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Systematic review

# Vaginal delivery in women with a low-lying placenta: a systematic review and meta-analysis

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**Background** Low-lying placentas are positioned close to the internal os of the cervix. The preferred way of delivery within this group is unclear.

**Objectives** To review the literature on the success of a vaginal delivery with a low-lying placenta.

**Search strategy** We searched OVID EMBASE and MEDLINE for studies on vaginal delivery with a low-lying placenta.

**Data collection and analyses** Data was extracted on successful vaginal delivery and emergency caesarean section due to haemorrhage. We distinguished between different distances between the cervical os and the placenta (internal os distance, IOD); 0–10, 11–20, and >20 mm. A meta-analysis of proportions was made for successful vaginal delivery and emergency caesarean section at every cut-off value. Maternal morbidity (i.e. antepartum blood loss, postpartum haemorrhage and blood transfusion) at different cut-off values was evaluated.

**Main results** Of the 999 articles retrieved, 10 articles met our inclusion criteria. A vaginal delivery was successful at an IOD of 0–10 mm in 43%, at an IOD of 11–20 mm in 85%, and at an IOD of >20 mm in 82%. A shorter IOD had a higher chance of antepartum haemorrhage, whereas a larger IOD needed postpartum blood transfusion more often. Postpartum haemorrhage did not depend on IOD.

**Conclusion** A low-lying placenta is not a contraindication for a trial of labour, and the morbidity in these women is not increased. However, women with a low-lying placenta have a higher chance of an emergency caesarean section compared with women with a placenta outside the lower uterine segment. Therefore, shared decision-making is mandatory in case of a trial of labour.

**Keywords** Caesarean section, haemorrhage, low-lying placenta, vaginal delivery.

**Tweetable abstract** This systematic review demonstrates the possibility of a vaginal delivery in women with a low-lying placenta within 20 mm of the cervix.

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## Introduction

A placenta covering the internal os of the cervix, a placenta praevia, has a higher risk of bleeding before and during delivery.[1] Therefore, a caesarean section is always indicated. For a low-lying placenta, lying close to but not covering the internal os of the cervix, the mode of delivery is less defined. A low-lying placenta may be associated with maternal and fetal-neonatal complications as well. However, according to a recently published meta-analysis focusing on the risk of postpartum haemorrhage (PPH), the incidence of PPH was significantly lower in women with low-lying placenta than in women with placenta praevia.[2] Women with a low-lying placenta usually remain asymptomatic during the first trimester of pregnancy and are generally diagnosed during routine sonography in the second trimester.[3] The distance between the placental edge and the internal os of the cervix (i.e. internal os distance,

IOD) is measured using transvaginal sonography (TVS).[4] The IOD is used to determine the possibility of a vaginal delivery. Women with an IOD of more than 20 mm are considered to be safe for a vaginal delivery.[5] For a low-lying placenta with an IOD between 0 and 20 mm, there is no consensus concerning the recommended mode of delivery.

In 2011, the Royal College of Obstetricians and Gynaecologists stated that patients with a low-lying placenta are likely to need delivery by caesarean section.[6] The Society of Obstetricians and Gynaecologists of Canada (SOGC) agrees, however, they state that a vaginal delivery is still possible depending on clinical circumstances.[7] In the Netherlands a new guideline in 2015 stated that with an IOD > 10 mm, it is advised to pursue a vaginal delivery, as the chance of an emergency caesarean section due to haemorrhage is low. With an IOD of < 10 mm, however, the patient should be informed of a higher risk of an emergency caesarean section due to haemorrhage, and planned caesarean delivery can therefore be considered.[8]

In general, physicians are well aware of the importance to avoid unnecessary caesarean sections, mainly because of risks in subsequent pregnancies, among which the recurrence of a low-positioned placenta.[9] At this moment, some women with a low-lying placenta deliver through caesarean section, even though its benefit within this group is not yet proven. We aim to evaluate the possibility of a vaginal delivery in patients with a low-lying placenta, without the need for emergency caesarean section due to haemorrhage.

## Methods

This systematic review was reported according the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[10] The review protocol was registered in the international prospective register of systematic reviews (PROSPERO) (systematic review record CRD42017057246). This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors. As our study concerned a review, there was no direct patient- or public involvement.

