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Diagnostic Terminology in Placenta Accreta Spectrum: a Scoping Review

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Abstract

Background: Anaesthetic management strategies for Placenta Accreta Spectrum (PAS) remain diverse, and literature interpretation is complicated by a range of terminology. The International Federation for Gynaecology and Obstetrics (FIGO) published guidance (2018) to improve PAS diagnosis and management by standardising definitions. We aimed to map the range, clarity and consistency of terminology in literature pertaining to both PAS and anaesthesia, and determine whether this changed following FIGO guidance.

Methods: A literature search of four medical databases was performed. Papers included, had PAS (or any 'synonym') in the title, and mode of anaesthesia in title or abstract. Narrative reviews and papers not containing original data, were excluded. Diagnostic terms, and evidence supporting their use, were described.

Results: Among identified 680 abstracts, 62 papers were included. Thirty distinct terms were used to describe PAS and subtypes. Terminology was clearly defined 46% of the time, and used consistently within a paper 47% of the time. Nine papers (15%) provided no diagnostic evidence to support terminology used. In 14 (23%) papers published after FIGO guidelines, 14 terms were used to describe PAS. Two papers (14%) specified the diagnostic criteria used. Six (43%), confirmed diagnoses using pathology. Four (29%) were consistent in use of terminology throughout the paper.

Conclusions: Despite international consensus criteria for reporting PAS, in the literature pertaining to PAS and anaesthesia, language remains heterogeneous, inconsistent, and variably defined. Reporting of PAS should adhere to FIGO criteria to allow unambiguous interpretation of work, and generation of evidence that is transferrable into clinical practice.

Keywords: Adherent placenta, Diagnostic terminology, Invasive placenta, PAS, Placenta Accreta, Placenta Accreta Spectrum, Placenta Percreta, Scoping Review, Terminology

Introduction

Placenta Accreta spectrum (PAS) is the internationally recognised term for the spectrum of disorders resulting from abnormal adherence or invasion of placental trophoblast cells into the uterine myometrium, due to absence or disruption of the normal decidua basalis.¹ Potential catastrophic peripartum haemorrhage in PAS risks maternal and fetal morbidity and mortality. Major haemorrhage is the leading direct cause of maternal mortality worldwide,² and the prevalence of PAS is increasing, as caesarean section rates rise.^{3,4} Optimal modes of anaesthesia for PAS cases remain unclear and assessment of this is challenging due to the heterogeneity of cases described.

Antenatal diagnosis of suspected PAS is associated with reduced maternal morbidity,⁵⁻⁷ In 2016, the European Working Group on Abnormally Invasive Placenta, published diagnostic descriptors with the aim of promoting clear, standardised, antenatal identification of PAS.⁸ The definitive diagnosis is confirmed by direct visualisation at laparotomy and subsequent histopathological examination of the junction between the placental villi and myometrium.⁹ The International Federation of Gynaecology and Obstetrics (FIGO) has published criteria for both clinical and histopathological classification of PAS.¹⁰ Structured diagnostic, clinical and histopathological classifications for PAS appear to be variably utilised or referenced in literature, with a multitude of 'synonymous' terminology used to describe both the entire spectrum of disease, and to label the specific extent of disease in individuals. Structured diagnostic definitions and consistent use of terminology are integral to clear interpretation of the literature, and translation of findings (including the optimal mode of anaesthesia) into clinical practice. The full extent of this issue within PAS literature has not previously been defined.

The dual aims of this scoping review were, firstly, to evaluate the literature pertaining to anaesthesia for PAS, to define the range, clarity and consistency of terminology used, and diagnostic criteria reported. Secondly, to determine whether literature published following the FIGO guidelines on Placenta Accreta Spectrum disorders (Feb 2018),¹ has adhered to consensus recommendations on PAS reporting.

Methods

This Scoping Review is based on the methodological framework described in 2005 by Arksey and O'Malley.¹¹

A literature search of four medical databases (MEDLINE, Embase, Cochrane Database of Systematic Reviews, Trials and Editorials, Web of Science, [December 2020]) was performed (*supplementary table 1*). Papers included, had PAS (or any 'synonym') in the title, and mode

of anaesthesia mentioned in title or abstract. Narrative reviews and papers not containing original data, were excluded. Screening was carried out by two independent reviewers, and any conflicts resolved by a third-party. Data were extracted by a single reviewer. At three separate points during the process, a random sample of five papers were independently extracted by a second reviewer, and data compared to ensure quality and consistency of data extraction.

Terms were characterised as 'defined' if the accompanying text made clear exactly what they were referring to; either the broad general condition, or a description of a specific pathology on the spectrum. Terms were described as being 'consistent' if they were then used in a similar way throughout the paper (or between different papers). We also recorded the diagnostic criteria which was used to justify the use of chosen terms (antenatal imaging, intraoperative findings and/or histopathology).

To assess the impact of the FIGO consensus guidelines, data were examined in only those studies published greater than six-months after their publication (August 2018 onwards).

Results

The literature search yielded 680 results, with 62 papers selected for data extraction (**Supplementary Fig.1**).¹²⁻⁷³

Case reports (n=27, 44%) and case series (n=18, 29%) were the most common article types. Data were collected retrospectively in 48 (77%) papers, prospectively in eight (13%), with six (10%) using a combination. Most papers (n=49, 79%) were published in 2010 or later. Anaesthesia was the primary speciality focus of 43 (69%) papers. Characteristics of eligible papers are detailed in **Table 1**.

Diagnostic terminology

Thirty different terms were used to describe PAS and its subtypes across the 62 papers. Terms, frequency of use, and frequency of definition are shown in **Table 2**. Most terms (n=22) were used interchangeably, to describe both the broad spectrum of disease *and* specific pathology or had an unclear use. Placenta Accreta was the most commonly used term, appearing in 54 articles (87%) and defined in 23 (43%). Fourteen terms appeared in single papers.

