indication for its application and reducing future legal litigations, due to the reason that although fundal pressure is still used in some settings, given its safety is yet unproven, WHO and FIGO do not recommend its use. Further studies are needed to assess more clearly in the population the real maternal and fetal complication rate.

## **COMPLIANCE WITH ETHICAL STANDARDS**

### **Authors contribution**

G.R.D.<sup>1</sup>, A.M.<sup>1</sup>: Conceptualization, project administration, writing – original draft

D.D.G.<sup>1</sup>: writing – review & editing

A.V.<sup>1</sup>: supervision

G.L.<sup>1</sup>: investigation, methodology

A.T.<sup>2</sup>, M.B.<sup>1</sup>, M.G.<sup>1</sup>, E.D.N.<sup>1</sup>: validation, visualization

M.D.<sup>1</sup>: resources, software

### **Funding**

None.



## Study registration

N/A.

## Disclosure of interests

The authors declare they have no conflict of interests.

## Ethical approval

N/A.

## Informed consent

N/A.

## Data sharing

N/A.

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Manuscript accepted for publication

Study title	Study type	Author Year	Findings/conclusions
Does gentle assisted pushing or giving birth in the upright position reduce the duration of the second stage of labour? A three-arm, open-label, randomised controlled trial in South Africa [7]	Multicentre randomized, unblinded, controlled Trial	Hofmeyr GJ et al. 2018	No benefit was identified from gentle pushing in the second stage
Fundal pressure during the second stage of labour [9]	Systematic Review	Verheijen EC et al. 2017	No evidence that this maneuver raised numbers of vaginal births
The usual suspect: cross-sectional study of fundal pressure at second stage of delivery and the association with pelvic floor damage [10]	Cross-sectional Study	Takmaz T et al. 2021	Second stage duration was significantly shorter in the control group compared to the fundal pressure group  Fundal pressure was identified as the only independent predictor of LAM defect
The role of uterine fundal pressure in the management of the second stage of labor: a reappraisal [11]	Review	Mehri ZO et al. 2005	The extant literature does not demonstrate any benefit and hints at potentially serious risks

<b>Study title</b>	<b>Study type</b>	<b>Author Year</b>	<b>Findings/conclusions</b>
Fundal pressure in second stage of labor (Kristeller maneuver) is associated with increased risk of levator ani muscle avulsion [12]	Prospective case -control Study	Youssef A et al. 2019	Women who underwent the maneuver had a significantly higher risk of LAM avulsion
Fundal pressure during the second stage of labor in a tertiary obstetric center: a prospective analysis [13]	Prospective observational Study	Moiety FM et al. 2014	Study found a significant increase in the admission to NICU after fundal pressure application
Perineal trauma: incidence and its risk factors [14]	Cross sectional Study	Abedzadeh-Kalahroudi M et al. 2019	Perineal trauma odds found in this study are very high with this maneuver
The prevalence of uterine fundal pressure during the second stage of labour for women giving birth in health facilities: a systematic review and meta-analysis [15]	Systematic Review and Meta-analysis	Farrington E et al. 2021	Increased rates of: perineal damage, shoulder dystocia, neonatal fractures, brachial plexus injuries, higher rates of NICU admission

<b>Study title</b>	<b>Study type</b>	<b>Author Year</b>	<b>Findings/conclusions</b>
Use of uterine fundal pressure maneuver at vaginal delivery and risk of severe perineal laceration [17]	Cross-sectional Study	Matsuo K et al. 2009	Uterine fundal pressure maneuver during the second stage of labor increased risk of severe perineal laceration.
Uterine rupture due to traumatic assisted fundal pressure [19]	Case report	Wei SC et al. 2006	Assisted fundal pressure during painful delivery can be traumatic and results in uterine rupture.
Maternal and fetal outcomes after uterine fundal pressure in spontaneous and assisted vaginal deliveries [20]	Retrospective cohort Study	Furrer R et al. 2016	Fundal pressure is associated with increased occurrence of shoulder dystocia and fetal acidosis
Shortening the second stage of labor? [21]	Pilot Study	Mahendru R et al. 2010	No significant differences in second stage duration. Significant adverse findings: one case of retained placenta, uterine prolapse and perineal injuries
Uterine rupture in an unscarred uterus after application of fundal pressure. A case report [22]	Case Report	Pan HS et al. 2002	Risk factors for uterine rupture include weakness of the uterine wall and fundal pressure.