### Identification and selection of studies

A medical librarian (J.L.) performed a comprehensive search in OVID MEDLINE (including Epub Ahead of Print, In-Process & Other Non-Indexed Citations), OVID EMBASE and clinicaltrials.gov from inception to 20 February 2017. We searched for the concepts low-lying placenta and vaginal delivery, using a wide variety of controlled terms, including MESH, and text words (see Supporting Information Appendix S1 for entire MEDLINE search). We safely excluded animal studies and twin pregnancies by double negation, i.e. not (exp animals/not humans/). No date, language or other restrictions were applied. We cross-checked the reference lists and the citing articles of the identified relevant papers in Web of Science and adapted the search in case of additional relevant studies. The bibliographic records retrieved were imported and de-duplicated in ENDNOTE.

Two review authors (C.J., Y.M.) independently screened title and abstract of retrieved papers. Discrepancies were resolved by consensus and, where necessary, a third reviewer was consulted (E.P.). Papers were eligible for screening full-text if they described a vaginal delivery in patients with a low-lying placenta in the third trimester and/or if morbidity related to the way of delivery in patients with a low-lying placenta in the third trimester was described. After screening title and abstract, a final decision on inclusion or exclusion was made after reading all remaining articles independently in more detail. We included all prospective and retrospective cohort studies, case-control studies, and case series of more than ten cases. We included conference abstracts and contacted the author if the study seemed eligible.

### Quality assessment

Two reviewers (C.J., Y.M.) independently scored the included studies on methodological quality using predesigned characteristics based on the Newcastle-Ottawa-Scale (NOS). The NOS is fitted for quality assessment of analytical studies and is recommended by the Cochrane collaboration of assessing non-randomised studies.[11] Separate NOS scales are developed for both cohort studies and case-control studies, which were included in this review. The NOS contains eight items, categorised into three dimensions, each of which can be scored: selection (maximum of four stars), comparability (maximum of two stars) and outcome (maximum of three stars). We used the following thresholds for converting the NOS to good, fair and poor standards: good quality was represented by 3 or 4 stars in the selection domain AND 1 or 2 stars in the comparability domain AND 2 or 3 stars in the outcome domain; fair quality as 2 stars in the selection domain AND 1 or 2 stars in the comparability domain AND 2 or 3 stars in the outcome domain; poor quality as 0 or 1 star in the selection domain OR 0 stars in the comparability domain OR 0 or 1 stars in the outcome domain. The checklist is included in Supporting Information Appendix S2.[12]

### Data extraction

Finally, both independent reviewers (C.J., Y.M.) extracted clinical characteristics from the remaining studies using predesigned extraction forms, including author, year, country, type and setting, study population, type of ultrasound (US), transabdominal sonography (TAS) or transvaginal

sonography (TVS), cases of low-lying placenta (LLP), cases doing trial of labour (ToL), different groups of distance between the placental edge and internal os (IOD-groups), mean interval between US and delivery and moment of last US. Also, data were extracted concerning successful vaginal delivery: IOD, number of cases (*N*), patients with elective caesarean section, patients having a trial of labour (ToL), total number of patients needing an emergency caesarean delivery (ESD), patients needing an emergency delivery due to intrapartum haemorrhage, number of successful vaginal deliveries, significance if mentioned. Also, data on morbidity were extracted concerning blood transfusion, antepartum and postpartum haemorrhage, and haemorrhage after vaginal delivery or a caesarean section if a low-lying placenta was extracted.

### Statistical analysis

The primary outcome was the proportion of women with a low-lying placenta and a successful vaginal delivery without an emergency caesarean delivery due to haemorrhage. We calculated the proportion at different measurements of IOD: >20, 0–20, 11–20, and 0–10 mm. We created a meta-analysis with the random effects model or fixed effects model depending on the heterogeneity using $I^2$ in which we decided that an $I^2$ of >50% showed significant heterogeneity. We calculated the mean proportion in percentage and 95% confidence intervals.

## Results

### Amendments to the study protocol

Prior to our search, we had no indication of the definite form and number of outcome measures on this topic. Therefore, the following amendments to the study protocol were made during the process of study selection and data extraction. Merging the predetermined primary and secondary outcome measurement (i.e. peripartum haemorrhage and successful vaginal delivery) fitted our research question, as peripartum haemorrhage results in an unsuccessful vaginal delivery and vice versa. Therefore, in our first amendment we decided to change the primary outcome in a successful vaginal delivery and emergency caesarean section due to haemorrhage. Due to lack of data on neonatal outcome, the second amendment was to focus on maternal morbidity instead of adverse neonatal outcome.

