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Systematic review

Incidence of and risk indicators for vasa praevia: a systematic review

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Background Vasa praevia (VP) is a rare phenomenon that is assumed to increase the risk of severe complications, including fetal death. Critical data on its incidence are lacking, so there is no rational basis for prenatal screening.

Objectives To review the literature on the incidence and risk indicators for VP.

Search strategy We searched OVID MEDLINE, OVID EMBASE, the Cochrane Library and PubMed for case–control and cohort studies on incidence and risk indicators for VP.

Selection criteria Two reviewers selected studies and scored their methodological quality.

Data collection and analysis We calculated the mean incidence of VP. We constructed 2 × 2 tables cross-classifying potential risk indicators against the incidence of VP to calculate common odds ratios and 95% confidence intervals, using the Mantel–Haenszel method.

Main results We included 13 studies (two prospective cohort studies, ten retrospective cohort studies and one case–control study) reporting on 569 410 patients with 325 cases of VP. Based on ten included cohort studies providing information on the incidence, the mean incidence of VP was 0.60 per 1000 pregnancies. We identified five different risk indicators and markers for VP: second-trimester placenta praevia, conception by assisted reproductive technologies, a bilobed or succenturiate placenta, umbilical cord insertion in the lower third part of the uterus at first-trimester ultrasound and velamentous cord insertion. Almost 83% of the cases of VP had one or more risk indicators.

Authors' conclusions In view of the low incidence, screening for VP in an unselected population is not advised. Targeted screening of women with one or more risk indicators as a part of routine mid-gestation scanning should be considered.

Keywords Incidence, risk factor, vasa praevia.

Tweetable abstract Vasa praevia is more common in placenta praevia, conception by ART, velamentous cord insertion and bilobed placenta.

Linked article This article is commented on by RM Silver, p. 1288 in this issue. To view this mini commentary visit http://dx.doi.org/10.1111/1471-0528.13870.

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Introduction

Vasa praevia (VP) is a condition in which fetal blood vessels overlie the cervical internal os, unsupported by either the umbilical cord or placental tissue. Compression of these vessels by the presenting part may lead to fetal heart decelerations and bradycardia on the cardiotocography.[1,2] Theoretically, in case of rupture of membranes, VP can rupture simultaneously, potentially causing fetal blood loss with serious neonatal morbidity or death.[3]

The accuracy of ultrasound in the prenatal diagnosis of VP is good with a sensitivity of 100% and specificity of 99.0–99.8%, when performed transvaginally with colour Doppler.[4]

Systematic review registration number PROSPERO—CRD42015013891.

It has been hypothesised that prenatal recognition of VP enables elective delivery of the fetus by caesarean section, so preventing potential rupture of the low-lying vessel(s) and subsequent fetal demise or neonatal morbidity.[5] Currently, the majority of pregnant women undergo several scans during pregnancy. It has been proposed to include a standard evaluation of the umbilical cord insertion site in the second-trimester scan in an attempt to increase the prenatal detection of VP.[3,6,7] However, at present, targeted transvaginal ultrasound screening with colour Doppler has not been routinely included in prenatal care, due to a lack of critical data on the incidence and the efficacy of screening. For the purpose of potential screening for VP it might be helpful to identify women at high risk by establishing identifiable risk indicators for VP.

We performed a meta-analysis to investigate the incidence and risk indicators of VP and to define the population at risk for the purpose of a potential future screening programme.

Methods

Identification of studies

The research protocol was published in the International prospective register of systematic reviews (Prospero).[8] A medical librarian (JL) performed a comprehensive search of MEDLINE (OVID, from 1948), EMBASE (OVID, from 1947), the Cochrane Library including the Cochrane Central Register of Controlled Trials (CENTRAL, from inception), PubMed [the publisher(sb)-fraction which contains publications ahead of print, not yet included in OVID MEDLINE] and ongoing Trial registers (http://clinicaltrials.gov/) between inception and February 2014. There were no language restrictions and animal studies were excluded. The search strategies consisted of Subject Headings (MeSH, SH) and words in title and abstract for VP or its synonyms (vasa praevia I). In addition we broadly searched for diagnostic imaging and screening of abnormal umbilical cord location and the subject of risk or association (vasa praevia II and III, see Supplementary material, Appendix S1, for the entire MEDLINE search). For each database the search strategy was refined using an iterative process through incorporation of new search terms when new relevant citations were identified, i.e. by checking reference lists and citing articles using ISI Web of Science. The bibliographic records retrieved were downloaded and imported into REFERENCE MANAGER® (Thomson Reuters, Carlsbad, CA, USA) software (version 12.0) to remove duplicates, and to store and analyse the search results.