Defining the terminology

Terminology was clearly defined 46% of the time, unclearly or implicitly defined 25% of the time and undefined 29% of the time. Of the 14 terms used by single papers, only one was clearly defined.

Terminology was used consistently within an individual paper 47% of the time, with unclear consistency 28% of the time and inconsistently 24% of the time. Twelve papers used multiple terms alluding to the same pathology without clarification or evidence for their alternating use.

In 11 (18%) papers, the term, placenta accreta was used interchangeably to describe the spectrum as a whole and a specific subtype, without clarification. Of the 31 papers that either clearly or implicitly defined the term placenta accreta, seven papers did not then consistently adhere to that definition.

Evidence for Diagnostic Terminology

Evidence to support diagnostic terminology used, is summarised in **Table 3**.

Forty papers (65%) assigned patients diagnostic labels by antenatal investigations only, six (10%) by an intraoperative-only diagnosis, and 16 (26%) using both an antenatal and intraoperative information. Nine (15%) of these 62 papers did not, however, specify the diagnostic evidence used, either antenatal, intraoperative *or* postoperative, to guide their choice of terminology when labelling the extent of disease.

Thirty nine papers (63%), reported how a definitive confirmation of the disease process was made. Nineteen (31%) reported using histopathology to confirm the specific diagnosis and 20 (32%) report confirming diagnoses using intraoperative findings only. Twenty three (37%) papers, did not specify any confirmatory evidence beyond the antenatal diagnosis.

Studies published after FIGO consensus guidelines

Fourteen of the 62 studies (23%) were published six-months or more after the FIGO consensus guidelines.¹ Fourteen separate terms were used to describe PAS and its subtypes across these papers. Antenatal ultrasound was the most commonly used diagnostic modality (n=10, 71%), but specific criteria were only stated in two papers. Six (43%) papers confirmed diagnoses using pathology (+/- intraoperative findings). Three papers did not offer any diagnostic information.

Four of the 14 papers were consistent in their use of terminology throughout. Most frequently, terms were either not defined, or defined but used inconsistently or interchangeably and without any diagnostic justification.

Discussion

In 2018, the FIGO published consensus guidelines on PAS disorders.¹ The current study finds that PAS remains variably and inconsistently defined and that FIGO criteria have not yet been widely adopted into the literature surrounding PAS and anaesthetic practice. We believe that this is the first comprehensive review of the extent of the problem in PAS reporting, and the first to report on the adoption of the FIGO consensus guidelines.

The range of terminology used within the literature to describe PAS, is highlighted by the 30 different diagnostic terms included across 62 papers in this scoping review. These terms were clearly defined less than half of the time and were only used consistently within an article less than half of the time. Clear communication of the nature and extent of disease is integral to good delivery planning, which includes patient consent and preparation, for example, the likelihood of hysterectomy.

The inconsistent use of both terminology and diagnostic criteria within the literature, means that drawing definitive conclusions about optimal mode of anaesthesia is challenging. For most caesarean sections, it is accepted that RA is preferable to GA, due to a more favourable risk profile and improved neonatal outcomes.^{74,75} However, complex PAS surgery may bear little resemblance to a standard caesarean delivery. In these circumstances, both GA and RA, used alone, or in combination, may confer benefits.⁵

This scoping review defines the range, precision and consistency of diagnostic terminology used in PAS literature, pertaining to anaesthesia. It adds to the literature in two important aspects. Firstly, we believe this to be the first time that the full range and extent of the issue has been mapped, highlighting an important problem; the need for all involved specialties to adopt clear, standardised criteria, as defined by FIGO, before any consensus on the optimal mode of anaesthesia (or many other aspects of management) for women with a diagnosis of PAS can be drawn. There is unlikely to be a 'one size fits all' answer. Secondly, we have demonstrated that despite the excellent work of FIGO, adoption of their recommendations appears limited, and so an issue remains with the clarity of PAS reporting in scientific literature.

Despite clear guidance, with important clinical rationale, there remains a significant issue with the range, clarity, and consistency of terminology when reporting on PAS.

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References

1. Jauniaux E, Chantraine F, Silver RM, Langhoff-Roos J. FIGO consensus guidelines on placenta accreta spectrum disorders: Epidemiology. *Int J Gynaecol Obstet*. 2018; **140**(3): 265–273. <https://doi.org/10.1002/ijgo.12407>
2. Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS, et al. Global, regional, and national levels and causes of maternal mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2014; **384**(9947): 980–1004. [https://doi.org/10.1016/S0140-6736\(14\)60696-6](https://doi.org/10.1016/S0140-6736(14)60696-6)
3. Silver RM, Branch DW. Placenta Accreta Spectrum. *N Engl J Med*. 2018; **378**(16): 1529–1536. <https://doi.org/10.1056/NEJMcp1709324>
4. Public Health Scotland. Data Tables: Maternity and Births 2020. Available from: <https://www.isdscotland.org/Health-Topics/Maternity-and-Births/Publications/data-tables2017.asp?id=2553#2553>. Accessed August 3, 2021.