### Study selection and study characteristics

The study selection is displayed in Figure 1. The initial search retrieved 999 unique articles after excluding duplicates. After screening title and abstract, 975 articles were

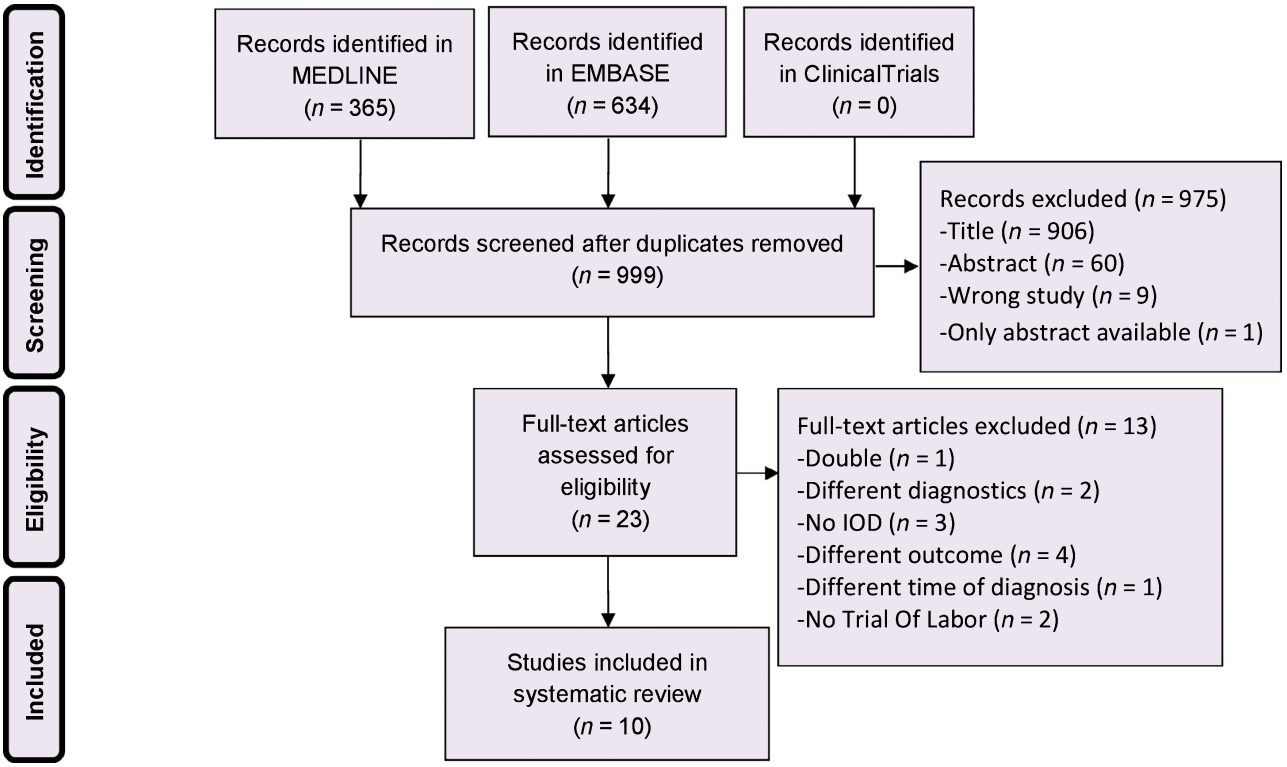


**Figure 1.** Flowchart summarising study selection of papers on vaginal delivery and emergency caesarean section due to haemorrhage in women with a low-lying placenta.

excluded. One conference abstract was excluded because the authors did not respond to our request for data.[13] After reading the full-text of the remaining 23 articles, 13 articles were excluded.[14–26]

Of the 10 included articles, seven were retrospective cohort studies and three prospective cohort studies, with a total of 592 patients with low-lying or placenta praevia (Table 1). All studies used transvaginal ultrasound, one study used transabdominal and transvaginal ultrasound, and one study used additional translabial ultrasound. The time interval between ultrasound and delivery differed from 10 days to multiple weeks. Most studies divided their cohort into subgroups to compare different cut-off values. Four studies used 9 or 10 mm as a cut-off distance to compare groups.[27–30] In our analysis, we merged these studies creating four studies with a cut-off distance of 10 mm. Four other studies compared subgroups with a cut-off distance of 20 mm.[5,31–33] Two studies did not compare groups but investigated one group of women with an IOD of 11–20 mm.[34,35]

## Critical appraisal

All studies scored moderate (5 stars) on the critical appraisal. Selection of the non-exposed cohort was not applicable in all studies, as some studies did not have a control group. All women included in the studies had a low-lying placenta and underwent a trial of labour, and thus were exposed. Health practitioners were not blinded for the presence of a low-lying placenta. Therefore, the knowledge of a low-lying placenta during delivery by the obstetric caretaker may have influenced the decision to perform a caesarean section. Supporting Information Appendix S3 summarises the results of the critical appraisal using the Newcastle-Ottawa Scale quality assessment of cohort studies.