Quality assessment

The included studies were systematically scored on their methodological quality, based on predetermined key features using the Newcastle–Ottawa Quality Assessment Scale. Key features were cohort study design, consecutive patient enrolment and prospective study design. Additional key features for studies on potential risk indicators were a representative exposed cohort and non-exposed cohort from the same population, ascertainment of exposure and outcome by the investigator or from the medical record, absence of the outcome at start of the study period and completeness of follow up. For case–control studies similar items were rated for the cases and controls. Two reviewers independently scored all studies on the individual items using the Newcastle–Ottawa Quality Assessment Scale scale.[9]

Study selection and data extraction

Studies were eligible if they were cohort or case–control studies. A study was included in this review if (1) the study population included subjects with a confirmed or assumed diagnosis of VP (tubular structures or vessels from fetal origin visualised over the internal cervical os on ultrasound); (2) a control group without VP (or non-cases) was available; (3) at least one potential risk indicator was measured in all subjects. Case–control studies were also included when VP was the outcome of interest and exposed subjects [e.g. pregnancies with placenta praevia or by assisted reproductive technologies (ART)] were compared with their unexposed (e.g. pregnancies with normal placentation or natural conception) controls. Case reports, letters to the editor and conference abstracts were excluded. Disagreements about inclusion or exclusion of full text articles were resolved by discussion.

Study selection was performed in a three-stage process. First, two reviewers (LR, NK) scrutinised titles and abstracts of all references for reporting on VP and one or more potential risk indicators. The two reviewers then examined all references that were selected by at least one reviewer. Separate final inclusion and exclusion decisions were made for both incidence rate and potential risk indicators after duplicate examination of the full text versions.

Data were extracted by one reviewer (LR) with the use of a predesigned data extraction form. Study characteristics that were summarised on the form included: country of investigation, period of data collection, total cohort size, number of cases of VP during the study period and study population. In the absence of absolute numbers on cases of VP these were calculated when possible from given percentages or proportions.[10] For studies with additional data on potential risk indicators, their prevalence in the subjects and controls in cohort studies and in the cases and controls in case–control studies was extracted. Crude odds ratios (OR) had to be available either directly or, in case the paper reported adjusted odds ratios, had to be derivable from the

original data supplied. If an estimate of the odds ratio for an association with a risk indicator was reported together with its precision, these numbers were used. A second reviewer (NK) examined the extracted data on accuracy and completeness. Disagreements were solved by discussion.

Statistical analysis

Calculation of the incidence of VP (defined as the proportion of women who suffered VP during the study period) was based on cohort studies only. To allow for study size, the mean incidence rate of VP was calculated from the original demographic data (denominator) and the number of cases included (numerator). For each included study with information on potential risk indicators 2 × 2 tables were constructed cross-classifying the potential risk indicator against the incidence of VP. Quantitative analysis was conducted using REVIEW MANAGER (REVMAN) software version 5.3.

The effect of a potential risk indicator on the incidence of VP was expressed as odds ratio with a 95% confidence interval (95% CI) and calculated using the Mantel–Haenszel method. To assess the extent of heterogeneity, the magnitude of the value of I^2 was used.[11] When heterogeneity was present we used a random-effect model to calculate a common odds ratio and 95% confidence interval. When heterogeneity was rejected, we used a fixed-effect model. There was no adjustment for potential confounders in the meta-analysis. In addition, we calculated the number needed to screen to detect one case of VP for the individual risk indicators.

Results

Figure 1 summarises the results of the literature search. The search resulted in 572 unique articles, of which 553 articles were excluded after reading title and abstract. Articles that were excluded were mainly case reports or studies that reported on umbilical cord anomalies other than VP. Nineteen studies were selected for full text reading. One study had insufficient data to estimate either the incidence rate or to construct 2 × 2 tables.[12] One cohort was described twice and therefore one study was excluded.[7,13] Two studies were (conference) abstracts of articles not yet published, one author was reached but no more data were