5. Jauniaux E, Alfirevic Z, Bhide AG, et al. Placenta Praevia and Placenta Accreta: Diagnosis and Management: Green-top Guideline No. 27a. *Br J Obstet Gynaecol*. 2019; **126**(1): e1–e48. <https://doi.org/10.1111/1471-0528.15306>
6. Eller AG, Porter TF, Soisson P, Silver RM. Optimal management strategies for placenta accreta. *Br J Obstet Gynaecol*. 2009; **116**(5): 648–654. <https://doi.org/10.1111/j.1471-0528.2008.02037.x>
7. Warshak CR, Ramos GA, Eskander R, et al. Effect of predelivery diagnosis in 99 consecutive cases of placenta accreta. *Obstet Gynecol*. 2010; **115**(1): 65–69. <https://doi.org/10.1097/AOG.0b013e3181c4f12a>
8. Collins SL, Ashcroft A, Braun T, et al. Proposal for standardized ultrasound descriptors of abnormally invasive placenta (AIP). *Ultrasound Obstet Gynecol*. 2016; n**47**(3): 271–275. <https://doi.org/10.1002/uog.14952>
9. Hecht JL, Baergen R, Ernst LM, et al. Classification and reporting guidelines for the pathology diagnosis of placenta accreta spectrum (PAS) disorders: recommendations from an expert panel. *Mod Pathol*. 2020; **33**(12): 2382–2396. <https://doi.org/10.1038/s41379-020-0569-1>
10. Jauniaux E, Ayres-De-Campos D, Langhoff-Roos J, Fox KA, Collins S. FIGO classification for the clinical diagnosis of placenta accreta spectrum disorders. *Int J Gynaecol Obstet*. 2019; **146**(1): 20–24. <https://doi.org/10.1002/ijgo.12761>
11. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol*. 2005; **8**(1): 19–32. <https://doi.org/10.1080/1364557032000119616>

Refs 12 – 73 (papers included in Scoping Review) shown in appendix 1

74. National Institute for Health and Care Excellence. Caesarean Birth: Clinical Guidelines [CG192] 2021. Available from: <https://www.nice.org.uk/guidance/ng192>. Accessed August 3, 2021.
75. Kearns RJ, Shaw M, Gromski PS, Iliodromiti S, Pell JP, Lawlor DA, Nelson SM. Neonatal and early childhood outcomes following maternal anesthesia for cesarean section: a population-based cohort study. *Reg Anesth Pain Med*. 2021; **46**(6):482–489. <https://doi.org/10.1136/rapm-2020-102441>

Table 1: Baseline characteristics of eligible papers

Characteristic	Category	Number of papers (%)
Continent	Europe	13 (21)
	North America	26 (42)
	South America	1 (2)
	Asia	19 (31)
	Oceania	3 (5)
Year of Publication	1982 – 1989	2 (3)
	1990 – 1999	4 (6)
	2000 – 2009	7 (11)
	2010 – 2019	43 (69)
	2020 – present	6 (10)
Study Site	Single centre	59 (95)
	Multicentre	3 (5)
Type of Study	Cohort Study	12 (19)
	Prospective	5 (8)
	Retrospective	2 (3)
	Combination	5 (8)
	Case-Control	1 (2)
	Survey	2 (3)
	Case Series	18 (29)
	Prospective	1 (2)
	Retrospective	17 (27)
	Case Report	27 (44)
	Conference Supplement	2 (3)
Primary Specialty Focus	Anaesthetics	43 (69)
	Obstetrics	4 (7)
	Combination	15 (24)
Anaesthetic Focus	Integral	55 (89)
	Incidental	7 (11)

Table 2: Range of diagnostic terminology, showing frequency and definition/clarity of use. Values are number (%)

Diagnostic term	Papers in which term was used	Papers in which term was defined
Placenta accreta	54 (87)	23 (43)
Placenta percreta	50 (80)	29 (58)
Placenta increta	39 (63)	24 (62)
Abnormal placentation	15 (24)	5 (33)
Morbidly adherent placenta	8 (13)	3 (38)
Abnormally invasive placenta	7 (11)	6 (86)
Placenta accreta vera	5 (8)	5 (100)
Pernicious placenta praevia	5 (8)	2 (40)
Invasive placenta	5 (8)	2 (40)
Abnormal placental attachment	4 (6)	3 (75)
Placenta accreta spectrum	4 (6)	1 (25)
Abnormally adherent placenta	4 (6)	-
Placenta accreta/percreta	4 (6)	-
Adherent placenta	3 (5)	1 (33)
Placenta praevia-accreta	2 (3)	-
Placenta praevia percreta	2 (3)	-
Abnormal placental invasion	1 (2)	1 (100)
Abnormal placental implantation	1 (2)	-
Abnormally adherent placental implantation	1 (2)	-
Adherent placenta praevia	1 (2)	-
Invasive placenta praevia	1 (2)	-
Morbidly adherent major placenta praevia	1 (2)	-
Morbidly adherent placenta praevia	1 (2)	-
Pernicious placenta accreta	1 (2)	-
Placenta creta	1 (2)	-
Placental invasion anomalies	1 (2)	-
Placenta praevia-increta	1 (2)	-
Placental abnormality	1 (2)	-
Placental anomaly	1 (2)	-
Placental implantation abnormality	1 (2)	-

