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Management of Impacted Fetal Head at Caesarean Birth

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Plain language summary

Over one-quarter of women in the UK have a caesarean birth (CB). More than one in 20 of these births occurs near the end of labour, when the cervix is fully dilated (second stage). In these circumstances, and when labour has been prolonged, the baby's head can become lodged deep in the maternal pelvis making it challenging to deliver the baby. During the caesarean birth, difficulty in delivery of the baby's head may result – this emergency is known as impacted fetal head (IFH). These are technically challenging births that pose significant risks to both the woman and baby. Complications for the woman include tears in the womb, serious bleeding and longer hospital stay. Babies are at increased risk of injury including damage to the head and face, lack of oxygen to the brain, nerve damage, and in rare cases, the baby may die from these complications.

Maternity staff are increasingly encountering IFH at CB, and reports of associated injuries have risen dramatically in recent years. The latest UK studies suggest that IFH may complicate as many as one in 10 unplanned CBs (1.5% of all births) and that two in 100 babies affected by IFH die or are seriously injured. Moreover, there has been a sharp increase in reports of babies having brain injuries when their birth was complicated by IFH.

When an IFH occurs, the maternity team can use different approaches to help deliver the baby's head at CB. These include: an assistant (another obstetrician or midwife) pushing the head up from the vagina; delivering the baby feet first; using a specially designed inflatable balloon device to elevate the baby's head and/or giving the mother a medicine to relax the womb. However, there is currently no consensus for how best to manage these births. This has resulted in a lack of confidence among maternity staff, variable practice and potentially avoidable harm in some circumstances.

This paper reviews the current evidence regarding the prediction, prevention and management of IFH at CB, integrating findings from a systematic review commissioned from the National Guideline Alliance.

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1 | DEFINITION

Impacted fetal head (IFH) at caesarean birth (CB) is an unpredictable and challenging obstetric emergency.[1–3] There is no clear, consensus definition for IFH in the published literature. This can lead to variable recognition and documentation of IFH, with an associated risk of bias in research comparing techniques. Regarding definition, most obstetricians responding to a national survey on IFH at CB would use 'the need for additional manoeuvres' as a diagnostic criterion.[4] IFH can therefore be described as 'a caesarean birth where the obstetrician is unable to deliver the fetal head with their usual delivering hand, and additional manouevres and/or tocolysis are required to disimpact and deliver the head'. UK Research by the Avoiding Brain Injuries in Childbirth (ABC) collaboration is in progress to refine the taxonomies in relation to this definition and determine whether it is acceptable to clinical practitioners.

Within this document we use the terms woman and women. However, it is important to acknowledge that it is not only women for whom it is necessary to access women's health and reproductive services in order to maintain their gynaecological health and reproductive wellbeing. Gynaecological and obstetric services and delivery of care must therefore be appropriate, inclusive and sensitive to the needs of those individuals whose gender identity does not align with the sex they were assigned at birth.

2 | INCIDENCE

IFH and its complications are being encountered more frequently by healthcare professionals.[1,5,6] Single-centre UK studies estimate that IFH may complicate as many as one in 10 unplanned caesarean births (1.5% of all births)[1,5] and 16% of second-stage caesarean births[7] (MIDAS study of IFH at CB). The apparent rise in cases of IFH may, in part, be explained by an increasing rate of caesarean births[8] and a rise in CB at full cervical dilatation.[9,10] Worldwide, it is estimated that 21% of women give birth by CB, with rates closer to 30% in more developed countries.[11] At least 5% of these births occur at full cervical dilatation.[1,9,10,12] Reduced skill and confidence in the use of rotational and mid-cavity forceps births, and the resulting decline in assisted vaginal birth, have been proposed as contributory factors.[13–15] Increased use of regional analgesia and rising rates of maternal obesity may also exacerbate the problem.[16] However, IFH is not limited to CB at full cervical dilatation and there is emerging evidence that obstetricians may frequently encounter IFH in caesarean section performed before full cervical dilatation.[1]

3 | RISK FACTORS

IFH is a more heterogeneous condition than previously considered.[1,5] Until recently, most research characterising the risk

NATIONAL GUIDELINE ALLIANCE SYSTEMATIC REVIEW

Identification and assessment of evidence (Figures 1–3 and Table 1).

A targeted search of medical databases (Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Database of Reviews of Abstracts of Effectiveness, EMCare, EMBASE and MEDLINE) was undertaken for studies published in English from 1980 to 13 September 2021, comparing various techniques used for managing IFH. Studies were included from any maternity unit or delivery suite setting worldwide in women undergoing unplanned CB, either before (first stage) or at full cervical dilatation (second stage), who were at risk of IFH (risk factors include full cervical dilatation, unsuccessful assisted vaginal birth, prolonged labour, low fetal station or features of obstructed labour, such as caput or moulding) (prevention) or who had an IFH (management). Studies were excluded in women who were having an elective CB or with non-cephalic presentation (i.e. breech, transverse presentation or unstable lie) or multiple gestations.

The studies included were RCTs of any size or non-randomised comparative prospective or retrospective cohort studies with more than 30 participants per treatment arm. The studies should have adjusted for the following covariates in their analysis when there were differences between groups at baseline: maternal age, maternal BMI, smoking, parity, diabetes, gestational age +/– full cervical dilatation. If they did not adequately adjust for important covariates, they were still included, but they were downgraded for risk of bias. Studies published in languages other than English or before 1980 were not included due to time and resource constraints with translation and change in clinical practice since 1980, respectively.

One reviewer screened the titles and abstracts of the retrieved citations to identify studies that potentially met the inclusion criteria. Another reviewer independently screened 10% of the records, and disagreements were resolved via discussion between the two reviewers, and consultation with senior staff if necessary. Full-text versions of the potentially relevant studies identified at title and abstract screening were obtained for assessment and based on the inclusion and exclusion criteria, one reviewer in consultation with authors classified these studies into 'includes' and 'excludes'.

One reviewer extracted all the relevant data into a standardised form and performed the risk of bias assessments, and another reviewer checked all these extractions and assessments. Any disagreements were resolved by discussion or by involvement of senior staff.

All studies included one of the following comparisons: Fetal Pillow versus no Fetal Pillow (including inserted but not inflated Fetal Pillow) (prevention); vaginal push-up versus reverse breech extraction or Patwardhan method (management); reverse breech extraction versus the Patwardhan method (management); or tocolysis (e.g. GTN (glyceryl trinitrate/nitroglycerine), terbutaline, salbutamol) versus other tocolysis, no tocolysis or placebo (management). Studies that compared interventions across prevention and management were also included, e.g. Fetal Pillow versus vaginal push-up.

All evidence included in the review was evaluated for each outcome using an adaptation of the Grading of Recommendations Assessment, Development and Evaluation (GRADE) toolbox to provide a certainty rating from very low to high. Randomised studies were assessed for risk of bias using RoB 2 and cohort studies, using ROBINS-I.

DATA ANALYSIS

Mean differences (MD) were calculated using means and standard deviations (SDs) for continuously reported outcomes. Risk ratios (RR) were calculated for dichotomously reported outcomes. Where the target outcome data were not presented as means and SDs for continuous outcomes, data were extracted as reported e.g. as medians and ranges. Where there were zero events in at least one of the intervention groups, precluding the calculation of RR, Peto odds ratios (POR) or risk differences (RD) were calculated.

All analyses were undertaken in Review Manager 5.4.1 (The Cochrane Collaboration 2020). Mantel–Haenszel statistical analysis was used to calculate RR and RD, Peto statistical analysis method for POR, and inverse variance statistical method for MD. Where multiple studies reported on the same outcome for the same comparison, meta-analyses were conducted. Heterogeneity in the effect estimates of the individual studies was assessed using the I^2 statistic. Random effects meta-analyses were conducted when I^2 was ≤80%. Data were not pooled when I^2 was >80%. In the latter cases, effect estimates for each study are presented separately.

factors for IFH at CB, has used second-stage CB as a surrogate for IFH.[16–18] Approximately one in three CB at full cervical dilatation may be complicated by an IFH and the risk is twice as high where unsuccessful attempts have been made to assist the birth of the baby vaginally.[1] However, although full cervical dilatation increases the risk, IFH can also occur in caesarean section performed in the first stage of labour and occasionally in non-labouring women.[5,19] A recent retrospective cohort study of nearly 900 unplanned CBs identified that more than 50% of cases of IFH occurred in the first stage of labour.[1]

The fetal head is more likely to become impacted with fetal malpositions.[19] IFH is also more likely to be encountered in cases of prolonged labour, augmented with oxytocin, and associated with features of obstructed labour, such as caput and moulding, and low fetal station.[1] Maternity staff should therefore carefully manage labour, identify slow progress and take appropriate action to minimise the risk of IFH. However, IFH cannot be reliably predicted, and therefore, clinicians should be vigilant and anticipate IFH during any CB, and particularly in these circumstances.

There is emerging evidence that less experienced obstetricians are more likely to diagnose an IFH and employ more advanced manoeuvres to disimpact the fetal head.[1] This trend may reflect differences in practice between generations of practitioners and it would be useful to understand these cohort differences in more detail. Further research is needed to establish how these differences impact outcomes for women and/or babies.

4 | COMPLICATIONS

IFH at CB can be associated with potentially devastating consequences for both mother and baby. Difficulty disimpacting the fetal head, with a stretched and oedematous uterine lower segment, increases the risk of extension of the uterine incision, haemorrhage, bladder and ureteric injury, with potential long-term consequences for women in future pregnancies, such as increased risk of spontaneous preterm birth.[1,16,20,21] Reduced space between the fetal head and maternal pubic symphysis makes it difficult for the operator to insert their hand to get below the fetal head to flex and elevate it.[2] Excessive force at this stage poses a risk of fetal head trauma.[22] Problems elevating the fetal head to the uterine incision may be further compounded by attempts to deliver the head during a uterine contraction limiting flexion of the fetal spine.[23] Such difficulties can be associated with birth trauma such as skull fractures, subgaleal and intracranial haemorrhage, and/or delay the birth of an already compromised fetus leading to hypoxic ischaemic encephalopathy and, rarely, perinatal death.[17,20,22,24]

5 | MEDICOLEGAL CONSEQUENCES

There has been a sharp increase in reports of perinatal brain injury associated with IFH, prompting numerous coronial inquiries[22] and increased litigation nationally[24] and internationally.[25] The NHS Resolution Early notification scheme identified IFH as a contributory factor in nearly 10% of potentially the most expensive maternity claims from 2018,[6] almost twice as common as those relating to shoulder dystocia.[6]

6 | TECHNIQUES FOR PREVENTION AND MANAGEMENT

The maternity team can use different approaches to help deliver the baby's head when an IFH occurs (Appendix 1), as described in Table 2.