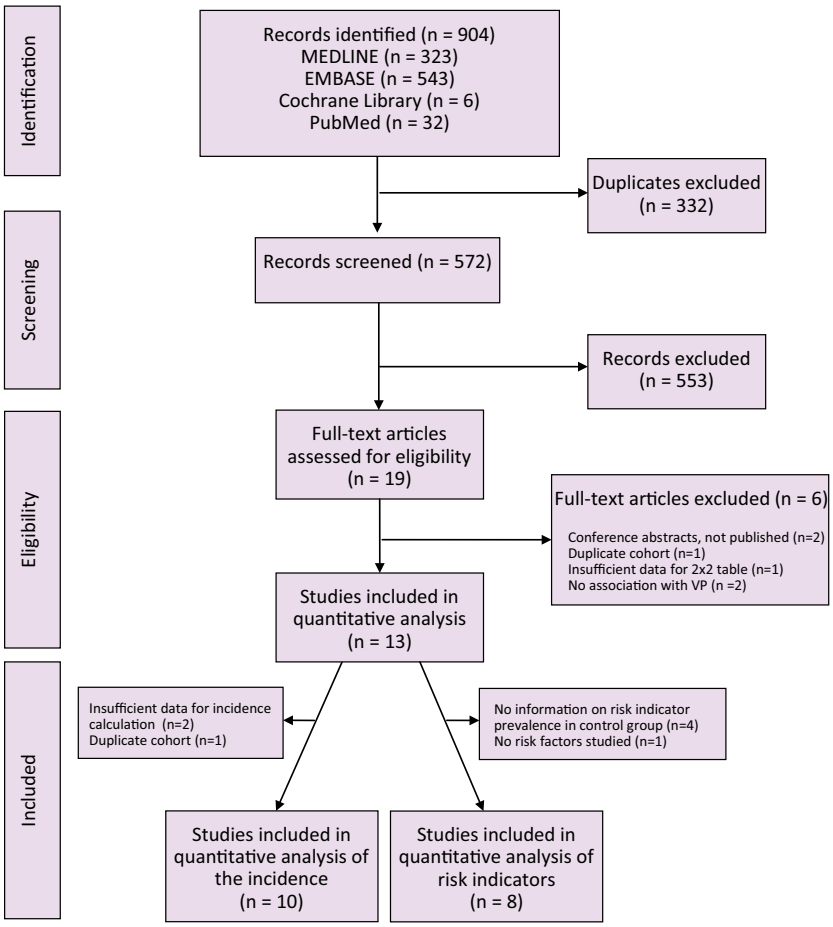

Figure 1. Results of literature search.

obtained.[14,15] Two studies only reported on associations between velamentous cord insertion and low serum pregnancy-associated plasma protein A or cord insertion in the lower part of the uterus in the first trimester; associations with VP itself were not investigated and therefore these studies were excluded.[16,17] Finally, we included a total of 13 unique studies, ten studies reported on the incidence rate and eight studies reported on potential risk indicators.

Table 1 gives an overview of the included studies and their characteristics. The total number of patients included was 569 410, including 325 cases of VP.

Quality assessment

Figure 2 summarises the results of the quality assessment of the included studies. All but one study were cohort studies. Data collection was prospective in two of 13 studies (15%), all studies performed consecutive patient enrolment. For the studies on potential risk indicators seven of eight studies (88%) reported the use of a representative exposed cohort. All studies drew the non-exposed controls from the same population as the exposed cases. Ascertainment of exposure was in four studies (50%) by the investigator or by medical record, four studies did not report ascertainment of exposure. All eight studies assessed the outcome by medical record. Furthermore, follow up was long enough in all studies for the outcome to occur. All studies provided effect measures with confidence intervals.

Assessment of heterogeneity and quantitative analysis

Heterogeneity among studies was assessed per potential risk indicator. The results of these tests demonstrated sub-

Table 1. Characteristics of the included studies

Author, year and country of publication	Type of study	Risk factors studied*	Study population	Incidence (per 1000 pregnancies)
Baulies, 2007 (Spain)[6]	Retrospective cohort	Second-trimester placenta praevia, bilobed placenta, ART (not reported)	All deliveries between 2000 and 2005 (n = 12 063, 9 cases of VP)	0.75
Catanzarite, 2001 (USA)[23]	Prospective cohort	No risk factors studied	All patients with ultrasound between 1991 and 1998 (n = 33 208, 10 cases of VP)	0.3
Eddleman, 1992 (USA)[20]	Retrospective cohort	Second-trimester placenta praevia and VCI (not adjusted)	All deliveries between 1985 and 1988 (n = 15 942, 3 cases of VP)	0.19
Francois, 2003 (Arizona)[19]	Case–control	Second-trimester placenta praevia (not adjusted)	13 cases of VP matched in a 1:4 ratio with controls (n = 65)	N.A.
Hasegawa, 2006 (Japan)[22]	Prospective cohort	First-trimester lower cord insertion (not adjusted)	318 patients with successful screening of lower third of uterus (n = 318, 1 case of VP)	N.A.
Hasegawa, 2010 (Japan)[13]	Retrospective cohort	VCI, second-trimester placenta praevia, low umbilical cord insertion (not adjusted)	All deliveries between 2006 and 2009 (n = 4532, 10 cases of VP)	2.21
Kanda, 2011 (Japan)[32]	Retrospective cohort	No risk factors studied	All deliveries between 2002 and 2007 (n = 5131, 10 cases of VP)	1.95
Lee, 2000 (USA)[33]	Retrospective cohort	No risk factors studied	All deliveries between 1991 and 1998 (n = 93 874, 18 cases of VP)	0.19
Rebarber, 2014 (USA)[34]	Retrospective cohort	No risk factors studied	All patients with ultrasound between 2005 and 2012 (n = 27 573, 13 cases of VP)	0.47
Rosenberg, 2011 (Israel)[10]	Retrospective cohort	Placenta praevia (not adjusted)	All singleton deliveries between 1988 and 2009 (n = 185 476, 204 cases of VP)	1.1
Schachter, 2002 (Israel)[18]	Retrospective cohort	ART (not reported)	All deliveries between 1987 and 2001 (n = 72 818, 12 cases of VP)	N.A.
Smorgick, 2010 (Israel)[35]	Retrospective cohort	No risk factors studied	All deliveries between 1988 and 2007 (n = 110 684, 19 cases of VP)	0.17
Suzuki, 2008 (Japan)[21]	Retrospective cohort	Succenturiate placenta (not adjusted)	All deliveries between 2002 and 2005 (n = 7713, 3 cases of VP)	0.39