Table 3: Evidence given within papers for choice of diagnostic terminology

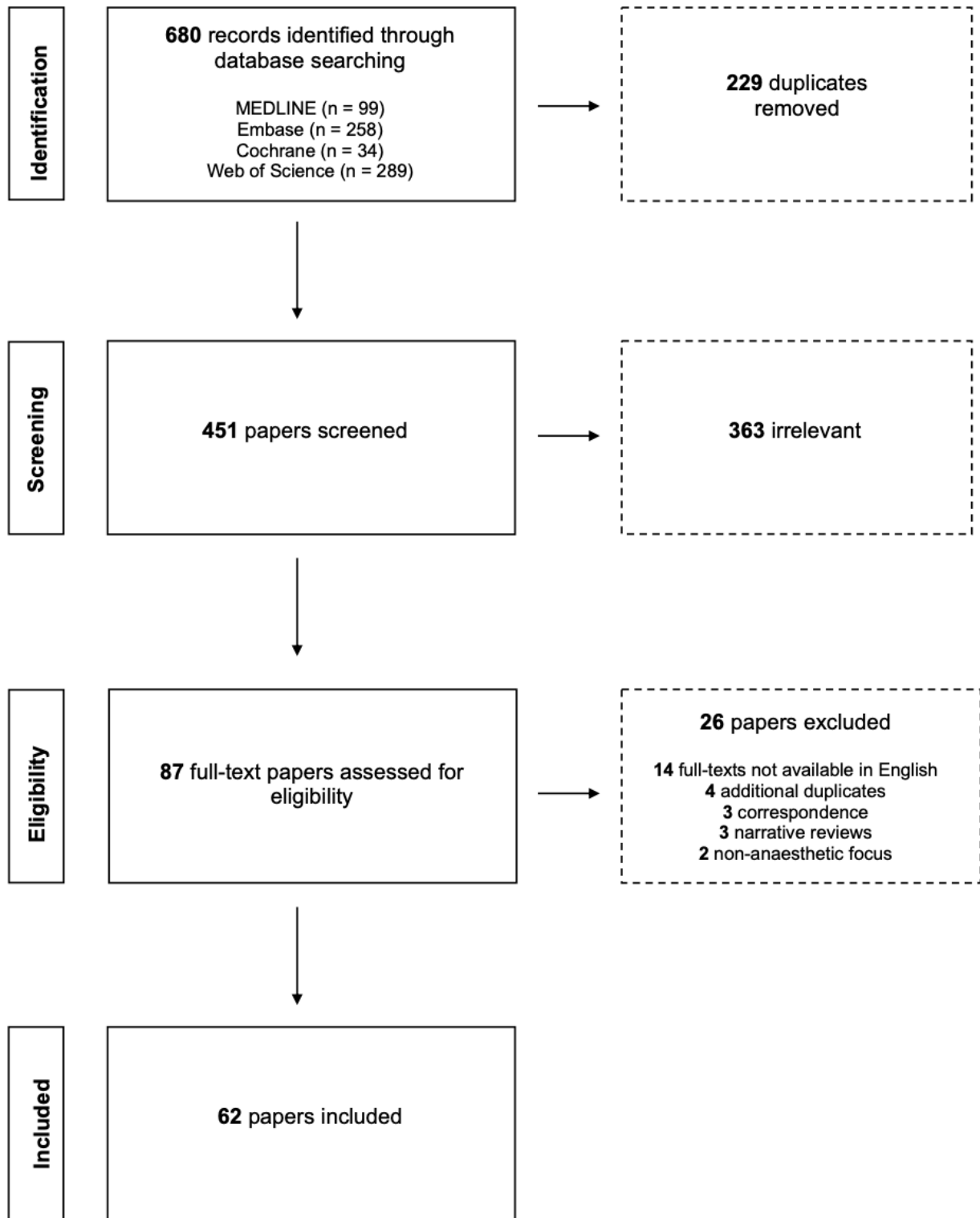
	Diagnostic modality	Number of papers (%)
Papers reporting evidence for an antenatal diagnosis	Ultrasound Only	23 (37)
	Specified criteria	5 (8)
	Unspecified criteria	18 (29)
	MRI only	2 (3)
	Ultrasound & MRI	19 (31)
	Specified criteria	4 (6)
	Unspecified criteria	15 (24)
	Unclear	3 (5)
Papers reporting a definitive confirmation of diagnosis	Intraoperative findings only	20 (32)
	Histopathology (+/- intraoperative findings)	19 (31)

Supplementary Table 1: Scoping Review search strategy

Database	Search Terms
MEDLINE	<p>(“Placenta Accreta”[MeSH term] OR (“abnormal* adj3 invasiv* adj3 placenta*”[ti,ab] OR (abnormal* adj3 invasiv* adj3 placenta* adj3 disease*”[ti,ab] OR (invasive* adj3 placenta* adj3 disease*”[ti,ab] OR (invasive* adj3 placenta*”[ti,ab] OR (placenta* adj3 accret* adj3 spectr*”[ti,ab] OR (morbid* adj3 adher* adj3 placenta*”[ti,ab] OR (abnormal* adj3 adher* adj3 placenta*”[ti,ab] OR ((accret* OR increta OR percreta) adj3 placenta*”[ti,ab] OR (major* adj1 obstetric* adj1 (hemorrhag* OR haemorrhag*”[ti,ab] OR (obstetric* adj1 (hemorrhag* OR haemorrhag* adj5 placenta*”[ti,ab])) AND ((“anesthetics”[MeSH term] OR “anesthetics, combined”[MeSH term] OR “anesthetics, general”[MeSH term] OR “anesthetics, local”[MeSH term] OR “anesthesiology”[MeSH term]) OR (anaesthe* OR anesthe*”[ti,ab] OR (general* adj3 (anaesthe* OR anesthe*”[ti,ab] OR (region* adj3 (anaesthe* OR anesthe*”[ti,ab] OR (spin* adj3 (anaesthe* OR anesthe*”[ti,ab] OR (epidural* adj3 (anaesthe* OR anesthe*”[ti,ab] OR (combine* adj3 spin* adj3 epidural*”[ti,ab])) AND (“English language”[Limit] AND “humans”[Limit] AND “yr=1982-Current”[Limit]) AND (“Journal Article”[Publication Type] OR “Case Reports”[Publication Type] OR “Review”[Publication Type] OR “Comparative Study”[Publication Type] OR “Letter”[Publication Type] OR “Multicentre Study”[Publication Type] OR “Observational Study”[Publication Type] OR “Evaluation Study”[Publication Type] OR “Randomized Controlled Trial”[Publication Type])</p>
Embase	<p>(“Placenta Accreta”[MeSH term] OR (“abnormal* adj3 invasiv* adj3 placenta*”[ti,ab] OR (abnormal* adj3 invasiv* adj3 placenta* adj3 disease*”[ti,ab] OR (invasive* adj3 placenta* adj3 disease*”[ti,ab] OR (invasive* adj3 placenta*”[ti,ab] OR (placenta* adj3 accret* adj3 spectr*”[ti,ab] OR (morbid* adj3 adher* adj3 placenta*”[ti,ab] OR (abnormal* adj3 adher* adj3 placenta*”[ti,ab] OR ((accret* OR increta OR percreta) adj3 placenta*”[ti,ab] OR (major* adj1 obstetric* adj1 (hemorrhag* OR haemorrhag*”[ti,ab] OR (obstetric* adj1 (hemorrhag* OR haemorrhag* adj5 placenta*”[ti,ab])) AND ((“epidural anesthesia”[MeSH term] OR “obstetric anesthesia”[MeSH term] OR “anesthesia”[MeSH term] OR “general anesthesia”[MeSH term] OR “regional anesthesia”[MeSH term] OR “spinal anesthesia”[MeSH term]) OR (anaesthe* OR anesthe*”[ti,ab] OR (general* adj3 (anaesthe* OR anesthe*”[ti,ab] OR (region* adj3 (anaesthe* OR anesthe*”[ti,ab] OR (spin* adj3 (anaesthe* OR anesthe*”[ti,ab] OR (epidural* adj3 (anaesthe* OR anesthe*”[ti,ab] OR (combine* adj3 spin* adj3 epidural*”[ti,ab])) AND (“human”[Limit] AND “English language”[Limit] AND “yr=’1982-Current”[Limit]) AND (“Article”[Publication Type] OR “Review”[Publication Type] OR “Letter”[Publication Type] OR</p>