**Table 1.** Characteristics of included studies

| Author, year, country | Type and setting | Study population (*N*) | Type of US | Cases LLP | Cases ToL | IOD groups mm | Mean interval US-delivery (days) | Last US |
|---|---|---|---|---|---|---|---|---|
| Al Wadi, 2014, Canada | Prospective cohort, single centre | Deliveries between August 2010 and June 2013 (± 5400/year) | TVS | 17 | 14 | 11–20 | 17.2 ± 9.6 | 37+5 GA |
| Bhide, 2003, UK | Retrospective cohort, single centre | Placenta praevia between February 1997 and March 2002 (125) | TVS | 121 | 20<br>27 | 1–20<br>21–35 | 11.5 (1–32)<br>15 (0–47) | 36 GA |
| Bronsteen, 2009, USA | Retrospective cohort, single centre | Women between January 1990 and December 2007 (NA) | TVS<br>TAS<br>TLS | 86 | 11<br>34 | 0–9<br>10–20 | 13.8 ± 9.1 | <4 weeks of delivery |
| Matsubara, 2008, Japan | Retrospective cohort, single centre | Deliveries between January 1940 and December 2005 (NA) | TVS | 73 | 25<br>26 | 0–20<br>21–40 | NA | <3 weeks before delivery |
| Nakamura, 2012, Japan | Retrospective cohort, single centre | Deliveries between 2004 and 2010 (4978) | TVS | 56 | 23 | 11–20 | NA | 35–36 GA |
| Ohira, 2012, Japan | Retrospective cohort, single centre | Women with TVS between April 2005 and November 2009 (2518) | TVS | 64 | 18<br>31 | 0–20<br>>20 | NA | 36–37 GA |
| Oppenheimer, 1991, Canada | Prospective cohort, NA | Women with blood loss or previous praevia (*N* = 127) | TVS<br>TAS | 21 | 8<br>9 | 0–20<br>>20 | NA | 33 GA |
| Taga, 2017, Japan | Prospective cohort, single centre | Deliveries between April 2012 and December 2015 | TVS | 18 | 5<br>6 | 0–9<br>10–20 | NA | 36 GA |
| Vergani, 2009, Italy | Retrospective cohort, single centre | Deliveries between January 2003 and August 2008 (14 973) | TVS | 53 | 8<br>20 | 0–10<br>11–20 | 10.0 ± 7.1 | <28 days before delivery |
| Wortman, 2016, USA | Retrospective cohort, single centre | Deliveries between May 2002 and December 2012 (NA) | TVS | 98 | 16<br>58 | 0–10<br>11–20 | NA | 34.3 GA |

CD, caesarean delivery; GA, gestational Age; LLP, low-lying placenta; TAS, transabdominal sonography; TLS, translabial sonography; TVS, transvaginal sonography; US, ultrasound; VD, vaginal delivery.

## Proportions of successful vaginal delivery and emergency caesarean section due to haemorrhage

Table 2 shows the results of the included articles. Figure 2A and B shows the meta-analysis of a successful vaginal delivery versus an emergency caesarean section due to haemorrhage in women with a low-lying placenta.

Of women with an IOD of >20 mm, 82% (95% CI 58–97) had a successful vaginal delivery and 10% (95% CI 2.2–22.3) needed an emergency cesarean section due to haemorrhage. Of women with an IOD of 0–20, 30% (95% CI 12–53) had a successful vaginal delivery and 38% (95% CI 27–50) had an emergency cesarean due to haemorrhage. Of women with an IOD of 11–20 mm, 85% (95% CI 70–96) had a successful vaginal delivery and 14% (95% CI 4.2–29) had an emergency cesarean section due to haemorrhage. Of women with an IOD of 0–10 mm, 43% (95% CI 28–59) had a successful vaginal delivery in and 45% (95% CI 22–69) needed an emergency cesarean section due to haemorrhage .