*In case of adjustment; adjusted for.

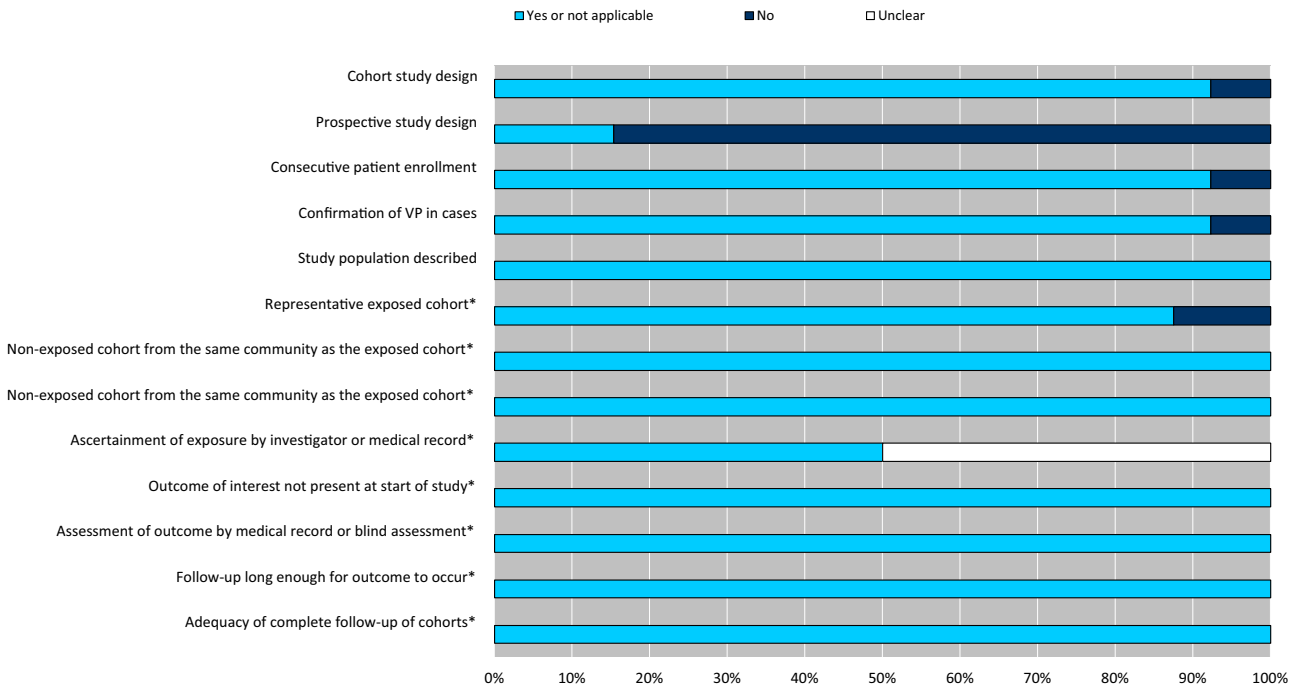

Figure 2. Quality assessment of the included studies. *Only scored for studies with information on risk indicators.

stantial heterogeneity for two risk indicators (I^2 = 66 and 77%) and moderate heterogeneity for one risk indicator (I^2 = 29%), consequently the random effect method was used. For the remaining three risk indicators the I^2 demonstrated no heterogeneity and so the fixed effect method was used.