	<p>“Editorial”[Publication Type] OR “Note”[Publication Type] OR “Short Survey”[Publication Type]</p>
Cochrane Database of Systematic Reviews, Trials and Editorials	<p>(“Placenta Accreta”[MeSH term] OR “Placenta Diseases”[MeSH term] OR (abnormal* near invasive* near placenta*)[ti,ab] OR (abnormal* near invasive* near placenta* near disease*)[ti,ab] OR (invasive* near placenta* near disease*)[ti,ab] OR (invasive* near placenta*)[ti,ab] OR (placenta* near accret* near spect*)[ti,ab] OR (morbid* near adher* near placenta*)[ti,ab] OR (abnormal* near adher* near placenta*)[ti,ab] OR (placenta* near accret*)[ti,ab] OR (placenta* near increta)[ti,ab] OR (placenta* near percreta)[ti,ab] OR (major* near obstetric* near (hemorrhag* OR haemorrhag*)) [ti,ab] OR (obstetric* near (hemorrhag* OR haemorrhag*) near placenta*) [ti,ab] AND (“Anesthesia”[MeSH term] OR (anaesthe* OR anesthe*) [ti,ab] OR (general* near (anaesthe* OR anesthe*)) [ti,ab] OR (region* near (anaesthe* OR anesthe*)) [ti,ab] OR (spin* (anaesthe* OR anesthe*)) [ti,ab] OR (epidural* (anaesthe* OR anesthe*)) [ti,ab] OR (combine* near spin* near epidural*) [ti,ab]))</p>
Web of Science	<p>((TI=(abnormal* near invasive* near placenta*) OR AB=(abnormal* near invasive* near placenta*)) OR ((TI=(abnormal* near invasive* near placenta* near disease*) OR AB=(abnormal* near invasive* near placenta* near disease*)) OR (TI=(invasive* near placenta* near disease*) OR AB=(invasive* near placenta* near disease*)) OR (TI=(invasive* near placenta*) OR AB=(invasive* near (placenta*)) OR (TI=(placenta* near accret* near spectr*) OR AB=(placenta* near accreta* near spectr*)) OR (TI=(morbid* near adher* near placenta*) OR AB=(morbid* near adher* near placenta*)) OR (TI=(abnormal* near adher* near placenta*) OR AB=(abnormal* near adher* near placenta*)) OR (TI=((accret* OR increta OR percreta) near placenta*) OR AB=((accret* OR increta OR percreta) near placenta*)) OR (TI=(major* near obstetric* near (hemorrhag* OR haemorrhag*)) OR AB=(major* near obstetric* near (hemorrhag* OR haemorrhag*)) OR (TI=(obstetric* near (hemorrhag* OR haemorrhag*) near placenta*) OR AB=(obstetric* near (hemorrhag* OR haemorrhag*) near placenta*)) AND ((TI=(anaesthe* OR anesthe*) OR AB=(anaesthe* OR anesthe*)) OR (TI=(general* near (anaesthe* OR anesthe*)) OR AB=(general* near (anaesth* OR anesthe*)) OR (TI=(region* near (anesthe* OR anaesthe*)) OR AB=(region* near (anaesthe* OR anesthe*)) OR (TI=(spin* near (anaesthe* OR anesthe*)) OR AB=(spin* near (anaesthe* OR anesthe*)) OR (TI=(epidural* near (anaesthe* OR anesthe*)) OR AB=(epidural* near (anaesthe* OR anesthe*)) OR (TI=(combine* near spin* near epidural*) OR AB=(combine* near spin* near epidural*)) AND “Timespan=1982-2020”[Limit] AND “Search language = English”[Limit] m</p>

Results were limited to papers in the English language, pertaining to human subjects and from no earlier than 1982, when the first antenatal diagnostic ultrasound of a case of PAS was reported.¹⁴

Supplementary Figure 1: Flow chart showing selection of papers for data extraction