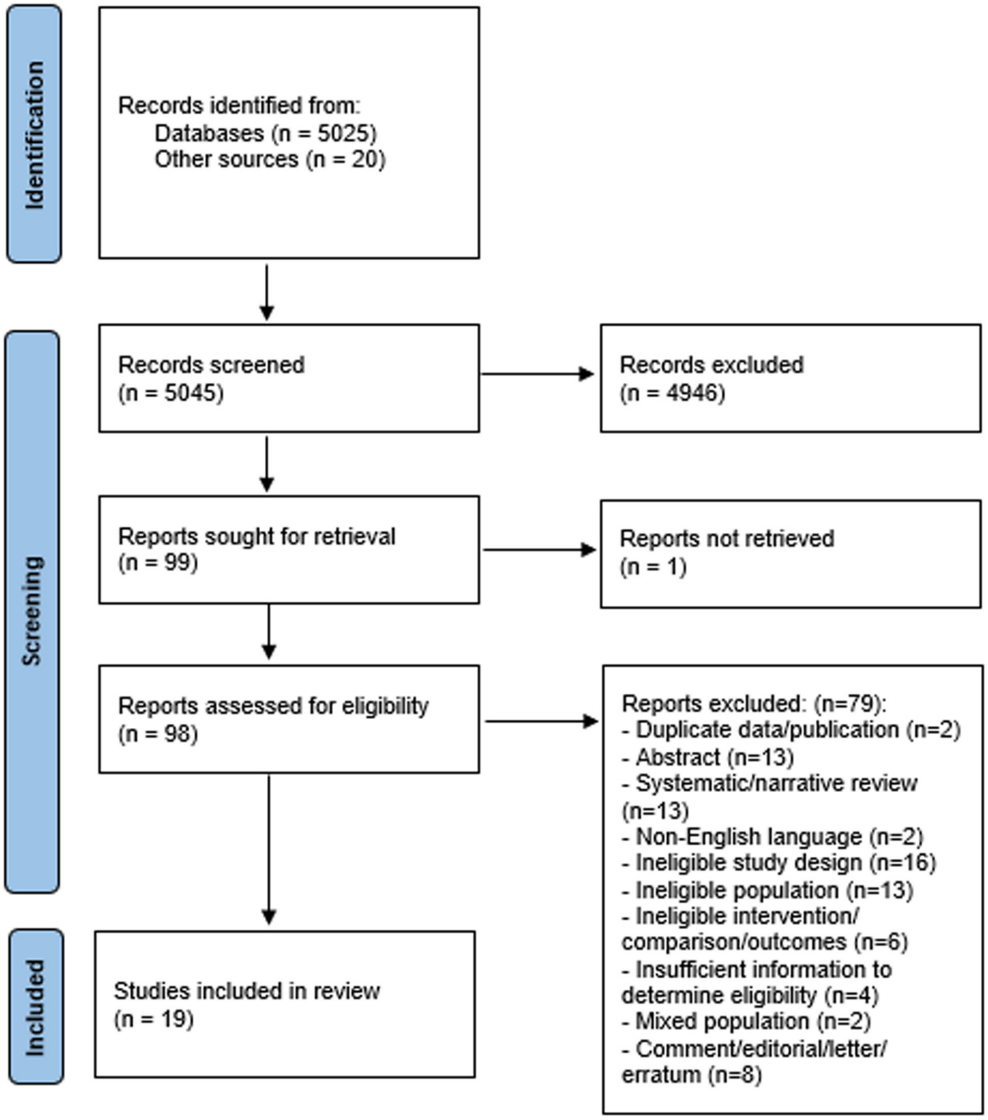

FIGURE 1 Studies identified and screened.

6.1 | Prevention

6.1.1 | Manual vaginal disimpaction pre-incision

Many obstetricians advocate performing manual vaginal disimpaction (push technique) to elevate the fetal head following an unsuccessful assisted vaginal birth and before skin incision. Canadian guidelines suggest keeping the woman's legs in stirrups, and lowering them so the thighs are parallel to the woman's abdomen, a so-called 'frog-leg' position, to facilitate vaginal disimpaction pre-incision and/or intraoperatively.[18] If electing to take this approach, the team should ensure they have appropriate operating tables where this position can be maintained without compromising anaesthetic support. There is currently no evidence to support or oppose this approach. However, if this approach is employed, an accurate technique for vaginal disimpaction should be used, as described below.

6.1.2 | Fetal Pillow

The Fetal Pillow is a device that is inserted vaginally, before commencing a CB to elevate the fetal head, aiming to make the birth less traumatic and quicker. The device is a soft silicone balloon that is steadily inflated in an upward direction from a platform below the balloon. The Fetal Pillow is used when performing a caesarean section with a deeply engaged head, at a fetal station at or below the ischial spines or following an unsuccessful assisted vaginal birth.

Evidence from this systematic review (Tables 3-6 and Figures 4-5)

There is evidence that Fetal Pillow may reduce difficulties associated with disimpacting the fetal head at CB,[26–28] anecdotal evidence of operator preference for the device and an increasing trend in its use.[4] However, high-quality data establishing the efficacy of the Fetal Pillow remains very limited.

Seven studies comparing Fetal Pillow were included in the systematic review. All the women ($n = 1249$) underwent CB at full (10 cm) cervical dilatation. One randomised controlled trial (RCT)[27] and three non-randomised studies[26,29,30] compared Fetal Pillow with no Fetal Pillow, and another RCT compared inflated Fetal Pillow with non-inflated Fetal Pillow.[28] One study each compared Fetal Pillow with vaginal push-up[31] and Patwardhan method.[32] Details of how the vaginal push up and Patwardhan method were performed were not provided and there were no data about local training for these manoeuvres.

Most of the studies identified were at serious risk of bias and provided low or very low certainty evidence (see Figures 2 and 3). Therefore, there is generally little confidence in the effect estimates and the true effect may be substantially different from the estimates of effect. Moreover, due to very high levels of heterogeneity, it was not possible to provide pooled estimates for all outcomes.

Studies comparing Fetal Pillow with no Fetal Pillow,[26,27] non-inflated Fetal Pillow[28] and Patwardhan method[32] demonstrated that use of Fetal Pillow was associated with a reduced uterine incision-to-birth interval. There is also some evidence that Fetal Pillow may be associated with reduced rates of unintentional extension of the uterine incision when compared with no Fetal Pillow (RR 0.51 [0.24–1.08]),[27] non-inflated Fetal Pillow (RR 0.46 [0.2–1.05])[28] and vaginal push-up (RR 0.57 [0.34–0.96]).[31] There was conflicting evidence regarding the impact of Fetal Pillow on operative blood loss with some studies[29,30] suggesting an increased risk of postpartum haemorrhage and others suggesting the reverse.[27,31] The impact of Fetal Pillow use on risk of blood transfusion was equivocal.[26–31]

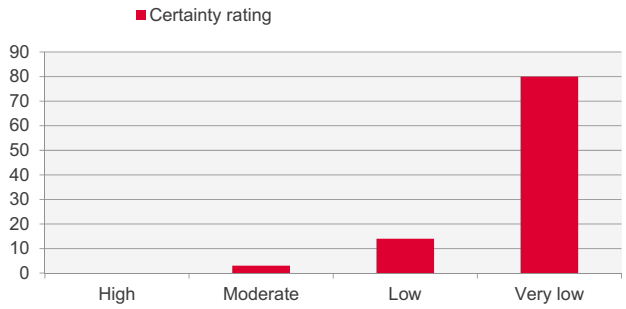

FIGURE 2 Certainty rating of all the outcomes across each included study.

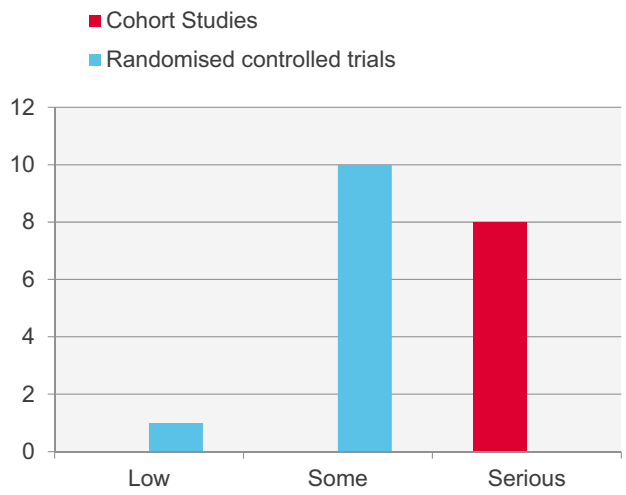

FIGURE 3 Overall level of bias for studies included in the review.

There is emerging evidence that Fetal Pillow may be associated with improved neonatal outcomes. Meta-analysis of studies comparing Fetal Pillow with no Fetal Pillow[26,27,29,30] and Patwardhan method[32] demonstrated a reduced risk of NICU (neonatal intensive care unit) admission (RR 0.74 [0.56–0.99] and RR 0.2 [0.07–0.61] respectively). However, evidence on Apgar score and umbilical arterial pH was equivocal. The study comparing Fetal Pillow with vaginal push-up showed that Fetal Pillow may be associated with better umbilical arterial pH.[31] However, this finding must be interpreted cautiously, as although it could reflect a shorter incision-to-birth interval, it may also represent selection bias, since clinicians may have been reluctant to take the time to insert a Fetal Pillow where there were concerns about severe fetal compromise.[31]

Other evidence

An Italian meta-analysis of outcomes following Fetal Pillow (10 studies with 1326 women), published in 2021, reported a reduced incision-to-birth interval, reduced estimated blood loss, and reduced rates of uterine incision extension and blood transfusion.[33] The review also suggested a possible improvement in some neonatal outcomes, including arterial pH and reduced risks of sepsis and admission to NICU.[33] In the context of the low or very low certainty of these data, the results of the systematic review, broadly speaking, are in agreement with those findings, despite a number of methodological differences between these two studies. Although there was substantial overlap between the target outcomes and between the studies included here and in the Italian study, the review did not include neonatal sepsis as a separate outcome or smaller non-randomised studies, but notably the review did include the study by Dutta et al,[32] which was not included in the Italian study. There were also some differences in analytic approach, for example, unlike the authors' analyses their analyses did not distinguish between the different alternative interventions that the effect of Fetal Pillow was compared to. Rather they pooled estimates for studies comparing Fetal Pillow with no Fetal Pillow, non-inflated Fetal Pillow and vaginal push-up.