Incidence

From ten included cohort studies there was information on the incidence of VP, which varied from 0.17 to 2.2 per 1000 pregnancies (Table 1). A total of 496 196 women were included in these studies of which 299 women had VP, the mean incidence of VP was 0.60 per 1000 pregnancies.

Risk indicators

Among the studies on risk indicators, at least 83% of the VP cases had one or more risk indicators except for one study. In this study only one indicator was investigated and 63% of the VP cases had this risk indicator.[18] All but one of the studies reported results from univariate analyses on associations between potential risk indicators and VP; as a consequence, unless stated otherwise, these numbers were used.[6]

Second-trimester placenta praevia

Four studies investigated the association between placenta praevia in the second trimester and VP; one case–control study and three cohort studies with a total of 202 060 women and 236 cases of VP.[6,10,13,19] For women with a placenta praevia in the second trimester the common odds ratio for VP was 19 (95% CI 6.1–58, heterogeneity I^2 = 66%) compared with women with a normal placental localisation (Figure 3A). One study performed a multivariate analysis in which the odds ratio remained statistically significant after correction for potential confounders (OR 23; 95% CI 5.6–93.8); however, the potential confounders that were adjusted for in this study were not reported and were not obtained after contact with the authors.[6] Based on the raw data, the number needed to screen for women with a second-trimester placenta praevia was 63 to detect one case of VP compared with women without a second-trimester placenta praevia.

Velamentous cord insertion

Two studies reported on the association between velamentous cord insertion and VP.[13,20] Velamentous cord insertion was defined as an umbilical cord insertion outside the chorionic plate. Women with velamentous insertion of the umbilical cord had an increased risk as compared with women with a normal placental cord insertion (common OR 672; 95% CI 112–4034, heterogeneity I^2 = 0%) (Figure 3B). For women with a velamentous cord insertion, the number needed to screen to find one case of VP was 13.