Appendix 1: References 12 – 73, showing papers included in Scoping Review

12. Alvarado-Ramos S, Lara-Diaz VJ, Lopez-Gutierrez MR, Torcida-Gonzalez ME, Campos-Rodriguez JF. Minimally Invasive Hemodynamic Assessment during Obstetric Hysterectomy for Invasive Placentation with Epidural Anesthesia. *Anesthesiol Res Pract*. 2020: 1968354. <https://doi.org/10.1155/2020/1968354>
13. Angstmann T, Gard G, Harrington T, Ward E, Thomson A, Giles W. Surgical management of placenta accreta: a cohort series and suggested approach. *Am J Obstet Gynecol*. 2010; **202**(1): 38. e1–9. <https://doi.org/10.1016/j.ajog.2009.08.037>
14. Barth Jr WH, Kwolek CJ, Abrams JL, Ecker JL, Roberts DJ. Case 23-2011: A 40-year-old pregnant woman with placenta accreta who declined blood products. *N Engl J Med*. 2011; **365**(4): 359–366. <https://doi.org/10.1056/NEJMcp1103561>
15. Bergakker SA. Case report: Management of elective cesarean delivery in the presence of placenta previa and placenta accreta. *AANA J*. 2010; **78**(5): 380–384.
16. Bhatia N, Arora S, Bhukal I, Padmanaban A. Placenta percreta in a parturient with uncorrected Tetralogy of Fallot. *Int J Obstet Anesth*. 2013; **22**(4): 358–360. <https://doi.org/10.1016/j.ijoa.2013.04.002>
17. Binici O, Buyukfirat E. Anesthesia for Cesarean Section in Parturients with Abnormal Placentation: A Retrospective Study. *Cureus*. 2019; **11**(6): e5033. <https://doi.org/10.7759/cureus.5033>
18. Bishop S, Butler K, Monaghan S, Chan K, Murphy G, Edozien L. Multiple complications following the use of prophylactic internal iliac artery balloon catheterisation in a patient with placenta percreta. *Int J Obstet Anesth*. 2011; **20**(1): 70–73. <http://dx.doi.org/10.1016/j.ijoa.2010.09.012>
19. Coates VA, Fishman MS, Mccall WG. Placenta percreta: report of a case. *CRNA* 1999; **10**(4): 165–169.
20. Davies MH, Brunning T, Kerr J, Cullis K. Anaesthesia for abnormally invasive placenta: a single-institution case series. *Int J Obstet Anesth*. 2017; **32**: 95–96. <https://doi.org/10.1016/j.ijoa.2017.07.008>
21. Dhansura T, Kapadia D, Bhorkar N, Shaikh T. Anaesthesiologist's role in the multidisciplinary approach to placenta percreta. *Indian J Anaesth*. 2015; **59**(8): 513–515. <https://doi.org/10.4103/0019-5049.163002>

22. Feng S, Liao Z, Huang H. Effect of prophylactic placement of internal iliac artery balloon catheters on outcomes of women with placenta accreta: an impact study. *Anaesthesia*. 2017; **72**(7): 853–858. <https://doi.org/10.1111/anae.13895>
23. Fox KA, Buffie A, Erfani H, et al. General endotracheal anesthesia used at the time of delivery for morbidly adherent placenta is associated with increased need for neonatal resuscitation and short-term respiratory morbidity. *Am J Obstet Gynecol*. 2018; **218**(1): S181. <https://doi.org/10.1016/j.ajog.2017.10.214>
24. Frasca D. A Cesarean hysterectomy for invading placenta percreta: anesthetic safety considerations--a case report. *AANA J*. 2012; **80**(5): 373–378.
25. Fratto VM, Conturie CL, Ballas J, et al. Assessing the multidisciplinary team approaches to placenta accreta spectrum across five institutions within the University of California fetal Consortium (UCfC). *J Matern Fetal Neonatal Med*. 2019; **34**(18): 2971–2976. <https://doi.org/10.1080/14767058.2019.1676411>
26. Grant TR, Ellinas EH, Kula AO, Muravyeva MY. Risk-stratification, resource availability, and choice of surgical location for the management of parturients with abnormal placentation: a survey of United States-based obstetric anesthesiologists. *Int J Obstet Anesth*. 2018; **34**: 56–66. <https://doi.org/10.1016/j.ijoa.2018.01.008>
27. Green AT, Green M, Ostheimer GW, Datta S, Naulty JS. Risks of placenta previa-accreta in patients with previous cesarean deliveries. *Anesthesiology*. 1988; **69**(supplement): A659.
28. Gunaydin B, Kurdoglu M, Guler I, Bashiri M, Buyuktasgin F, Kelesoglu MD, Inan G. Management of Neuraxial Anaesthesia for Emergent Caesarean Section for Placenta Previa. *Turk J Anaesthesiol Reanim*. 2016; **44**(1): 40–43. <https://doi.org/10.5152/tjar.2016.52385>
29. Hall T, Wax JR, Lucas FL, Cartin A, Jones M, Pinette MG. Prenatal sonographic diagnosis of placenta accreta--impact on maternal and neonatal outcomes. *J Clin Ultrasound*. 2014; **42**(8): 449–455. <https://doi.org/10.1002/jcu.22186>
30. Harrison EA, Yentis SM, Bennett AM. Anaphylaxis during caesarean section in a patient with undiagnosed placenta accreta: It never rains but it pours! *Int J Obstet Anesth*. 1999; **8**(4): 279–283. [https://doi.org/10.1016/s0959-289x\(99\)80110-1](https://doi.org/10.1016/s0959-289x(99)80110-1)
31. Hunter T, Kleiman S. Anaesthesia for caesarean hysterectomy in a patient with a preoperative diagnosis of placenta percreta with invasion of the urinary bladder. *Can J Anaesth*. 1996; **43**(3): 246–248. <https://doi.org/10.1007/bf03011743>