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<b>Study title</b>	<b>Study type</b>	<b>Author Year</b>	<b>Findings/conclusions</b>
Shoulder dystocia: predictors and outcome. A five-year review [23]	Retrospective Analysis	Gross SJ et. al 1987	Fundal pressure, in the absence of other maneuvers to resolve dystocia, resulted in a 77% complication rate and was strongly associated with orthopedic and neurologic damage.
"Just a little help": A qualitative inquiry into the persistent use of uterine fundal pressure in the second stage of labor in Spain [24]	Qualitative Inquiry	Rubashkin N et al. 2019	Providers made women's refusal more difficult. Women did not experience the KM as gentle, and the force of the procedure made their refusal nearly impossible.
Shoulder dystocia: guidelines for clinical practice from the French College of Gynecologists and Obstetricians (CNGOF) [25]	Peer Review	Sentilhes L et al. 2016	In shoulder dystocias it is recommended to avoid fundal pressure due to higher brachial plexus injury risk

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<b>Study title</b>	<b>Study type</b>	<b>Author/year</b>	<b>Findings/conclusions</b>
Fundal pressure to shorten the second stage of labor: Systematic review and meta-analysis [26]	Systematic Review	Kanninen T et al. 2022	20-minute decrease in the length of labor.  No significant difference in rates of neonatal trauma, vaginal/perineal laceration, cervical laceration, episiotomy, cesarean section, operative vaginal deliveries and admissions in NICU
The condemned fundal pressure maneuver: time to reconsider? [27]	Systematic Review	Sagin-Dain L et al. 2022	Previously published evidence of unfavorable effects of FP might not be relevant to the common practice
Applying fundal pressure in the second stage of labour and its impact on mother and infant health [28]	Cross-sectional Study	Pinar S et al. 2018	Fundal pressure does not have an adverse impact on maternal satisfaction or the health of the mother and infant
Risk of obstetric anal sphincter injury with fundal pressure in second stage of labor: Transperineal ultrasound study [29]	Prospective case-control Study	Oncu HN et al. 2021	No increase in anal sphincter injury rates was found
The effect of fundal pressure manoeuvre on intrauterine pressure in the second stage of labour [30]	Prospective Study	Buhimschi et al. 2002	Women in the second stage of labour transiently increased their expulsive force by 86% of their baseline contraction using Valsalva maneuver and fundal pressure simultaneously.

Study title	Study type	Author/year	Findings/conclusions
The influence of the fundal pressure manoeuvre at delivery on the anal sphincter injury diagnosed with endoanal ultrasonography [31]	Retrospective Study	Bukovec P et al. 2022	No correlation found between anal sphincter injury and fundal pressure
Risk factors of uterine rupture with a special interest to uterine fundal pressure.	Retrospective Analysis	Sturzenegger K et al. 2017	Caution must be applied in patients with certain risk factors
Selective uterine fundal pressure maneuver during the second stage of the first twin delivery at near term [33]	Retrospective Analysis	Suzuki S. et al. 2015	No evidence found that selective fundal pressure is unsafe for both mother and two babies during the second stage of the first twin delivery
The effects of uterine fundal pressure (Kristeller maneuver) on pelvic floor function after vaginal delivery [37]	Retrospective Study	Sartore A et al. 2012	Urinary and anal incontinence, genital prolapse and pelvic floor strength were not significantly different between the groups