There are no available published studies of the Fetal Pillow that report data in relation to decision-to-delivery interval or cost-effectiveness. Furthermore, studies comparing outcomes in CB at full cervical dilatation between those using a Fetal Pillow and alternative disimpaction methods are likely to overestimate the benefits, since two thirds of CB at full cervical dilatation are not complicated by an IFH.[1] Those requiring advanced disimpaction techniques, such as vaginal push-up or reverse breech extraction, are likely to be more difficult and at greater

TABLE 1 Summary of the characteristics and risk of bias of included studies.

First author	Year	Country	Study design	Total (*n*)	Overall risk of bias
Fetal Pillow vs no Fetal Pillow					
Sacre	2021	UK	Retrospective cohort	391	Serious (ROBINS-I)
Hanley	2020	Australia	Retrospective cohort	174	Serious (ROBINS-I)
Seal	2014	India	Retrospective cohort	174	Serious (ROBINS-I)
Seal	2016	India	RCT	240	Some (RoB 2)
Inflated Fetal Pillow vs non-inflated Fetal Pillow					
Lassey	2020	USA	RCT	60	Low (RoB 2)
Fetal Pillow vs vaginal push-up					
Safa	2016	Australia	Retrospective cohort	160	Serious (ROBINS-I)
Fetal Pillow vs Patwardhan method					
Dutta	2019	India	RCT	50	Some (RoB 2)
Vaginal push-up vs reverse breech extraction					
Tahir	2020	Pakistan	RCT	110	Some (RoB 2)
Nooh	2017	Egypt	RCT	192	Some (RoB 2)
Saleh	2014	Egypt	RCT	80	Some (RoB 2)
Veisi	2012	Iran	RCT	72	Some (RoB 2)
Bastani	2012	Iran	RCT	59	Some (RoB 2)
Frass	2011	Yemen	RCT	118	Some (RoB 2)
Fasubaa	2002	Nigeria	RCT	108	Some (RoB 2)
Vaginal push-up vs Patwardhan method					
Keepanasseril	2019	India	Retrospective cohort	298	Serious (ROBINS-I)
Lenz	2019	Switzerland	Retrospective cohort	137	Serious (ROBINS-I)
Vaginal push-up or reverse breech extraction vs Patwardhan method					
Bhoi	2019	India	RCT	420	Some (RoB 2)
Bansiwal	2017	India	Retrospective cohort	135	Serious (ROBINS-I)
Saha	2014	India	Retrospective cohort	79	Serious (ROBINS-I)

TABLE 2 Techniques for the prevention and management of impacted fetal head at caesarean birth.

Techniques for prevention (before starting CB)	
Manual vaginal disimpaction (vaginal push method)	Introducing a hand into the vagina to move the fetal head up into the abdomen before making a uterine incision to reduce likelihood of IFH
Fetal Pillow	Using an inflatable device in the vagina to move the fetal head up into the abdomen before making a uterine incision to reduce likelihood of IFH
Techniques for management (when IFH encountered during CB)	
Uterine relaxation	Administration of medicine (tocolysis) to relax the uterus and facilitate advanced disimpaction techniques.
Abdominal cephalic disimpaction	Using dominant or non-dominant hand to flex and lift baby's head upwards into the maternal abdomen to deliver the head
Manual vaginal disimpaction (vaginal push method)	Introducing a hand into the vagina to move the head up into the abdomen
Reverse breech extraction	Hand is introduced in the upper aspect of the uterus, baby's feet are grasped and baby is delivered feet first (breech). Once baby's shoulders are delivered, head is lifted out of the pelvis
Patwardhan method	A modification of reverse breech extraction, whereby the arms are delivered first followed by delivery of the breech. Once the buttocks and the feet are delivered, the head is lifted out of the pelvis.

risk of complications. Finally, confidence performing alternative disimpaction methods is recognised to be low[4] and this may also lead to overestimation of the benefits of the Fetal Pillow.

The Fetal Pillow is promising as a device for preventing IFH at full dilatation CB, and the National Institute of Health and Care Excellence (NICE) interventional procedures guidance suggests the device is safe to use, provided

TABLE 3 Summary of findings for Fetal Pillow versus no Fetal Pillow.

			Quality assessment		Effect	
Outcome	**Number of studies**	**Sample size**	**Risk of bias**	**Heterogeneity I^2 (%)**	**RR / RD / OR / mean difference (95% CI)**	**Certainty**
Maternal						
Incision to delivery interval (s) (RCT)[a]	1	120 vs 120	Serious	0	MD -120.7 (–126.2 to –115.2)	Low
Incision to delivery interval (s) (NRS)[a]	1	50 vs 124	Very serious	**0**	MD -338.4 (–357.55 to –319.3)	Very low
Operative time (min)	2	170 vs 244	Serious	0	MD -20.81 (–22.31 to –19.31)	Moderate
Uterine incision extension	4	64/454 vs 120/525	Serious	80	RR 0.51 (0.24 to 1.08)	Very low
Injury to the urinary tract	1	2/114 vs 2/60	Very serious	0	RR 0.53 (0.08 to 3.64)	Very low
Estimated blood loss >1000 mL (RCT)[b]	1	5/120 vs 26/120	Serious	0	RR 0.19 (0.08 to 0.48)	Very low
Estimated blood loss >1000 mL (NRS)[b]	3	55/334 vs 58/405	Very serious	17	RR 1.2 (0.7 to 1.77)	Very low
Blood transfusion	4	14/454 vs 40/523	Serious	61	RR 0.39 (0.12 to 1.21)	Very low
Perinatal						
NICU admission	4	68/452 vs 84/525	Very serious	0	RR 0.74 (0.56 to 0.99)	Very low
Mean Apgar score at 5 min	1	113 vs 60	Serious	0	MD 0.02 (–0.31 to 0.35)	Very low
Apgar score <7 at 5 min	2	117/283 vs 68/281	Very serious	8	RR 1.01 (0.84 to 1.21)	Very low
Apgar score <3 at 5 min	2	3/170 vs 12/244	Serious	67	RR 0.43 (0.04 to 4.33)	Very low
Mean umbilical artery pH	1	98 vs 49	Very serious	0	MD 0.06 (0.03 to 0.09)	Very low
Umbilical artery pH <7.10	1	12/170 vs 29/221	Very serious	0	RR 0.54 (0.28 to 1.02)	Very low
Infant birth trauma	1	0/50 vs 6/124	Very serious	0	Peto OR 0.24 (0.04 to 1.42)	Very low
Neonatal death	2	0/170 vs 5/244	Serious	0	Peto OR 0.16 (0.03 to 1.02)	Very low

[a]Outcomes not pooled for incision to delivery interval outcome as $I^2 = 100\%$; [b]Outcomes not pooled for blood loss as direction of effect is opposing.

TABLE 4 Summary of findings for inflated Fetal Pillow versus non-inflated Fetal Pillow (one randomised controlled trial).

Outcome	Sample size	Quality assessment	Effect	
		Risk of bias	RR or OR (95% CI) / median difference (p-value)	Certainty
Maternal				
Incision to delivery interval (s)	30 vs 30	No serious	MD 23 (<0.01)	Low
Operative time (min)	30 vs 30	No serious	MD -3 (0.14)	Low
Uterine incision extension	6/30 vs 13/30	No serious	RR 0.46 (0.2 to 1.05)	Low
Estimated blood loss (ml)	30 vs 30	No serious	MD -100 (0.09)	Low
Blood transfusion	0/30 vs 0/30	No serious	Peto OR 0.13 (0.01 to 1.26)	Low
Postpartum pyrexia / sepsis	6/30 vs 5/30	No serious	RR 1.2 (0.41 to 3.51)	Low
Perinatal				
Median Apgar score at 5 min	30 vs 30	No serious	MD 0 (0.84)	Low

TABLE 5 Summary of findings for Fetal Pillow versus vaginal push-up (one non-randomised study).

Outcome	Sample size	Quality assessment	Effect	
		Risk of bias	RR / RD / OR / mean difference (95% CI)	Certainty
Maternal				
Uterine incision extension	18/91 vs 24/69	Very serious	RR 0.57 (0.34 to 0.96)	Very low
Estimated blood loss (ml)	91 vs 69	Very serious	MD -130 (–185.61 to –74.39)	Very low
Blood transfusion	3/91 vs 2/69	Very serious	RR 1.14 (0.2 to 6.62)	Very low
Perinatal				
NICU admission	14/91 vs 17/69	Very serious	RR 0.62 (0.33 to 1.18)	Very low
Apgar score <7 at 5 min	3/91 vs 4/69	Very serious	RR 0.57 (0.13 to 2.46)	Very low
Mean umbilical artery pH	91 vs 69	Very serious	MD 0.05 (0.03 to 0.07)	Very low

TABLE 6 Summary of findings for Fetal Pillow versus Patwardhan method (one randomised controlled trial).

Outcome	Sample size	Quality assessment	Effect	
		Risk of bias	RR / RD / OR / mean difference (95% CI)	Certainty
Maternal				
Uterine incision extension	2/25 vs 6/25	Serious	RR 0.33 (0.07 to 1.5)	Very low
Blood transfusion	0/25 vs 4/25	Serious	Peto OR 0.12 (0.02 to 0.9)	Very low
Perinatal				
NICU admission	3/25 vs 15/25	Serious	RR 0.2 (0.07 to 0.61)	Very low
Neonatal death	0/25 vs 1/25	Serious	Peto OR 0.14 (0.00 to 6.82)	Very low

maternity staff have adequate training.[34] However, there remains a lack of robust evidence and Fetal Pillow is not a panacea. It is only licensed for use in second-stage CB and its role in preventing IFH in first-stage CB has not been assessed. Moreover, other disimpaction techniques may still be required to assist delivery of an IFH when the device is used.[35] While the Fetal Pillow may be useful to prevent an IFH at CB, the device should be inserted before commencing CB and takes approximately 1 minute to inflate. It is therefore not of use where an IFH is encountered unexpectedly. Larger scale, high quality RCTs reporting clinical effectiveness and cost effectiveness are required before widespread use can be recommended.