## Successful vaginal delivery versus emergency caesarean section due to haemorrhage

Women with an IOD of > 20 mm had significantly more chance of having a successful vaginal delivery compared with an emergency caesarean section due to haemorrhage ($P < 0.01$; OR 18.76, 95% CI 8.83–39.88). Women with an IOD of 11–20 mm had a significantly higher chance of a successful vaginal delivery as well ($P < 0.01$; OR 9.90, 95% CI 5.78–16.96).

Conversely, in women with an IOD of 0–20 mm and an IOD of 0–10 mm, there was no difference between a successful vaginal delivery and an emergency caesarean section (IOD 0–20 mm $P = 0.22$; OR 0.44, 95% CI 0.12–1.65 and IOD 0–10 mm $P = 0.41$; OR 0.70, 95% CI 0.31–1.61).

## Morbidity

Antepartum bleeding was reported in six of nine studies,[29–34] postpartum haemorrhagein four studies,[29–31,34] and blood transfusion in six studies[27,28,30,32,34,35]. Data on morbidity is summarised in Table 3. Haemorrhage was defined in three of four studies as >500 ml in vaginal deliveries and >1000 ml in caesarean sections. In one study, no specific definition of haemorrhage was given.

### *Antepartum bleeding*

Three cohorts showed a significantly higher rate of antepartum haemorrhage in patients with a smaller IOD, whereas

**Table 2.** Results of successful vaginal delivery and emergency cesarean section for women in different IOD groups

| Study | IOD | *N* | Elective cesarean section | Trial of labor (TOL) | Total emergency cesarean delivery (ESD) *n*/TOL (%) | Emergency cesarean delivery (ESD) due to IPH *n*/TOL (%) | Successful vaginal delivery *n*/TOL (%) | Significance |
|---|---|---|---|---|---|---|---|---|
| Al Wadi | 11–20 | 17 | 3 | 14 | 1/14 (7) | 1/14 (7) | 13/14 (93) | NA |
| Bhide | 1–20 | 40 | 20 | 20* | 18/20 (90) | 6/20 (30) | 2/20 (10) | Total ESD group 1 > group 2: $P < 0.0001$ |
| | 21–35 | 39 | 12 | 27* | 10/27 (37) | 2/27 (7.4) | 17/27 (63) | |
| Bronsteen | 0–9 | 86 | 41 | 11 | 16/45 (35) | 8/11 (73) | 3/11 (27) | Successful VD group 1 < group 2: $P = 0.0085$ |
| | 10–20 | | | 34 | | 8/34 (23) | 26/34 (77) | |
| Matsubara | 0–20 | 38 | 13 | 25 | 15/25 (60) | 12/25 (48) | 10/25 (40) | IPH during vaginal delivery group 1 > group 2: $P = 0.0046$ |
| | 21–40 | 35 | 9 | 26 | 10/26 (38) | 7/26 (27) | 16/26 (62) | |
| Nakamura | 11–20 | 56 | 33 | 23 | 3/23 (13) | 3/23 (13) | 20/23 (87) | NS |
| Ohira | 0–20 | 64 | 15 | 18 | 8/18 (44) | 8/18 (44) | 10/18 (56) | ESD group 1 > group 2: $P < 0.01$ |
| | >20 | | | 31 | 1/31 (3) | 1/31 (3) | 30/31 (97) | |
| Oppenheimer | 0–20 | 8 | 0 | 8 | Na | 7/8 (88) | 1/8 (12) | NA |
| | >20 | 13 | 4 | 9 | Na | 0/9 (0) | 9/9 (100) | |
| Taga | 0–9 | 8 | 3 | 5 | 3/5 (60) | 3/5 (60) | 2/5 (40) | Successful VD group 1 < group 2: $P = 0.026$ |
| | 10–20 | 10 | 4 | 6 | 0/6 (0) | 0/6 (0) | 6/6 (100) | |
| Vergani | 0–10 | 24 | 16 | 8 | 1/8 (13) | 1/8 (13) | 6/8 (75) | NA |
| | 11–20 | 29 | 9 | 20 | 0/20 (0) | 0/20 (0) | 20/20 (100) | |
| Wortman | 0–10 | 40 | 24 | 16 | 10/16 (63) | 9/16 (56) | 6/16 (38) | NS |
| | 11–20 | 58 | 21 | 37 | 16/37 (43) | 15/37 (41) | 21/37 (57) | |

ESD, emergency caesarean delivery; IPH, intrapartum haemorrhage; NA, not applicable; NS, not significant; TOL, trial of labour.
*Women presenting in labour, not specifically having a trial of labour.