Paper ID	Study type	Why favourable	Why contrary	Why neutral
[7]	Multicentre randomized, unblinded, controlled Trial		No benefit was identified from gentle pushing in the second stage	
[9]	Systematic Review		No evidence that this maneuver raised numbers of vaginal births	
[10]	Cross-sectional Study		Second stage duration was significantly shorter in the control group compared to the fundal pressure group  Fundal pressure was identified as the only independent predictor of LAM defect	
[11]	Review		The extant literature does not demonstrate any benefit and hints at potentially serious risks	
[12]	Prospective case - control Study		Women who underwent the maneuver had a significantly higher risk of LAM avulsion	
[13]	Prospective observational Study		Study found a significant increase in the admission to NICU after fundal pressure application	
[14]	Cross sectional Study		Perineal trauma odds found in this study are very high with this maneuver	
[15]	Systematic Review and Meta-analysis		Increased rates of: perineal damage, shoulder dystocia, neonatal fractures, brachial plexus	

Paper ID	Study type	Why favourable	Why contrary	Why neutral
			injuries, higher rates of NICU admission	
[16]	Multicentre, randomized, unblinded, controlled Trial			The lack of a standardized method of application is contributing to differences of opinion regarding fundal pressure.
[17]	Cross-sectional Study		Uterine fundal pressure maneuver during the second stage of labor increased risk of severe perineal laceration.	
[18]	Retrospective observational Study			Laceration of the birth canal was the most frequently occurring maternal AE, followed by cervical laceration
[19]	Case report		Assisted fundal pressure during painful delivery can be traumatic and results in uterine rupture.	
[20]	Retrospective cohort Study		Fundal pressure is associated with increased occurrence of shoulder dystocia and fetal acidosis	
[21]	Pilot Study		No significant differences in second stage duration. Significant adverse findings: one case of retained placenta, uterine prolapse and perineal injuries	
[22]	Case Report		Risk factors for uterine rupture include weakness of the uterine wall and fundal pressure.	

Paper ID	Study type	Why favourable	Why contrary	Why neutral
[23]	Retrospective Analysis		Fundal pressure, in the absence of other maneuvers to resolve dystocia, resulted in a 77% complication rate and was strongly associated with orthopedic and neurologic damage.	
[24]	Qualitative Inquiry		Providers made women's refusal more difficult. Women did not experience the KM as gentle, and the force of the procedure made their refusal nearly impossible.	
[25]	Peer Review		In shoulder dystocias it is recommended to avoid fundal pressure due to higher brachial plexus injury risk	
[26]	Systematic Review	<p>20-minute decrease in the length of labor.</p> <p>No significant difference in rates of neonatal trauma, vaginal/perineal laceration, cervical laceration, episiotomy, cesarean section, operative vaginal deliveries and admissions in NICU</p>		
[27]	Systematic Review	Previously published evidence of unfavorable effects of FP might not be relevant to the common practice		
[28]	Cross-sectional Study	Fundal pressure does not have an adverse impact on maternal satisfaction or the health of the mother and infant		

Paper ID	Study type	Why favourable	Why contrary	Why neutral
[29]	Prospective case-control Study	No increase in anal sphincter injury rates was found		
[30]	Prospective Study	Women in the second stage of labour transiently increased their expulsive force by 86% of their baseline contraction using Valsalva maneuver and fundal pressure simultaneously.		
[31]	Retrospective Study	No correlation found between anal sphincter injury and fundal pressure		
[32]	Retrospective cohort Study			Fundal pressure should be used with caution in presence of other supposed risk factors
[33]	Retrospective Analysis	No evidence found that selective fundal pressure is unsafe for both mother and two babies during the second stage of the first twin delivery		
[34]	Review article			Only well-trained and experienced medical staff or nurses should be allowed to practice this intervention

Paper ID	Study type	Why favourable	Why contrary	Why neutral
[35]	Retrospective Study	Urinary and anal incontinence, genital prolapse and pelvic floor strength were not significantly different between the groups		
[36]	Randomized controlled Trial			No significant differences in the mean duration of the second stage of labor and secondary outcome measures except for mean pO <sub>2</sub> which was lower and mean pCO <sub>2</sub> which was higher in the fundal pressure group.

Results according to favorable, contrary and neutral evidences of analyzed studies