6.2 | Management

Impaction of the fetal head can result in a lack of space for the operator to insert their hand anteriorly between the fetal head and pubic symphysis, hindering the standard approach

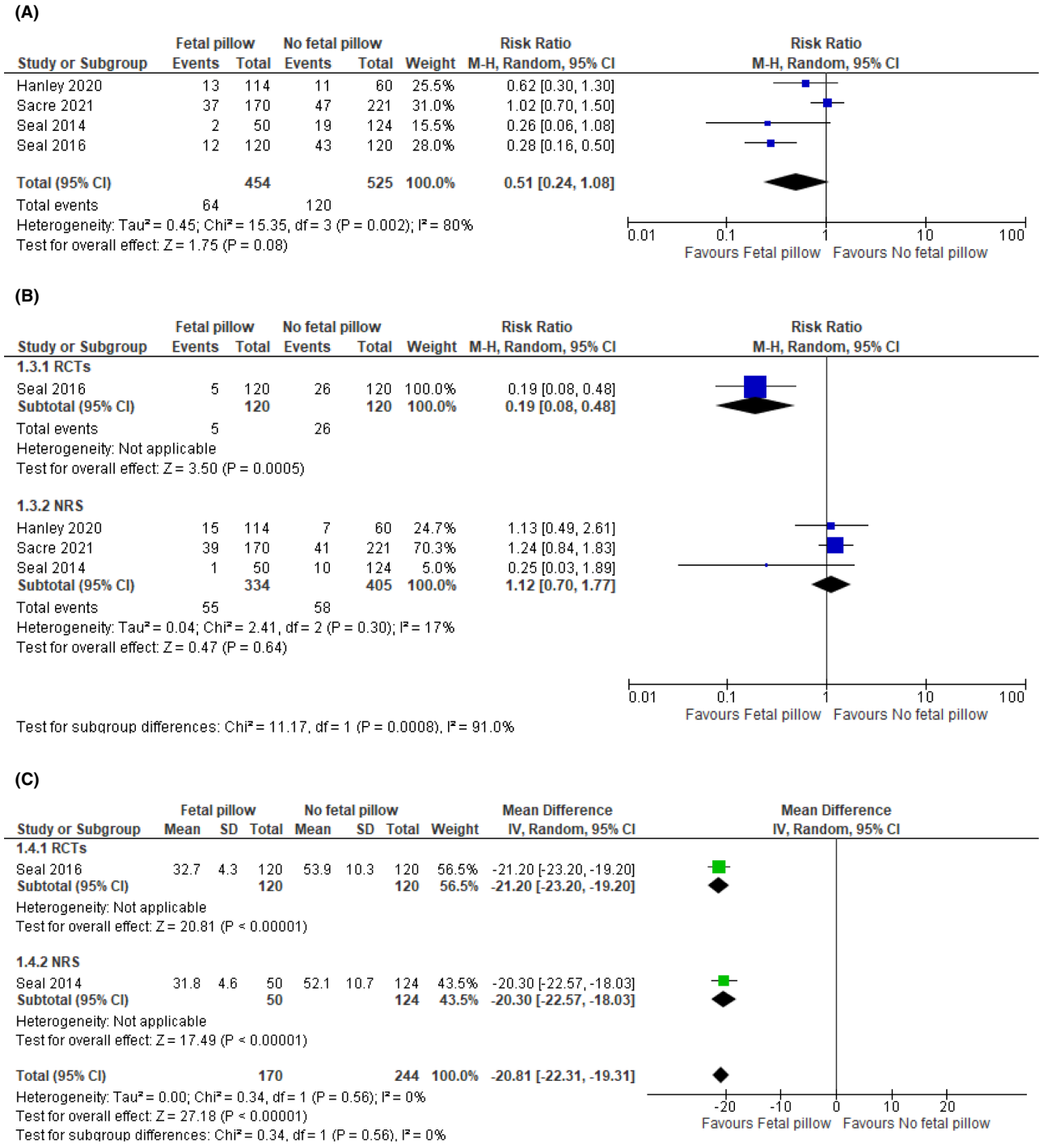

FIGURE 4 Maternal outcomes for Fetal Pillow versus no Fetal Pillow (a) uterine incision extension, (b) estimated blood loss >1000 mL and (c) operative time.

to deliver the fetal head at CB.[2] Abdominal cephalic disimpaction is likely to be effective in the majority of cases of IFH at CB.[1] However, if the obstetrician is unable to disimpact the head using these standard manoeuvres, several strategies can be employed, including: tocolysis,[36] vaginal disimpaction (push-up),[37] reverse breech extraction[23,38,39] and the Patwardhan method.[40,41] There are also a number of novel disimpaction devices that are currently under investigation.[42,43]

There remains a lack of consensus regarding which disimpaction technique is safest and/or most effective, particularly in relation to neonatal outcomes.[2,3] Moreover, some births may require the use of several techniques in a sequence to disimpact the fetal head.[1] Lack of standardised care pathways and evidence-based, multi-professional training[4,44] has resulted in widespread variation in practice[1,4,5] and may be associated with avoidable harm in some circumstances.[6,22,24,25]

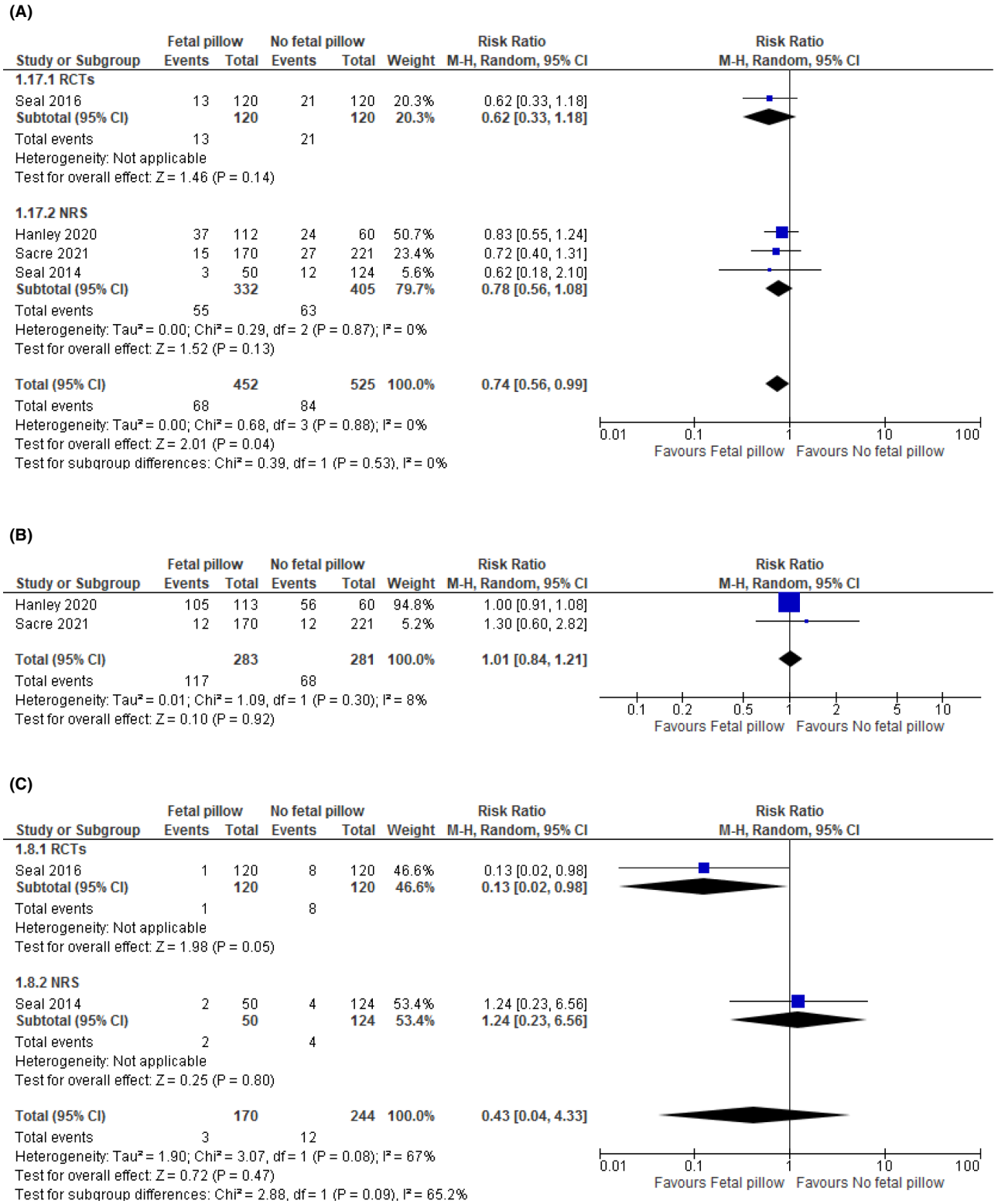

FIGURE 5 Perinatal outcomes for fetal pillow versus no fetal pillow (a) NICU admission, (b) Apgar score <7 at 5 minutes (c) Apgar score <3 at 5 minutes.

6.2.1 | Abdominal cephalic disimpaction

Coronial inquiries have identified repeated attempts by operators to push their hand anteriorly between the fetal head and maternal pubic symphysis as a common feature of perinatal death associated with skull fracture and second-stage CB.[22] However, there is no available evidence for how obstetricians should introduce their hand into the pelvis when the fetal head is deeply engaged. Moreover the specific techniques required to flex and elevate an IFH are poorly described.

Observation of simulated CB, and interviews with maternity staff, as part of the DiSIMpact study,[45] aimed to identify expert practices, common mistakes and areas for improvement. Safe practices and lessons for management and training are detailed below.

The transverse diameter of the maternal pelvis is most often wider above the impacted head than the anterior–posterior diameter. The obstetrician may therefore find it helpful to introduce their hand antero-laterally to get below the fetal head, while keeping their wrist straight and arm in the midline to avoid application of pressure on the uterine angles.[45]

Flexion of the fetal head is likely key to disimpaction. Biomechanics of labour suggest a flexed head presents the smallest antero-posterior diameter of the fetal head in the pelvis. The obstetrician should establish the position of the fetal head and attempt to sweep their hand over the face or occiput to flex it. The head should then be elevated towards the uterine incision with the pull applied towards the woman's head, and not the ceiling until out of the pelvis.[45]

The obstetrician should aim to keep their arm straight, in the midline, and parallel to the woman's body in order to avoid pressure on the uterine lower segment and lateral pressure on the uterine angles that may be vulnerable to tears. This can be facilitated by adjusting the height of the table or using a step, and the obstetrician turning to face the woman's head if using their dominant hand, or towards the woman's feet if using their non-dominant hand. The fetal head should be elevated in a calm and controlled manner with the obstetrician using their whole hand to maintain flexion of the fetal head, while avoiding any jerking movements or application of fingertip pressure.[45] Obstetricians may be able to flex and elevate the fetal head more easily using their non-dominant hand.