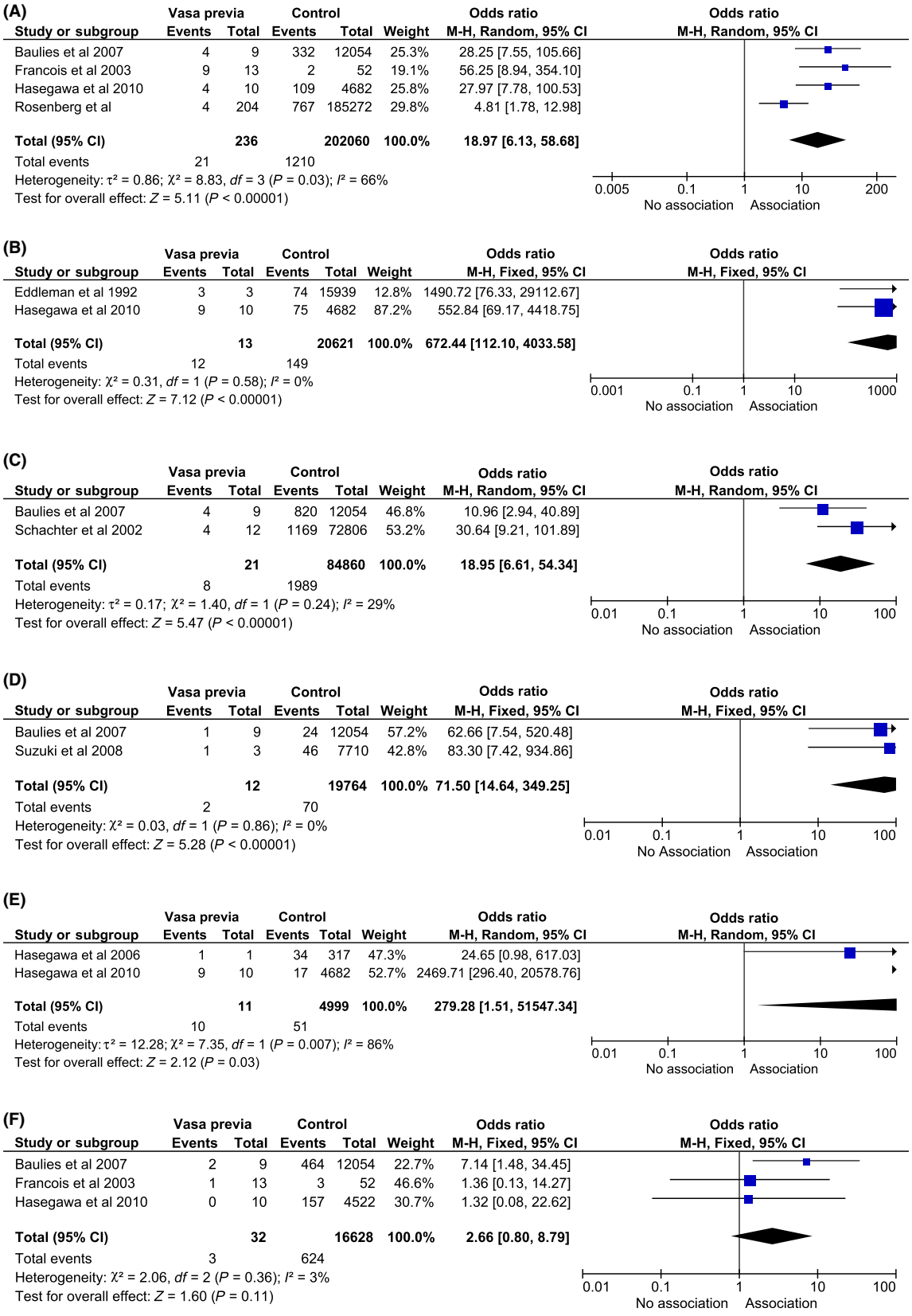

Figure 3. (A–F) Forest plots of the meta-analysis.

Assisted reproductive technologies

Two studies reported on the association between ART (*in vitro* fertilisation and intracytoplasmic sperm injection) and VP.[6,18] Women who conceived by ART had an increased risk compared with women who conceived spontaneously (common OR 19; 95% CI 6.6–54, heterogeneity I^2 = 29%) (Figure 3C). The number needed to screen for women conceived by ART to detect one case of VP was 260.

Bilobed placenta

Two studies reported on the association between placental morphological abnormalities (e.g. bilobed and succenturiate placenta) and VP.[6,21] Women with a bilobed or succenturiate placenta had an increased risk of VP compared with women with a normally developed placenta (common OR 71; 95% CI 14–349, heterogeneity I^2 = 0%) (Figure 3D). The number needed to screen for women with a bilobed or succenturiate placenta to detect one case of VP was 37.

Cord insertion in the lower third of the uterus at first-trimester ultrasound

Two studies investigated characteristics of first-trimester ultrasound scans. In these studies, the uterus was divided into three equal parts; upper, middle and lower third. A significant association was found between insertion of the umbilical cord in the lowest third of the uterus and VP.[13,22] Women with a low umbilical cord insertion had an increased risk compared with women with an umbilical cord insertion in the middle or upper third part of the uterus (common OR 280; 95% CI 1.5–51 547, heterogeneity I^2 = 86%) (Figure 3E). In case of detection of a lower cord insertion on first-trimester ultrasound, the number needed to screen to eventually find one case of VP was 6.1.

Multiple gestations

One case–control and two cohort studies reported on the association between multiple gestation and VP.[6,13,19] The common OR for VP was 2.66 (95% CI 0.80–8.8, heterogeneity I^2 = 3%) for women with a multiple gestation compared with a singleton gestation (Figure 3F).

Discussion

Main findings

Our systematic review showed a mean incidence of VP of 0.60 per 1000. Placenta praevia in the second trimester, velamentous cord insertion, conception by ART, placental morphological anomalies and lower umbilical cord insertion at first-trimester ultrasound were associated with an increased risk of VP.

Strengths and limitations

The importance of our study is that based on a systematic review of the literature, several clinical factors are associated with VP. Evidence for these factors so far mainly lies in small case series and case reports so we performed a thorough search strategy without any language restrictions. We made an effort to find and screen all the available articles on VP. For the purpose of a meta-analysis cohort studies are most valuable because there is a well-defined population where cases and non-cases stem from the same population. Cohort studies are therefore likely to yield the most robust findings. In this systematic review, 12 out of 13 studies were cohort studies. Furthermore, the included studies showed consistency on the different risk indicators, all studies found similar clinical factors associated with VP. Consistent results were found in both smaller and larger studies.

A limitation of our study is the absence of access to individual patient data, which makes adjustment for potential confounders impossible. For real consideration whether the previously described risk indicators are independently associated with VP, individual patient data or large longitudinal cohort studies are needed. The possibility to adjust for confounders will allow us to develop risk-adjusted prognostic models for VP, but it is difficult to achieve in, for example, the Netherlands because potential risk indicators and confounders such as mode of conception, maternal body mass index and presence of placenta praevia are non-obligatory fields in our birth register.

Another limitation is the overall methodological quality of the analysed studies, this was low and publication bias is a significant problem. The unavailability of several publications on VP more than 2 years after publication of a conference-abstract only supports this. Although we tried to obtain as much data as possible by contacting all authors of incomplete data, this will remain a limitation in future studies.