32. Ioscovich A, Shatalin D, Butwick AJ, Ginosar S, Orbach-Zinger S, Weiniger CF. Israeli survey of anesthesia practice related to placenta previa and accreta. *Acta Anaesthesiol Scand*. 2016; **60**(4): 457–464. <https://doi.org/10.1111/aas.12656>
33. Ioscovich AM, Nyman DJ, Briskin A, Grisaru-Granovsky S. Transient cortical blindness after caesarean hysterectomy for placenta percreta. *Int J Obstet Anesth*. 2004; **13**(4): 291–293. <https://doi.org/10.1016/j.ijoa.2004.05.002>
34. Jiang X, Lin X, Han X, Ma Y, Zhao F. Successful resuscitation of a patient with pernicious placenta previa and placenta accreta who had massive life-threatening bleeding during cesarean section: A case report. *Medicine*. 2019; **98**(14): e15025. <https://doi.org/10.1097/md.00000000000015025>
35. Kamani AaS, Gambling DR, Christilaw J, Flanagan ML. Anaesthetic management of patients with placenta accreta. *Can J Anaesth*. 1987; **34**(6): 613–617. <https://doi.org/10.1007/bf03010522>
36. Karacaer F, Bircik E, Ilginel M, Tunay D, Sucu M, Unlugenc H. Retrospective Analysis of Eighty-Nine Caesarean Section Cases with Abnormal Placental Invasion. *Turk J Anaesthesiol Reanim*. 2019; **47**(2): 112–119. <https://doi.org/10.5152/tjar.2018.31799>
37. Kocaoglu N, Gunusen I, Karaman S, Ergenoglu AM, Firat V. Management of anesthesia for cesarean section in parturients with placenta previa with/without placenta accreta: a retrospective study. *Ginekol Pol*. 2012; **83**(2): 99-103.
38. Korolev AY, Pyregov AV, Fedorova TA, Shmakov RG, Gerasimov YuA, Shpiluk MA, Medvedeva AA. Safety of regional anesthesia during delivery in pregnant women with placenta increta. *Akush Ginekol*. 2019; **(1)**: 92–97. <https://dx.doi.org/10.18565/aig.2019.1.92-97>
39. Kuczkowski KM. Anesthesia for the repeat cesarean section in the parturient with abnormal placentation: what does an obstetrician need to know? *Arch Gynecol Obstet*. 2006; **273**(6): 319–321. <https://doi.org/10.1007/s00404-005-0104-0>
40. Kuczkowski KM, Miller T. Cesarean hysterectomy for placenta percreta invading the anterior abdominal wall: anesthetic considerations--a case report. *Middle East J Anesthesiol*. 2008; **19**(5): 1105–1109.
41. Kume K, Y MT, Soga T, et al. A case of placenta percreta with massive hemorrhage during cesarean section. *J Med Invest*. 2014; **61**(1-2): 208–212. <https://doi.org/10.2152/jmi.61.208>

42. Lan JY, Wang MH, Fan SZ, Chen LK. Impact of anesthetic methods on neonatal outcome in women receiving temporary balloon occlusion of the common iliac artery during cesarean section for placenta accreta. *Taiwan J Obstet Gynecol.* 2011; **50**(4): 515–517. <https://doi.org/10.1016/j.tjog.2011.10.021>
43. Li P, Liu X, Li X, Wei X, Liao J. Clinical outcomes and anesthetic management of pregnancies with placenta previa and suspicion for placenta accreta undergoing intraoperative abdominal aortic balloon occlusion during cesarean section. *BMC Anesthesiol.* 2020; **20**(1): 133. <https://doi.org/10.1186/s12871-020-01040-8>
44. Lilker SJ, Meyer RA, Downey KN, Macarthur AJ. Anesthetic considerations for placenta accreta. *Int J Obstet Anesth.* 2011; **20**(4): 288–292. <https://doi.org/10.1016/j.ijoa.2011.06.001>
45. Liu X, Zhu Y, Ke D, Liu D, Zhu Z. Mode of anesthesia for cesarean delivery with pernicious placenta previa - a retrospective study. *Ginekol Pol.* 2020; **91**(2): 91–94. <https://doi.org/10.5603/gp.2020.0023>
46. Ma Y, You Y, Jiang X, Lin X. Use of nitroglycerin for parallel transverse uterine cesarean section in patients with pernicious placenta previa and placenta accrete and predicted difficult airway: A case report and review of literature. *Medicine.* 2020; **99**(5): e18943. <https://doi.org/10.1097/md.00000000000018943>
47. Ma Y, You Y, Jiang X, Lin X, Chen Y. Parallel transverse uterine incisions combined with cell salvage minimized bleeding in a patient with pernicious placenta previa and an unexplained decrease in hemoglobin after transfusion of allogeneic red blood cells: A case report. *Medicine.* 2019; **98**(18): e15434. <https://doi.org/10.1097/md.00000000000015434>
48. Markley JC, Farber MK, Perlman NC, Carusi DA. Neuraxial Anesthesia During Cesarean Delivery for Placenta Previa With Suspected Morbidly Adherent Placenta: A Retrospective Analysis. *Anesth Analg.* 2018; **127**(4): 930–938. <https://doi.org/10.1213/ane.0000000000003314>
49. Mok M, Heidemann B, Dundas K, Gillespie I, Clark V. Interventional radiology in women with suspected placenta accreta undergoing caesarean section. *Int J Obstet Anesth.* 2008; **17**(3): 255–261. <https://doi.org/10.1016/j.ijoa.2007.11.010>
50. Munoz LA, Mendoza GJ, Gomez M, Reyes LE, Arevalo JJ. Anesthetic management of placenta accreta in a low-resource setting: a case series. *Int J Obstet Anesth.* 2015; **24**(4): 329–334. <https://doi.org/10.1016/j.ijoa.2015.05.005>