6.2.2 | Uterine relaxation

A uterine contraction may occur when the operator introduces their hand into the uterus causing splinting of the fetal spine and hindering disimpaction of the fetal head.[18,23] A pause at this stage provides time for spontaneous uterine relaxation, while also providing an opportunity for the obstetrician to assess the situation and plan next steps, as well as communicate with the maternity theatre team and parents.

The obstetrician may request the administration of a tocolytic agent, most commonly sublingual or intravenous nitroglycerin (GTN).[18] Currently, there is insufficient robust evidence to support tocolysis.[3,36] However, there is anecdotal evidence that tocolysis can facilitate disimpaction by helping to relax the uterus and minimise uterine resistance, particularly during advanced disimpaction techniques such as reverse breech extraction. There is no evidence supporting use of a particular tocolytic agent. However, in view of the theoretical risk of atonic postpartum haemorrhage, administration of a tocolytic agent with a short half-life is advised, such as sublingual GTN.

6.2.3 | Vaginal disimpaction

Vaginal disimpaction (push technique) has been described generically in the literature as an assistant using a cupped hand and fingers to gently elevate the fetal head.[16,46] However, this description lacks precision. Midwives are often requested, as part of the maternity team, to 'push up' vaginally if an IFH at CB is encountered. However, this is not included in midwifery undergraduate or ongoing training. A 2017 survey of midwives at a tertiary maternity unit in the UK, reported that half of midwives surveyed would insert two fingers, as with vaginal examination, to apply pressure to the fetal head.[47]

Some case reports,[48] case series[41,49] and coronial inquiries[25] have suggested an association between the vaginal push technique and perinatal skull fracture although the precise mechanism of injury is unclear. It is axiomatic that pushing up on the fetal head with one or two fingers might increase the risk of fetal trauma, however this does not explain the most common parietal fractures that cannot be related to direct pressure by fingers.[50] Furthermore, it is difficult to flex the head using fingertips only; correctly undertaken manual vaginal disimpaction using cupped fingers facilitates better flexion and elevation of the fetal head.[45]

Vaginal disimpaction is a standard technique that requires effective training and dedicated practice, possibly using simulation, for multidisciplinary maternity teams to become confident with the steps required.

To perform vaginal disimpaction safely and effectively, a whole hand should be used to evenly distribute pressure across the fetal head.[37] To achieve adequate vaginal access for this, the woman's legs should be repositioned in semi-lithotomy with the knees flexed and thighs abducted.[16,37]

An allocated team member should remove the leg straps, and reposition and support the legs, assisted by one other person. Repositioning the legs in semi-lithotomy may help to release the impaction itself but it is essential to support the legs throughout.

Vaginal disimpaction is a combined process with the operating obstetrician attempting to disimpact from above and the clinician assisting by pushing up from below. Clear communication is essential. The operating obstetrician should reiterate the steps, confirm the fetal position and explain the direction of flexion required to their assistant. Both clinicians should communicate their actions, feedback on effectiveness and clearly say if they wish to stop.[45]

The assistant (senior midwife or obstetrician) should insert their whole hand in to the vagina using a 'Pringle hand' technique, previously described in the management of shoulder dystocia.[51] The fingers should be advanced into the sacral hollow and spread across the fetal head, with the flattened palmar surface of all four fingers and thumb used to cradle the fetal head.[45] Clinicians should avoid using fingertips or just one, two or three fingers to push up vaginally.[25]

As with abdominal cephalic disimpaction, flexion is key to successful elevation of the fetal head vaginally.[48] If pressure is applied incorrectly during a vaginal push-up,

the fetal head may become more deflexed, compounding impaction behind the pubic symphysis and birth further.[48] The clinician should therefore modify their hand and finger placement according to fetal position. Gentle pressure should be applied steadily, continuously and evenly to flex the fetal head. As the head is elevated towards the incision, the operating obstetrician's fingers may be met. Jabbing or prodding motions and application of excessive point pressure should be avoided. If no progress is made or either clinician feels it is unsafe to continue, vaginal disimpaction should be abandoned and the legs repositioned out of semi-lithotomy.[45]

6.2.4 | Reverse breech extraction

Reverse breech extraction is used widely internationally, particularly in low-resource settings where obstructed labour may be more common,[52–58] while vaginal disimpaction continues to be ubiquitous in UK practice.[4,5,59] This may reflect a lack of training and confidence among UK obstetricians in performing 'pull' methods, including reverse breech extraction.[4,44]

There have been concerns reported that delivering babies by reverse breech methods may increase the risk of limb injury, including femoral and humeral fractures.[41,60] Researchers have hypothesised that this risk of limb injury may be reduced if delivery is undertaken by more experienced obstetricians.[60] Given that consultant supervision may not always be feasible,[4] it is essential that obstetricians are trained in how to perform these delivery techniques safely.

The steps required for safe, effective reverse breech extraction are:

The operator should introduce their hand into the upper segment of the uterus to grasp one or both fetal feet.[38,39] If it is difficult to identify a foot, the operator can follow the baby's back, over the buttocks and down to a leg to grasp a foot. The feet may be slippery and a sterile swab can be used to ensure effective grasp. Steady, continuous traction should be applied to one or both feet towards the woman's feet to flex the waist and deliver the legs and breech.[38,39]

After the breech has been delivered through the uterine incision, to deliver the arms, the baby's body should be gently rotated in the midline, ensuring the back is anterior and rotating the baby to deliver each arm in turn (Lovset's manouevre), while avoiding any application of pressure to the baby's abdomen. Following delivery of both arms, gentle traction should be applied towards the woman's head to deliver the fetal head. If the head does not easily deliver with gentle traction, a Mauriceau-Smellie-Veit manoeuvre can be employed to flex the baby's head. To achieve this, the operator should support the baby's body on their arm, and promote flexion by placing their first and third finger on the baby's cheekbones while applying simultaneous pressure to the occiput with their other hand; hyperextension of the fetal neck should be avoided.

6.2.5 | Patwardhan manoeuvre

The Patwardhan manoeuvre is a modification of reverse breech extraction, where the arms are delivered first.[40,61] It is used more commonly in India, where the technique was first developed.[61] However, it is rarely practiced in the UK, and not part of current training for UK obstetricians. This is also a technique that requires specialist, effective training and dedicated practice, possibly using simulation. This is challenging outside of India, where exponents of this technique may be limited.

The Patwardhan manoeuvre has been advocated as helpful when the fetus is in an occipito-anterior position and the feet are difficult to access. Following delivery of both arms through the uterine incision, the operator holds the baby's back by hooking their fingers through both axillae, applying gentle traction while the assistant applies fundal pressure to flex the baby's abdomen and deliver the breech.[40,41] Following delivery of the breech, the head can be gently lifted out of the pelvis as with a reverse breech extraction. A gentle, skilful approach is required[41] and care must be taken to avoid application of any pressure to the fetal abdomen and excessive force to the limbs.[61,62]

6.2.6 | Extension of uterine incision

If there is insufficient access for the operator to deliver the breech or a risk of unintentional uterine extensions while performing a reverse breech extraction or Patwardhan manoeuvre, the operator can perform either an inverted T or J incision to improve access.[19,63] The operator should ensure a clear operative view and protect the baby using their non-dominant hand between the incision and the fetus while making a vertical incision upwards into the upper segment.

The operator may also need to extend the uterine incision if a Bandl's ring is encountered. A Bandl's ring is a constriction between the upper and lower uterine segments, associated with obstructed labour.[1] There is a lack of consensus but extending the incision to include the Bandl's ring may improve access.

6.2.7 | Comparison of techniques for management

Evidence from this systematic review (Tables 1, 7-9 and Figures 6-7)

Twelve studies comparing vaginal push-up, reverse breech extraction and Patwardhan method were included in this systematic review.[52–58] The studies: 8 RCTs and 4 non-randomised studies – reported on three different comparisons of management strategies with 1808 participants (Table 1). Lack of an internationally agreed definition was a concern for the review, as it was not possible to include some studies where inclusion criteria are poorly defined/differ markedly from the standard definition in this paper.

The inclusion criteria varied across studies. Most studies only included women undergoing CB at full (10 cm) cervical dilatation.[40,52,55,58,61,62] One study reported CB before full cervical dilatation.[41] In the remaining studies, it was not clear whether women with CB before full cervical dilatation were included.[40,52,55,58,61,62,64]

There was poor clarity about study methodology and analysis in all 8 RCTs, leading to potential large biases, specifically relating to the selection of participants, randomisation procedure and reporting (Table 1 and Figure 3). For non-randomised studies, all studies were at serious risk of bias due to confounding, where the baseline differences between groups were not considered when analysing the data (Table 1 and Figure 3). These studies were also limited by potential bias, particularly selection of participants, under-reporting of methodological details of the intervention and/or comparison. Most were also at risk of reporting bias in the selection of the results.

There was also lack of precision on the techniques employed in studies relating to Patwardhan method, and varying descriptions of vaginal push-up reported in studies investigating this technique. In one study, vaginal push-up was described simply as 'the head was dislodged through the vagina and this was then delivered through the uterine incision'.[52] In another study, the technique was described using fingers to push the fetal head up to disimpact it.[53] No studies reported using a whole hand and cupped fingers to flex and elevate the fetal head, nor did they report any training in disimpaction techniques being investigated.

The certainty of the evidence for nearly all the outcomes was very low, meaning there is little confidence in the estimates of effect. Furthermore, as with the meta-analysis of studies investigating Fetal Pillow, it was not possible to provide pooled estimates for several outcomes due to very high levels of heterogeneity. Results for outcomes where it was possible to estimate the pooled effect size are highlighted in the text below. Further details are provided in Tables 7–9.