In addition to the risks of bias, we also identified some other features that may limit the conclusions of our study. First, the small number of exposed subjects and the small number of events in most of the included studies limit their statistical power, also partially revealed by the wide confidence intervals of some effect measures. Furthermore, we found a relatively large difference in incidence of VP between the prospective and retrospective cohort studies. This might be explained by the fact that prospective studies focus more on detecting VP, which can lead to a higher incidence. This will almost certainly be accompanied by more false-positive cases as well, because the validity of postpartum confirmation of VP is limited.[4] Hence, defining the true incidence will also remain limited. In contrast, retrospective studies are known to have limitations from incompleteness of patient data; some incidences of VP and the presence of potential clinical risk factors might not have been accurately reported in the past. However, since VP is a rather rare complication, a prospective study with sufficient statistical power is not feasible.

Interpretation

In this meta-analysis almost 83% of all cases of VP had one or more clinical risk indicators for VP. This rate is potentially even higher because information on presence or absence was not available for all risk factors in all individual studies. Unadjusted numbers-needed-to-screen varied between 6 and 260; screening for VP can therefore potentially be effective in a specific population of pregnant women such as women with a velamentous cord insertion or a bilobed placenta. The limited evidence on the positive predictive value of an ultrasound diagnosis of VP indicate that the majority of positively screened patients will be truly diseased; however, unfortunately exact numbers are not available, limiting the usefulness of these results.[4]

We found velamentous cord insertion to have a remarkably strong association with VP; some studies reported that all cases of VP were found among women with a velamentous cord insertion. VP in those studies was not found in women with a normal cord insertion. Catanzarite et al. reported a case series on VP and classified two types. Type I in which there is a single placental lobe with a velamentous cord insertion over the cervix and type II in which the vessels over the cervix are connecting multiple lobes of the placenta.[23] Eight out of ten cases were type I. Together with the results of this meta-analysis we might conclude that velamentous cord insertion is not a risk indicator for VP but rather a marker for VP. Based on these results one cannot rule out VP after a normal cord insertion is seen in the second trimester, but the risk becomes significantly smaller. On the contrary, once a velamentous cord insertion is seen, obstetric care givers should be aware of the possible presence of VP. Potentially, the same explanation could apply for the significant association we found between a placental morphological abnormality, such as a succenturiate or bilobed placenta, and VP. We might approach a bilobed placenta, as well, as a marker of VP and not a risk indicator.

A second-trimester placenta praevia that is not connected to the internal ostium in the third trimester is also a risk indicator for VP. A potential explanation might be trophotropism, a unidirectional lateral growth of the placenta in the fundal direction to ensure blood supply from a more richly vascularised area.[24] Any fetal blood vessels embedded in the placenta in the cervical area will become unprotected once the placental tissue atrophies, resulting in velamentous vessels close to the cervix. Therefore, especially women with a resolved placenta praevia in the third trimester appear to be at risk for VP. The aetiology behind pregnancies resulting from ART and VP has been described before. It is hypothesised that abnormal cord insertion is a result of an oblique orientation of the blastocyst at nidation.[25–27]

Most authors of case reports report multiple pregnancies as a risk indicator for VP; however, our data fail to support this finding. Potentially, the assumed association between multiple pregnancies and VP can be explained by ART. Differentiating between multiple pregnancies by ART and by spontaneous conception would be informative; however, we did not have access to these data.

Regarding the feasibility of the risk indicators we must allow for the fact that some indicators are easy to recognise antenatally such as ART pregnancies and a second-trimester placenta praevia whereas for other indicators it is more difficult to recognise them antenatally such as velamentous cord insertion, a bilobed or succenturiate placenta and a first-trimester low cord insertion. Focusing on easy to recognise indicators for VP can potentially increase the prenatal detection. Additionally, any suspicion of risk indicators legitimises referral to more experienced sonographers for further evaluation.