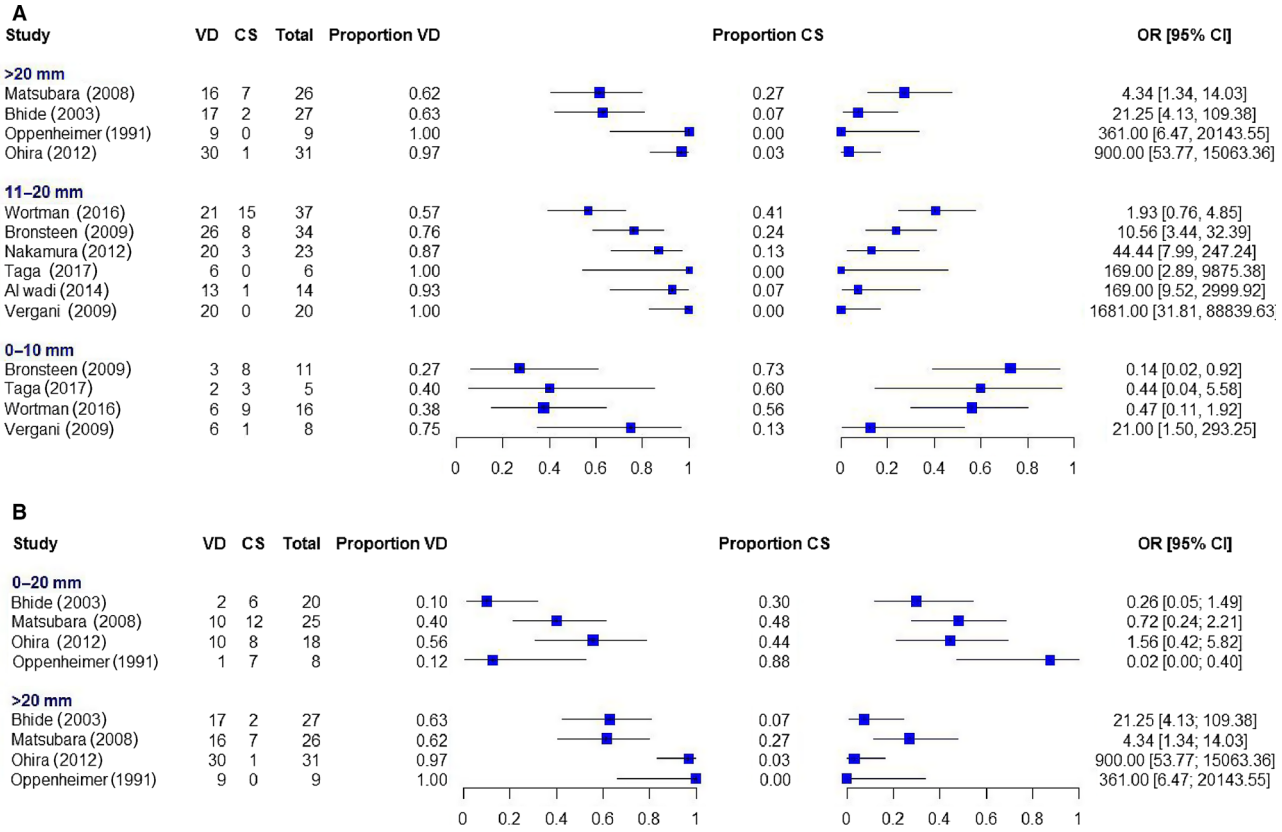


**Figure 2.** (A) Meta-analysis of a successful vaginal delivery versus an emergency caesarean section due to haemorrhage in women with a low-lying placenta. Absolute numbers and proportions of vaginal delivery and caesarean section. Odds ratio and 95% confidence intervals for vaginal delivery versus caesarean section. For IOD of (A) >20 , 11–20, and 0–10 mm. (B) >20 and 0–20 mm. CS, caesarean section; IOD, distance between placenta and the internal os of the cervix; VD, vaginal delivery.