6.3 | Vaginal push-up versus reverse breech extraction (Table 7)

Seven studies, all RCTs, compared vaginal push-up with reverse breech extraction ($n = 739$).[52–58] Compared with reverse breech extraction, vaginal push-up was associated with poor maternal outcomes, including: increased maternal operative blood loss, length of operative time, and risks of postpartum haemorrhage (RR 2.21 [1.04–4.69]), blood transfusion (RR 2.75 [1.55–4.88]), uterine incision extensions (RR 3.45 [2.41–4.93]), urinary tract injury (RD 0.01 [−0.01–0.03]), and maternal infection (endometritis, urinary tract and postpartum pyrexia/sepsis); although the evidence is very uncertain. The evidence for Apgar score at 5 minutes, umbilical artery pH and NICU admission was equivocal.

6.4 | Vaginal push-up versus the Patwardhan method (Table 8)

Two non-randomised studies compared vaginal push-up with the Patwardhan method ($n = 435$).[41,62] Vaginal push-up was associated with a lower risk of wound infection, compared with Patwardhan method (RR 0.41 [0.2–0.84]). Babies born in the vaginal push-up group also had a lower risk of needing NICU admission (RR 0.62 [0.48–0.81]).

6.5 | Vaginal push-up or reverse breech extraction versus the Patwardhan method (Table 9)

Three studies compared Patwardhan method with either vaginal push-up or reverse breech extraction ($n = 634$).[40,61,64] Analysis suggested that, compared with Patwardhan method, vaginal push-up or reverse breech extraction may increase the risk of incision extension on the lower segment (OR 5.42 [3.14–9.34]), risk of postpartum haemorrhage (RR 14.42 [1.97–105.7]), maternal blood transfusion (RR 3.62 [1.77–7.41]) and length of operative time (mean difference 6.58 min [3.27–9.89]).

Other evidence

Findings from this systematic review align with other systematic reviews[2,3,65,66] suggesting that 'pull' methods, including reverse breech extraction and Patwardhan method, may be associated with improved maternal outcomes compared with the 'push' method, but with very low certainty. However, the evidence base for the effectiveness of different methods of managing IFH at CB is very limited and the studies have multiple weaknesses. Very little attention has been given to unintended consequences of various techniques and there are minimal data on any improved outcomes for the infant.

Studies mainly focus on women undergoing CB at full cervical dilatation. However, given the growing body of evidence up to half of the cases are reported during CB at less than full dilatation,[1] many clinical scenarios are left unaddressed by this body of evidence. Some procedures (e.g. use of tocolytics to relax the uterus) commonly used in the UK,[4] were not included in any of the studies.

In addition, many studies were conducted in settings where maternal and fetal characteristics, and also clinical practice, may not be directly generalisable to all settings. A further major flaw across studies is that the training and competence assessment of the clinicians performing the techniques was not reported. The majority of improvement in outcomes is related to a reduction in extension of uterine incision when delivering the fetal head. However, it is not known whether the disimpaction procedures were performed correctly and whether potential errors in the execution of a technique contributed to poor outcomes. It is therefore difficult to assess the effectiveness of these techniques that are likely to depend on competence. UK

TABLE 7 Summary of findings for vaginal push-up versus reverse breech extraction.

Outcome	Number of studies	Sample size	Quality assessment		Effect	
			Risk of bias	Heterogeneity I^2 (%)	RR / RD / OR / mean difference (95% CI)	Certainty
Maternal						
Operative time (min)[a]	7	369 vs 370	Serious	99	Bastani: MD 0.1 (−5.77 to 5.97) Fasubaa: MD 32.9 (31.00 to 34.8) Frass: MD 14.3 (12.53 to 16.07) Nooh: MD 14.9 (13.47 to 16.33) Saleh: MD 15.5 (13.2 to 17.8) Tahir: MD 9.26 (8.29 to 10.23) Veisi: MD 11.91 (8.28 to 15.54)	Very low
Uterine incision extension	7	170/369 vs 48/370	Serious	29	RR 3.45 (2.41 to 4.93)	Low
Injury to the urinary tract	5	7/260 vs 2/261	Serious	0	RD 0.01 (−0.01 to 0.03)	Very low
Infection:						
Wound	6	38/314 vs 26/315	Serious	39	RR 1.67 (0.76 to 3.69)	Very low
Endometritis	2	39/113 vs 26/113	Serious	0	RR 1.54 (1.04 to 2.27)	Very low
UTI	1	10/30 vs 0/29	Serious	0	Peto OR 10.26 (2.66 to 39.52)	Very low
Postpartum pyrexia / sepsis	3	38/161 vs 9/162	Serious	46	RR 3.64 (1.35 to 9.84)	Very low
Estimated blood loss (ml)[a]	6	339 vs 341	Serious	97	Fasubaa: MD 358.1 (340.84 to 375.36) Frass: MD 444 (265.17 to 622.83) Nooh: MD 535 (456.88 to 613.12) Saleh: MD 443 (169.05 to 716.95) Tahir: MD 452.36 (391.88 to 512.84) Veisi: MD 114 (72.61 to 155.39)	Very low
Estimated blood loss >1000 mL	3	20/195 vs 9/195	Serious	0	RR 2.21 (1.04 to 4.69)	Very low
Blood transfusion	4	40/225 vs 14/224	Serious	0	RR 2.75 (1.55 to 4.88)	Very low
Perinatal						
NICU admission[a]	6	74/314 vs 36/315	Serious	90	Bastani: RD 0 (−0.06 to 0.06) Fasubaa: RD 0.46 (0.03 to 0.63) Frass: RD 0.03 (−0.11 to 0.18) Nooh: RD 0.08 (−0.01 to 0.17) Saleh: RD 0.07 (−0.08 to 0.23) Veisi: RD 0 (−0.05 to 0.05)	Very low
Mean Apgar score at 5 min[a]	3	119 vs 120	Serious	98	Bastani: MD 0.1 (−0.18 to 0.38) Fasubaa: MD -1.2 lower (−1.12 to −1.28) Veisi: MD 0.03 (−0.27 lower to 0.33)	Very low
Apgar score <7 at 5 min	2	35/155 vs 20/155	Serious	59	RR 1.72 (0.77 to 3.82)	Very low
Mean umbilical artery pH	1	30 vs 29	Serious	0	MD -0.01 (−0.05 to 0.03)	Very low
Infant birth trauma	3	3/119 vs 5/120	Serious	0	RD -0.01 (−0.06 to 0.03)	Very low
Neonatal death	3	16/180 vs 7/179	Serious	49	RD 0.03 (−0.03 to 0.9)	Very low

[a]Outcomes not pooled for operative time, estimated blood loss, NICU admission or mean Apgar score at 5 min due to very serious inconsistency.

clinicians have reported that they are not adequately prepared, competent and confident in all disimpaction techniques.[4]

At present, it is not possible to derive firm conclusions regarding the superiority of one technique over another. Clinicians should be trained in all available techniques and first choose the technique according to their experience and the clinical situation. Well-designed RCTs in which clinicians are appropriately trained in the techniques compared, are urgently required to further investigate this issue.

6.6 | Novel devices under investigation

A number of other strategies have been described to assist disimpaction of an IFH at CB, including the Tydeman tube,[42] C-snorkel[43] and fetal head elevating devices.[67]

TABLE 8 Summary of findings for vaginal push-up vs Patwardhan method.

Outcome	Number of studies	Sample size	Quality assessment		Effect	
			Risk of bias	Heterogeneity I^2 (%)	RR / RD / OR / mean difference (95% CI)	Certainty
Maternal						
Incision to delivery interval (min)	1	82 vs 55	Very serious	0	MD 0.3 (−0.66 to 1.26)	Very low
Operative time (min)	2	303 vs 132	Very serious	17	MD 4.1 (0.61 to 8.8)	Low
Uterine incision extension[a]	2	84/303 vs 25/132	Very serious	88	Keepanasseril: RR 0.96 (0.62 to 1.49) Lenz: RR 3.89 (1.6 to 9.43)	Very low
Injury to the urinary tract	1	4/221 vs 0/77	Very serious	0	Peto OR 3.9 (0.41 to 37.05)	Very low
Infection:						
Wound	1	14/221 vs 12/77	Very serious	0	RR 0.41 (0.2 to 0.84)	Very low
Estimated blood loss (ml)[b]	2	303 vs 132	Very serious	85	Keepanasseril: MD -6.10 (−77.82 to 65.62) Lenz: MD 149.50 (53.34 to 245.66)	Very low
Estimated blood loss >1000 mL	1	26/221 vs 8/77	Very serious	0	RR 1.13 (0.54 to 2.39)	Very low
Blood transfusion	1	13/221 vs 7/77	Very serious	0	RR 0.65 (0.27 to 1.56)	Very low
Perinatal						
NICU admission	2	82/303 vs 46/132	Very serious	0	RR 0.62 (0.48 to 0.81)	Very low
Apgar score <7 at 5 min	1	3/82 vs 0/55	Very serious	0	Peto OR 5.45 (0.53 to 55.77)	Very low
Umbilical artery pH <7.15	1	8/82 vs 4/55	Very serious	0	RR 1.34 (0.42 to 4.24)	Very low
Infant birth trauma	2	10/303 vs 5/132	Very serious	0	RR 0.79 (0.28 to 2.27)	Very low
Neonatal death	2	4/303 vs 3/132	Very serious	42	Peto OR 0.47 (0.09 to 2.48)	Very low

[a]Outcomes not pooled due to very serious inconsistency and opposing direction of effect.
[b]Outcomes not pooled for blood loss as direction of effect is opposing.

TABLE 9 Summary of findings for vaginal push-up or reverse breech extraction versus Patwardhan method.