Conclusions

In conclusion, as the majority of VP is preceded by one or more risk factors, screening for VP as part of routine mid-gestation scanning in the general low-risk population is not advised. This conclusion is supported by Cipriano et al., who demonstrated that general screening for VP is not cost-effective.[28] However, with several clinical factors being associated with VP, one could consider implementing a screening programme for patients presenting with one of these factors, as suggested by Derbala et al.[29] Nevertheless, even then, the incidence of VP remains low. Moreover, the aforementioned risk indicators and markers such as conception by ART and a second-trimester placenta praevia are relatively common. Subjecting all people with at least one risk indicator or marker to a screening initiative may not always be beneficial if one thinks in terms of uncertainty and generation of stress for patients as consequences of false-positive cases, the increasing number of caesarean sections and the additional healthcare costs.[30] These consequences should be taken into account before general introduction of a screening strategy for VP. Besides the practical issues, there is a general lack of knowledge of the potential risk factors for VP. In a national questionnaire survey Ioannou and Wayne found 34% of all questioned obstetricians not sufficiently expert to name at least one risk factor for VP—implying that there is more room for improvement of outcome in VP than screening alone.[31]

Before the introduction of a targeted screening strategy for patients with one or more risk indicators in prenatal care, large cohort studies can be helpful to develop risk-adjusted prognostic models. Furthermore, a thorough decision analysis should be performed to determine the best strategy to reduce fetal mortality due to VP. Meanwhile, it seems justified to exclude VP by transvaginal ultrasound with colour Doppler in women with a velamentous cord insertion or a bilobed or succenturiate placenta. Moreover,

it seems justified to add a transvaginal scan with colour Doppler in the third trimester in all women diagnosed with a placenta overlying the cervix in the second trimester.

Disclosure of interests
None declared. Completed disclosure of interests form available to view online as supporting information.

Contribution to authorship
LR wrote the article under the supervision of BWJM and EP. LR performed the analyses. NK, IMDG and JBD helped in reviewing the article.

Details of ethics approval
Not applicable.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Details of literature search 'Incidence of and risk indicators for vasa praevia'. ■

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Vasa praevia: more than 100 years in preventing unnecessary fetal deaths

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Placenta praevia and vasa praevia (VP) have been known to medical science for more than 200 years. Jean Lobstein (1777–1835) was a French surgeon, pathologist and obstetrician who is credited for describing the first case of rupture of vasa praevia (VP) in Strasbourg in 1801 (*Archives de L'art des Accouchements*, 1801, p. 320).

When Miles H. Phillips, an obstetrician from Sheffield, described a case of rupture of a 'velamentous' vessel during labour in 1914 (*J Obstet Gynaecol Br Emp* 1914;26:224) he could do very little more than deliver a dead fetus. He noted 'the doctor in attendance ruptured the membranes before the cervix was fully dilated'. This was associated with 'free bleeding' and the doctor 'suspected a placenta praevia' and called for his help. His examination of the placenta after delivery showed a velamentous insertion of the cord with a ruptured VP. A few years later, when caesarean delivery had become more widely available, Arthur J. McNair (1887–1964), a consultant obstetric surgeon at Guy's Hospital, was able to surgically deliver a live baby presenting with a 'marginal placenta praevia and velamentous cord' (*Proc R Soc Med* 1921;14:195–6). Like Phillips, he concluded that 'rupturing of the membranes had resulted in tearing of a large vein'.

Until the late 1960s, when ultrasound started to be used to diagnose placental pathologies such as hydatidiform moles and placenta localisation (Campbell et al. *J Obstet Gynaecol Br Commonw* 1968;75:1007–13), the diagnosis of placenta praevia and/or VP was exclusively clinical. The 'classic' fresh bleeding immediately after spontaneous or artificial rupture of the membranes suggested the rupture of a VP (also referred as the Benckiser's haemorrhage). Very often, the diagnosis was confirmed during a vaginal examination by feeling the pulsating fetal vessel near the internal os. This diagnostic approach is unreliable and can precipitate fetal haemorrhage by accidental rupture of the membranes and damage to the VP.

Gianopoulos et al. (*Obstet Gynecol* 1987;69:488–91) were the first to report on the prenatal diagnosis of VP with ultrasound. The performance of ultrasound for diagnosing VP is considered excellent. However, the incidence of VP is low and most studies have been conducted in specialist centres. There are no prospective studies on the value of screening for VP in an unselected population.

A systematic review of the incidence and risk factors of VP has indicated that 83% of the 325 cases reviewed have one or more risk factors including placenta praevia, bilobated placenta, succenturiate placental lobe, conception by assisted reproductive technologies and velamentous insertion of the cord (Ruiter et al. *BJOG* 2016; 123:1278–87). The current study has shown that velamentous cord insertion and abnormal placental morphology are strong markers of VP and therefore identification of cord insertion and placental shape should be part of the routine ultrasound examination at 12–14 and 20–23 weeks. There is no consensus about time of delivery in cases of VP but, unlike the time of Mr Phillips and Mr McNair, parents are aware of the condition (http://vasapraevia.co.uk/the-experts/) and know that prenatal diagnosis and early delivery can prevent 'unnecessary' death.

Disclosure of interests

None declared. Completed disclosure of interests form available to view online as supporting information. ■