**Table 3.** Results of morbidity including antepartum bleeding, postpartum bleeding, and blood transfusion for women in different IOD groups

| Study | IOD | Antepartum bleeding *n/N* (%) | Postpartum haemorrhage *n/N* (%) | Blood transfusion *n/N* (%) |
|---|---|---|---|---|
| Al Wadi | 11–20 | 3/14 (21) | 2/14 (14) | 0/14 (0) |
| Bhide | 1–20 | 19/40 (47.5)* | 2/40 (5.0) | N/A |
| | 21–35 | 11/39 (28.2)* | 3/39 (7.7) | N/A |
| Bronsteen | 0–20 | N/A | N/A | 3/86 (3) |
| Matsubara | 0–20 | 3/11 (27) | N/A | 3/38 (8) |
| | 21–40 | 4/18 (22) | N/A | 1/35 (3) |
| Nakamura | 11–20 | N/A | N/A | 2/23 (9) |
| Ohira | 0–20 | 8/18 (44)* | N/A | N/A |
| | >20 | 1/31 (3)* | N/A | N/A |
| Taga | 0–20 | N/A | N/A | 1/18 (6) |
| Vergani | 0–10 | 7/24 (29)* | 2/24 (8.3) | N/A |
| | 11–20 | 1/29 (3)* | 3/29 (10) | N/A |
| Wortman | <10 | 2nd trimester: 4/40 (10)<br>3rd trimester: 17/40 (43) | 13/40 (33) | 3/40 (8)* |
| | 11–20 | 2nd trimester: 6/58 (10)<br>3rd trimester: 26/58 (45) | 29/58 (50) | 15/58 (26)* |

*Significant.

two other studies did now show this difference to be significant (Table 3).[29–33] In a cohort of 14 women with a low-lying placenta, antepartum bleeding did occur in 21%. Hospital admission was required, but no emergency caesarean delivery was needed and all women delivered vaginally.[34]

*Postpartum haemorrhage*

Postpartum haemorrhage did not differ significantly according to the IOD in all cohorts. Postpartum haemorrhage was reported two of 14 women with a low-lying placenta. Both cases were managed with the administration of uterotonics only.[34]

*Blood transfusion*

One study showed a significant difference in blood transfusion between IOD but, unexpectedly, more blood transfusion was needed in the group with the larger IOD.[30] The other studies did not show a difference in blood transfusion between the different IODs.[27,28,32,34,35]

*Intrapartum blood loss during vaginal delivery and caesarean delivery*

Two studies investigated the difference in intrapartum blood loss associated with the means of delivery, vaginal or caesarean section. The first study showed that blood loss was similar in both groups ($P = 0.79$).[29]

The second study found that a caesarean section group had significantly more intrapartum haemorrhage compared with the vaginal delivery group ($P = 0.047$), which resulted in more blood transfusion in the scheduled caesarean group.[28]

Another study confirmed that blood transfusion was more often required in the women who delivered by caesarean delivery.[27]

# Discussion

## Main findings

The chance of having a successful vaginal delivery is greater than the need for an emergency caesarean section due to blood loss in women with an IOD of >20 mm or 11–20 mm. Therefore, a trial of labour is advised for women with an IOD of >10 mm. There is no significant difference between a successful vaginal delivery and an emergency cesarean section due to blood loss for women with an IOD of 0–10 mm. There is no compelling difference in morbidity between women with an IOD of 0–10 and those with a longer IOD. Therefore, a trial of labour is recommended for women with an IOD of 0–10 mm. Nevertheless, in-depth counselling and shared decision making are necessary before a trial of labour, and monitoring during labour is essential.

## Strengths and limitations

To our knowledge, this is the first article that reviews the literature on the possibility of a vaginal delivery in patients with a low-lying placenta. Because of our broad search in multiple literature sources it is unlikely that we missed any literature on this topic. By extending our search to ClinicalTrials.gov and by including conference abstracts, we were able to include all ongoing trials registered as well as any results not yet published. Most studies included women with antepartum bleeding and/or a diagnosis of low-lying placenta at the second trimester (anomalies) scan with follow up until a few weeks before delivery. Therefore, the risk of missing an asymptomatic low-lying placenta or placenta praevia was low in those studies. Also, by only including studies that used TVS, a homogeneous test was used in our review for the diagnosis of low-lying placenta.

Still, several limitations of our study should be addressed. Despite our broad literature search, we found considerably more retrospective studies than prospective studies. This illustrates the difficulty of performing prospective cohort studies on relatively rare events like a low-lying placenta, and can hardly be seen as a limitation itself. However, in retrospective studies, which were overrepresented in this review, there is a risk of selection bias. In a setting of a retrospective cohort, loss of records over the years may result in selection bias with overestimation and/or underestimation of the association between exposure, that is, low-lying placenta, and the outcome (here caesarean section or vaginal delivery).[36] A limitation of the individual studies is that women were grouped depending on IOD as 0–10, 11–20, 0–20, and >20 mm. Therefore, we made comparisons based on different cut-off values. However, although measuring the IOD is accurate to millimetres, observer bias can occur.