Outcome	Number of studies	Sample size	Quality assessment		Effect	
			Risk of bias	Heterogeneity I^2 (%)	RR / RD / OR / mean difference (95% CI)	Certainty
Maternal						
Operative time (min)	1	291 vs 129	Serious	0	MD 6.58 (3.27 to 9.89)	Moderate
Uterine incision extension:						
into lower segment	3	61/406 vs 2/228	Serious	0	Peto OR 5.42 (3.14 to 9.34)	Very low
Estimated blood loss >1000 mL	1	16/71 vs 1/64	Very serious	0	RR 14.42 (1.97 to 105.7)	Very low
Blood transfusion	3	67/406 vs 10/228	Serious	12	RR 3.62 (1.77 to 7.41)	Very low
Perinatal						
NICU admission	3	112/406 vs 56/228	Serious	0	RR 1.11 (0.84 to 1.48)	Low
Apgar score <7 at 5 min	1	6/44 vs 4/35	Very serious	0	RR 1.19 (0.36 to 3.90)	Very low
Apgar score <3 at 5 min	1	38/291 vs 10/129	No serious	0	RR 1.68 (0.87 to 3.28)	Low

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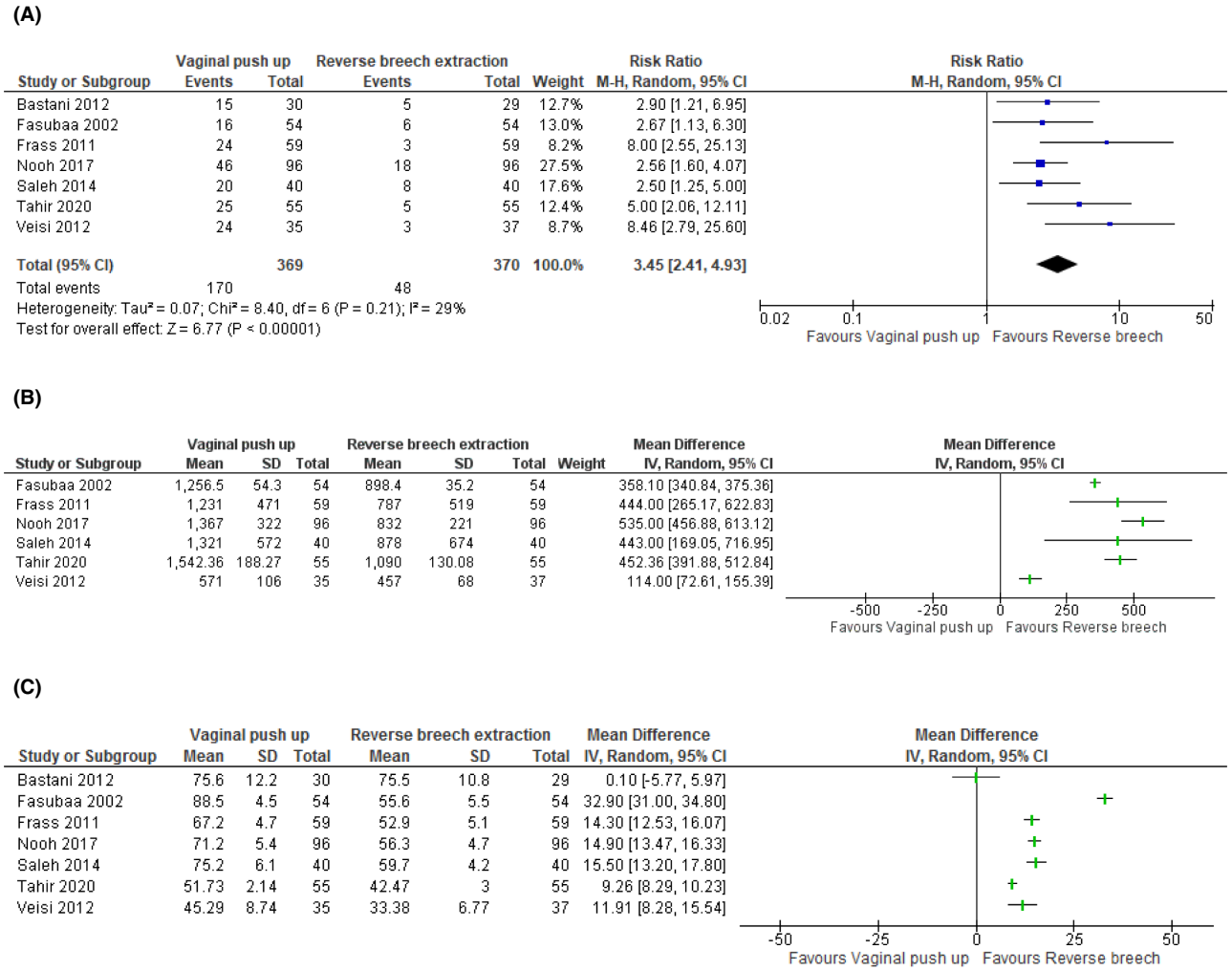

FIGURE 6 Maternal outcomes for vaginal push up versus reverse breech extraction (a) uterine incision extension, (b) estimated blood loss and (c) operative time. Pooled estimates not included for (b) and (c) due to very high levels of heterogeneity ($I^2 > 95\%$).

However, there are currently insufficient data to recommend their use.

6.6.1 | Tydeman Tube

The Tydeman tube is a single-use, hollow silicone tube with a rounded cup inserted vaginally to elevate the fetal head. It is designed to minimise applied pressure to the head and reduce any suction effect once access has been achieved.[42,68] Testing in simulation suggests that its use is associated with lower applied pressures and greater elevation of the fetal head compared with 'digital' vaginal push-up[42] and Fetal Pillow.[68] The clinical significance of the difference in elevation is uncertain and the precise technique used to perform digital push-up in the comparator group is not described. Given that it is difficult to perform manual vaginal disimpaction using a whole hand on the simulator in which the device was tested, and that the authors refer to measuring the surface area of fingertips, it is unlikely that a cupped, whole hand was used to perform the vaginal push-up. A minimal number of Tydeman Tubes have been used clinically.[42] Further research in a clinical setting, and compared with appropriately trained for and executed manual vaginal disimpaction, is required to investigate its efficacy and safety before use.[42]

6.6.2 | C-snorkel

The C-snorkel is a disposable tube with ventilation ports, intended to release the vacuum between the fetal head and vaginal wall. There are very little data on the use of the C-snorkel[43,69] and recent reports suggest that it may have been withdrawn from the market.[68]

6.6.3 | Fetal head elevators

Specifically designed obstetric spoons, which look similar to a single blade of an obstetric forceps, have been described to deliver an IFH.[67] These include the Coyne spoon, Sellheim

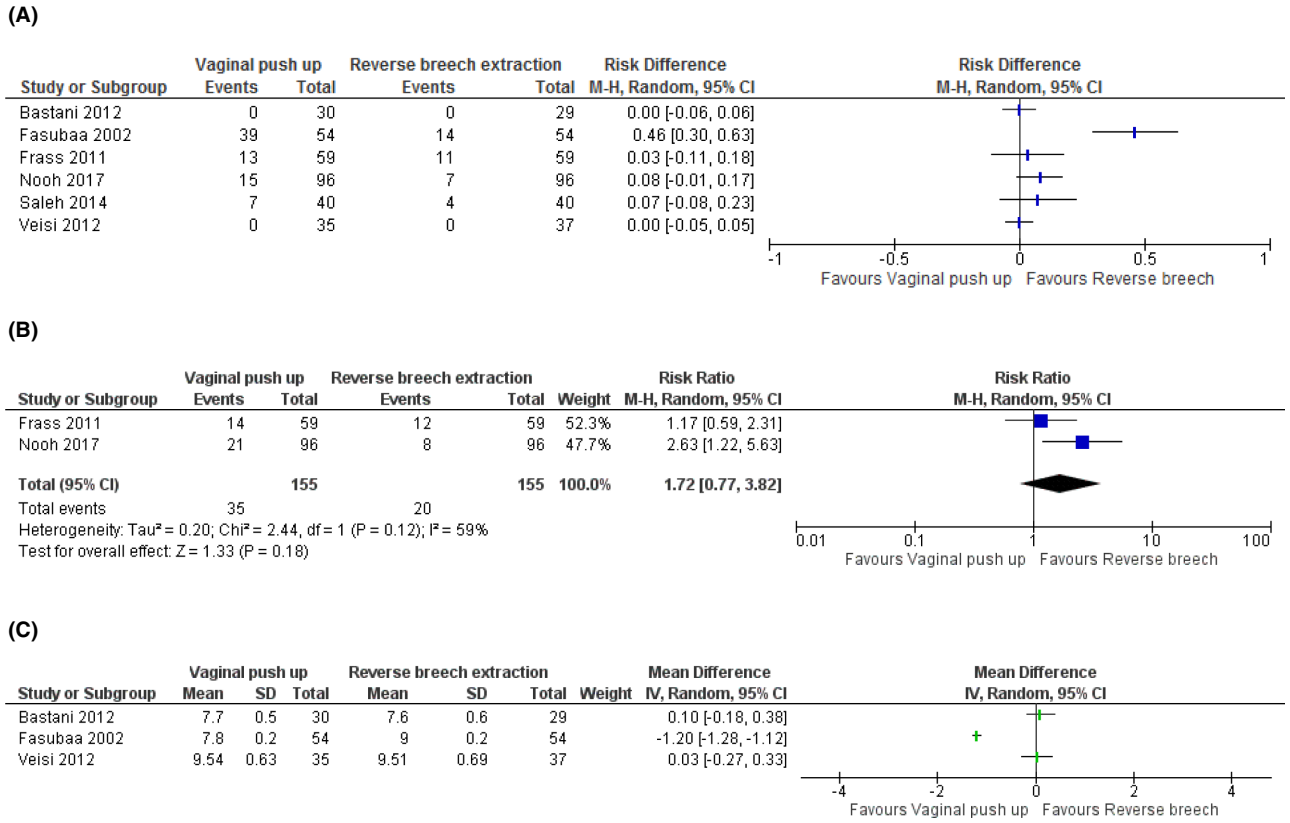

FIGURE 7 Perinatal outcomes for vaginal push up versus reverse breech extraction (a) NICU admission, (b) Apgar score <7 at 5 minutes and (c) Mean Apgar at 5 minutes. Pooled estimates not included for (a) and (c) due to very high levels of heterogeneity ($I^2 > 95\%$).

spoon and Murless head extractor, originally developed in the 1950s. However, there are an absence of data demonstrating safety, very little evidence for their use in modern obstetric practice and risk of inappropriate use resulting in maternal visceral injury.[67]

6.7 | Non-recommended techniques

Although it is not currently possible to make firm recommendations regarding the use of one technique over another, caution is advised against using a single forceps blade or ventouse employed abdominally, or bladder filling to assist delivery of an IFH.[24] None of these practices are supported by evidence. Moreover, use of a vacuum at CB has the potential to cause significant fetal injury such as intracranial and subgaleal haemorrhage, and should be avoided.[70,71]

7 | NON-TECHNICAL SKILLS

7.1 | Anticipation and preparation

While some intrapartum characteristics are associated with an increased risk of IFH at CB, it is not possible to reliably predict IFH. Obstetricians must therefore be prepared to encounter difficulties disimpacting a fetal head at all unplanned caesarean births.[1,5] If there is any clinical suspicion of an IFH at CB, the maternity theatre team should be alerted preoperatively in the standard safety briefing in theatre and a senior obstetrician informed. A trained midwife or obstetrician should be allocated to don sterile gloves in preparation for potential vaginal disimpaction. The team should ensure that any intrapartum oxytocin infusion is discontinued and GTN spray is readily available. The obstetrician should also ensure that the operating table is at an appropriate height and that a step is available if needed. These steps will help the multiprofessional team to respond effectively if an IFH is diagnosed.