51. Nguyen-Lu N, Carvalho JCA, Kingdom J, Windrim R, Allen L, Balki M. Mode of anesthesia and clinical outcomes of patients undergoing Cesarean delivery for invasive placentation: a retrospective cohort study of 50 consecutive cases. *Can J Anesth*. 2016; **63**(11): 1233–1244. <https://doi.org/10.1007/s12630-016-0695-x>
52. Omowanile YA, Weiler LN, Mhyre JM, Khan FA. Double Dilemma-Management of a Pregnant Patient With a Difficult Airway Presenting With Undiagnosed Placenta Percreta: A Case Report. *A A Case Rep*. 2017; **9**(1): 1–3. <https://doi.org/10.1213/xa.0000000000000508>
53. Paull JD, Smith J, Williams L, Davison G, Devine T, Holt M. Balloon occlusion of the abdominal aorta during caesarean hysterectomy for placenta percreta. *Anaesth Intensive Care*. 1995; **23**(6): 731–734. <https://doi.org/10.1177/0310057x9502300616>
54. Rai V, Shariffuddin II, Chan YK, Muniandy RK, Wong KK, Singh S. Peri-operative management of hysterostomy in a parturient with complete heart block, placenta accreta and intrauterine death. *BMC Anesthesiol*. 2014; **14**(49) <https://doi.org/10.1186/1471-2253-14-49>
55. Reitman E, Devine PC, Laifer-Narin SL, Flood P. Case scenario: Perioperative management of a multigravida at 34-week gestation diagnosed with abnormal placentation. *Anesthesiology*. 2011; **115**(4): 852–857. <https://doi.org/10.1097/aln.0b013e31822ea436>
56. Riveros-Perez E, Wood C. Retrospective analysis of obstetric and anesthetic management of patients with placenta accreta spectrum disorders. *Int J Gynaecol Obstet*. 2018; **140**(3): 370–374. <https://doi.org/10.1002/ijgo.12366>
57. Russo M, Krenz EI, Hart SR, Kirsch DK. Multidisciplinary approach to the management of placenta accreta. *Ochsner J*. 2011; **11**(1): 84–88.
58. Sadashivaiah J, Wilson R, Thein A, McLure H, Hammond CJ, Lyons G. Role of prophylactic uterine artery balloon catheters in the management of women with suspected placenta accreta. *Int J Obstet Anesth*. 2011; **20**(4): 282–287. <https://doi.org/10.1016/j.ijoa.2011.06.006>
59. Saha PK, Bagga R, Kalra JK, et al. An alternate surgical approach to reduce hemorrhage and complications during cesarean hysterectomy for adherent placenta. *Eur J Obstet Gynecol Reprod Biol*. 2018; **228**: 215–220. <https://doi.org/10.1016/j.ejogrb.2018.07.004>

60. Seyhan TO, Sungur MO, Edipoglu I, Bastu E. Combined Spinal Epidural Anaesthesia for Caesarean Section and Hysterectomy in a Parturient with Placenta Accreta. *Turk J Anaesthesiol Reanim*. 2014; **42**(3): 148–150. <https://doi.org/10.5152/tjar.2014.59389>
61. Shaylor R, Ginosar Y, Avidan A, Eventov-Friedman S, Amison N, Weiniger CF. Pre-delivery remifentanyl infusion for placenta accreta cesarean delivery under general anesthesia: an observational study. *J Matern Fetal Neonatal Med*. 2016; **29**(17): 2793–2797. <https://doi.org/10.3109/14767058.2015.1104297>
62. Sivasankar C. Perioperative management of undiagnosed placenta percreta: Case report and management strategies. *Int J Womens Health*. 2012; **4**(1): 451–454. <https://doi.org/10.2147/ijwh.s35104>
63. Styron AG, George RB, Allen TK, Peterson-Layne C, Muir HA. Multidisciplinary management of placenta percreta complicated by embolic phenomena. *Int J Obstet Anesth*. 2008; **17**(3): 262–266. <https://doi.org/10.1016/j.ijoa.2008.03.002>
64. Sultan P, Hilton G, Butwick A, Carvalho B. Continuous spinal anesthesia for Cesarean hysterectomy and massive hemorrhage in a parturient with placenta increta. *Can J Anaesth*. 2012; **59**(5): 473–477. <https://doi.org/10.1007/s12630-012-9681-0>
65. Taylor NJ, Russell R. Anaesthesia for abnormally invasive placenta: a single-institution case series. *Int J Obstet Anesth*. 2017; **30**: 10–15. <https://doi.org/10.1016/j.ijoa.2017.01.008>
66. Thon S, Mclintic A, Wagner Y. Prophylactic endovascular placement of internal iliac occlusion balloon catheters in parturients with placenta accreta: a retrospective case series. *Int J Obstet Anesth*. 2011; **20**(1): 64–70. <https://doi.org/10.1016/j.ijoa.2010.08.006>
67. Urfalioglu A, Oksuz G, Bilal B, Teksen S, Calisir F, Boran OF, Oksuz H. Retrospective Evaluation of Anesthetic Management in Cesarean Sections of Pregnant Women with Placental Anomaly. *Anesthesiol Res Pract*. 2020; **2020**: e1358258. <https://doi.org/10.1155/2020/1358258>
68. Walker MG, Allen L, Windrim RC, et al. Multidisciplinary Management of Invasive Placenta Previa. *J Obstet Gynaecol Can*. 2013; **35**(5): 417–425. [https://doi.org/10.1016/s1701-2163\(15\)30932-4](https://doi.org/10.1016/s1701-2163(15)30932-4)
69. Weiniger CF, Einav S, Deutsch L, Ginosar Y, Ezra Y, Eid L. Outcomes of prospectively-collected consecutive cases of antenatal-suspected placenta accreta. *Int J Obstet Anesth*. 2013; **22**(4): 273–279. <https://doi.org/10.1016/j.ijoa.2013.04.014>

70. Weiniger CF, Elram T, Ginosar Y, Mankuta D, Weissman C, Ezra Y. Anaesthetic management of placenta accreta: use of a pre-operative high and low suspicion classification. *Anaesthesia*. 2005; **60**(11): 1079–1084. <https://doi.org/10.1111/j.1365-2044.2005.04369.x>
71. Wong CK, Velickovic IA. Anesthetic implications of conservative management of placenta percreta. *Anesthesiology*. 2007; **106**(5): B123.
72. Yamada T, Hirahata E, Ihara N, et al. Cesarean hysterectomy in a hybrid operating room for placenta percreta: a report of three cases. *JA Clin Rep*. 2019; **5**(1): 9. <https://doi.org/10.1186/s40981-019-0230-5>
73. Zhu H, Wang S, Shi J, Yao L, Wang L, Chen H, Fang X. Prophylactic endovascular balloon occlusion of the aorta in cases of placenta accreta spectrum during caesarean section: points from the anaesthesiologist's perspective. *BMC Pregnancy Childbirth*. 2020; **20**(1): 446. <https://doi.org/10.1186/s12884-020-03136-y>