## Interpretation and future research

In our review, we found as primary outcome a significant higher chance of a successful vaginal delivery than an emergency caesarean section due to haemorrhage in women with an IOD of >20 mm or 11–20 mm. Thus, women with an IOD of >10 mm less often experienced peripartum haemorrhage where an emergency caesarean section was indicated. For women with an IOD of 0–10 mm there was no difference between a successful vaginal delivery and an emergency caesarean section due to haemorrhage. Therefore, these women could have peripartum haemorrhage due to the low-lying placenta indicating an emergency caesarean section, but this did not occur more or less often than a successful vaginal delivery .

There was no difference in a successful vaginal delivery and an emergency caesarean section in women with an IOD of 0–20 mm; this is notable and unexpected, as women with an

IOD of 11–20 mm had more chance of having a successful vaginal delivery. In our review, we evaluated the percentage of successful vaginal delivery and emergency caesarean due to haemorrhage by dividing the number of cases by the total number of women with a trial of labour. In the study of Bhide et al. in which 20 women with an IOD of 0–20 mm had a trial of labour, 12 women had a caesarean section due to reasons other than haemorrhage. Therefore, only two women had a successful vaginal delivery and six women had a caesarean section due to haemorrhage, both low percentages (10 and 30%), which lowered the overall proportion of successful vaginal delivery. Consequently, this low percentage is more likely due to our decision about analysis than to a low chance of vaginal delivery in this IOD group. All studies included in our review were of moderate quality due to the critical appraisal with the NOS tool. One reason was the lack of blinding of the patients and health professionals. In our studies, 30–60% of cases chose to deliver by planned caesarean, which might have been due to the fact that the IOD was known by patient and healthcare professional, who may have chosen for a planned caesarean delivery in case of a smaller IOD. Also, blinding during delivery was not possible, as the healthcare professionals needed to be aware of the risks during the delivery. These factors may have led to the fact that less stable patients might get a planned caesarean, leading to overestimation of the success rate of vaginal delivery.

The chance of a successful vaginal delivery in women with a low-lying placenta depends on multiple factors. A vaginal delivery has been shown to be more often successful in anterior than in posterior placenta praevia ($P = 0.037$).[20] Considering another factor, Taga et al.[28] suggested that all women with a low-lying placenta should be offered a trial of labour except those accompanied by a marginal sinus, defined as a hypo-echogenic area with slow blood flow, at the end of the third trimester. These authors suggest that in the presence of a marginal sinus, the low-lying placenta hardly moves upwards at the end of the third trimester, leading to a higher risk of antepartum bleeding and of an emergency caesarean section. Also, an increased speed of the placental migration per week is significantly associated with a successful vaginal delivery.[24] It has been known that the mean rates for placental migration in mm per week are lower for those patients in need of a caesarean delivery than for those in which a vaginal delivery is possible.[24,25] Finally, it has been suggested that the means of delivery in women with a low-lying placenta could also be predicted by antepartum blood loss in the third trimester. Wortman et al.[30] demonstrated that third trimester vaginal bleeding was a significant risk factor for development of bleeding leading to an emergency caesarean section.

In the near future, a prospective study would add value to the knowledge on the optimal delivery route in case of a low-lying placenta, especially with an IOD of 0–10 mm. Reducing the interval between the last ultrasound and delivery is obligated in future studies. These factors need to be used in the decision making concerning the optimal means of delivery in women with a low-lying placenta. This would create the possibility further to individualise the patients' mode of delivery.

## Conclusion

We found no contraindications for a vaginal delivery in case of a low-lying placenta with an IOD of 0–20 mm in asymptomatic patients. The morbidity is not increased in women with an IOD of 0–10 as compared with women with an IOD of >10 mm. Therefore, women with a low-lying placenta – having an IOD between 0 and 20 mm – can have a trial of labour in a clinical setting after in-depth counselling and shared decision making.

### Disclosure of interests

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### Contribution to authorship

All authors contributed significantly to this work by participating in the search, supporting in analyses and writing or revising this manuscript.

### Details of ethics approval

Ethics approval is not required for a systematic review.

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## Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

**Appendix S1.** MEDLINE search.

**Appendix S2.** Newcastle-Ottawa Scale quality assessment of cohort studies – checklist.

**Appendix S3.** Results of the critical appraisal using the Newcastle-Ottawa Scale quality assessment of cohort studies. ■

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