If difficulties delivering an IFH are encountered, the maternity team should anticipate and prepare for associated complications. This includes assessing for uterine incision extensions and taking measures to prevent and manage postpartum haemorrhage. The team should also consider the potential need for neonatal resuscitation and ensure that a senior neonatologist is present to assess the baby for signs of birth injury.

7.2 | Communication and teamworking

IFH at CB is a team emergency that should be managed with a multidisciplinary approach. While the operating

obstetrician performs many of the techniques required to disimpact the fetal head, everyone in theatre has a role to play, and shared understanding is key. Anaesthetists may need to administer tocolysis or adjust the operating table, as well as communicate with the parents and be cognisant of the increased risk of postpartum haemorrhage. Midwives may be requested to perform vaginal disimpaction, and crucially, should be trained and confident to do so effectively. Theatre staff may need to provide a step to the operating obstetrician to help with ergonomics and/or support the woman's legs during vaginal disimpaction. They may also need to call for help from senior obstetricians and neonatologists, clearly conveying the nature and urgency of the situation.

When managing an IFH at CB, maternity staff should apply the general principles of teamworking, communication and escalation, embedded in essential training for intrapartum emergencies. This includes using closed-loop communication when allocating roles, delegating tasks, and giving instructions.[72] It is important that the maternity team uses consistent language to escalate the emergency. In other obstetric emergencies, such as shoulder dystocia, clearly and calmly declaring the emergency using unambiguous terminology facilitates teamworking, communication and management.[73] Similarly, on diagnosing an IFH at CB, the obstetrician should clearly and calmly declare the emergency stating: 'this is an impacted fetal head'. Further work is ongoing to understand the specific principles for communication and teamworking in relation to the management of IFH at CB.

Issues concerning communication and shared decision-making with those in labour and their birthpartners are notably absent in the literature relating to IFH at CB. The ABC collaboration consulted with women who had experienced unplanned CB to understand what good communication looks like when an IFH occurs. Key principles involve communication, language and teamworking. Maternity staff should be mindful of conversations within earshot of parents, but also be aware that silence may cause women and birth partners to think the worst. Maternity staff should explain the meaning of unfamiliar and potentially alarming terms, such as impacted fetal head, and what is happening over time.

8 | DOCUMENTATION

Techniques used to disimpact the fetal head are often poorly documented, particularly where 'push' or 'pull' methods have not been employed.[1,4] However, lack of documentation hinders research, audit and learning from cases of IFH at CB. Furthermore, inadequate documentation is more likely to have medicolegal consequences. As with shoulder dystocia, the use of a structured documentation proforma would improve record keeping and facilitate understanding and training.[74] Such tools are under development as part of the ABC collaboration. Maternity units should also consider developing mechanisms for local incident reporting and monitoring of cases.

9 | TRAINING

It is essential that clinicians are familiar with disimpaction techniques to reduce the potentially devastating complications associated with IFH. However, techniques are difficult to learn experientially. In addition, IFH is unpredictable, and an experienced consultant obstetrician may not be easily available. A recent survey of UK trainees and consultant labour ward leads reported that current training for IFH at CB is inconsistent and inadequate.[4] Over half of UK obstetric registrars would not feel confident performing reverse breech extraction, and fewer than one in 10 are familiar with the Patwardhan technique.[4] This is likely to reflect inadequate training since relatively few obstetricians have received practical training (either in real-life or simulation) in disimpaction techniques.[4] Furthermore, techniques to disimpact the fetal head are mostly not visible and those supervising such births may not clearly articulate all the complex steps required. Midwives are often asked to push up vaginally to assist delivery of an IFH at CB, but few have received any training in how to do so.[47]

Appendix 2 shows a stepwise management algorithm to support maternity staff in managing IFH at CB, developed as part of the ABC collaboration. Algorithms can facilitate improvement in performance in both real-life and simulation-based training.[75,76] As with shoulder dystocia, simulation is likely to provide an effective and safe form of training for IFH.[77] Simulation should be multiprofessional and use a validated, high-fidelity birth simulator that realistically simulates an IFH and facilitates rehearsal of all disimpaction techniques.[78,79]

10 | OPINION

- There is a lack of high-quality, adequately powered, randomised trials comparing techniques to prevent and manage IFH at CB, with significant weaknesses in the current evidence base.
- A consensus-based, universally accepted definition of IFH at CB is required for future research and training.
- Research is needed into language, communication and shared decision-making with those in labour and their partners during and after IFH at CB.
- A high-quality, well-designed, large randomised controlled study based on agreed definitions and using structured documentation, should evaluate usefulness and safety of interventions for recognition and management of IFH.
- The context and indications for the use of Fetal Pillow requires further investigation into both clinical and cost-effectiveness.
- A standardised multiprofessional training programme based on best available evidence should be developed and implemented.

DISCLAIMER

The available literature on IFH at CB is limited but expanding. In view of the increased recognition of this obstetric emergency and associated severe injuries, this Scientific Impact Paper (SIP) has been released before the publication of some of the studies cited. The structure of this SIP therefore differs from the standard format. The developers will update the SIP when the systematic review and DiSIMpact study have been published.

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CONFLICT OF INTEREST STATEMENT

Full disclosure of interests are available to view online as supporting information.

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APPENDIX 1

Techniques for the prevention and management of impacted fetal head

FIGURE A1 Fetal Pillow. Image reproduced courtesy of Cooper Surgical, Inc.

FIGURE A2 Vaginal disimpaction. Image reproduced with permission from Avoiding Brain Injuries in Childbirth (ABC) Collaboration.

FIGURE A3 Reverse breech extraction. The operator grasps one or both feet (1), applies traction towards the woman's feet to deliver the legs and abdomen (2), rotates the body in the midline to deliver each arm in turn (3), and applies traction towards the woman's head to deliver the baby's head (4). Image reproduced with permission from Avoiding Brain Injuries in Childbirth (ABC) Collaboration.

FIGURE A4 Patwardhan method. Image reproduced with permission from Avoiding Brain Injuries in Childbirth (ABC) Collaboration.

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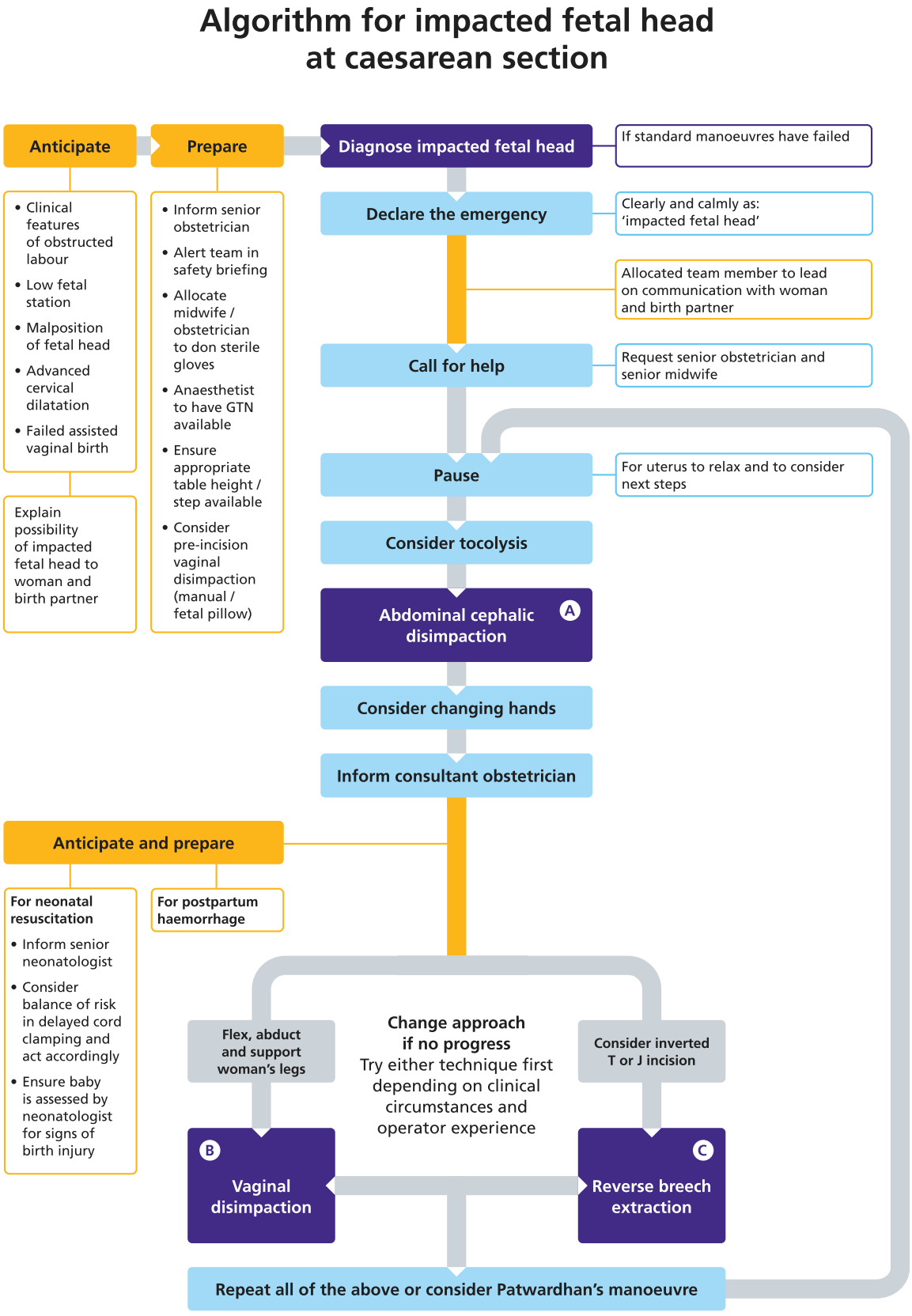
APPENDIX 2



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