Maternal morbidity associated with skin incision type at cesarean delivery in obese patients: a systematic review

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Aim: To describe the relationship between cesarean skin incision type and postoperative wound complications (WCs) in obese pregnant patients.

Materials & methods: MEDLINE (PubMed and OVID), Embase, Scopus, Web of Science Core Collection, Cochrane Library and ClinicalTrials.gov databases were used for publication search. Selection criteria consisted of articles studying pregnant patients with BMI ≥30 kg/m² undergoing cesarean delivery and assessing the effect of skin incision type on postoperative maternal outcomes.

Results: Ten publications met criteria for a systematic review of a total of 2946 patients. The transverse skin incision was associated with a lower rate of WCs compared with the vertical skin incision. The pooled risk ratio for WCs was 0.47 (95% CI: 0.37–0.58; p < 0.00001). Conclusion: Transverse skin incision may be preferable to vertical skin incision at cesarean delivery in pregnant patients with obesity as it may be associated with a lower rate of WCs.

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Lay abstract: This systematic review describes the relationship between skin incision type and postoperative wound complications in obese patients following cesarean delivery. The study results suggest that transverse skin incisions may be preferable to vertical skin incisions in the obese obstetric population for the reduction of wound complications.

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Keywords: cesarean delivery • obesity • transverse skin incision • vertical skin incision • wound complication

Cesarean delivery (CD) is one of the most common abdominal surgeries worldwide, representing a third of deliveries in the USA and even higher rates among obese patients [1–3]. Obesity is particularly prevalent in today’s society. In the USA, 37% of women aged 20–39 years are obese (BMI ≥30 kg/m²), and 10.1% have class III obesity (BMI ≥40 kg/m²) [2–5]. Obesity during pregnancy increases the risk of failed induction, failed vaginal birth after primary cesarean section, gestational diabetes, macrosomia and cephalopelvic disproportion, all factors which increase the risk of CD [6–8].

Research has shown that the risk of undergoing a CD is twofold higher in women with a BMI >35 kg/m² [3]. Other studies have also demonstrated that obesity increases the risk of wound complications (WCs) following CD, the risk of prolonged operative time as well as the rate of postpartum hemorrhage [9–14]. A study reviewing over 142,404 pregnancies reported a higher wound infection rate among obese compared with nonobese patients [15].

The aim of this study was to describe the relationship between cesarean skin incision type and postoperative WCs as well as other outcomes in obese women using the systematic review method.

Materials & methods

We searched MEDLINE (PubMed and OVID), Embase, Scopus, Web of Science Core Collection, Cochrane Library and ClinicalTrials.gov databases for relevant studies evaluating the association between cesarean skin incision types and maternal morbidity in obese pregnant patients. Search terms included ‘cesarean section’, ‘abdominal or...
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skin incision’, ‘vertical skin incision’, ‘Pfannenstiel’, ‘transverse skin incision’, ‘midline incision’, ‘supra-pannicular incision’, ‘obese’ and ‘body mass index’. Supplementary Appendix 1 illustrates the search strategy used for each database. The database searches were without restriction on study design type or date of publication. We further reviewed the reference section of the eligible articles to identify other relevant studies that may not have appeared in the literature search.

This systematic review was performed in accordance with version 5.1.0 of the Cochrane handbook for systematic reviews of interventions [16] and the PRISMA statement [17]. Two reviewers (O Zarudskaya and HN Moussa) independently screened the abstracts of all records identified through the initial search. Identified texts underwent inclusion analysis. We only included studies that compared the effectiveness of different skin incision types on postoperative maternal morbidity after CD in women with BMI ≥30 kg/m². The primary outcomes addressed WCs, whereas secondary outcomes focused on other morbidities such as blood loss and transfusion rate, operative time, and duration of hospital stay. Studies were excluded if they had insufficient or duplicate data, did not report maternal outcomes, or performed on the nonobese population. Any discrepancy during the study selection process was resolved by discussion.

Extracted data included the last name of the first author, year of publication, country of origin, study design and study period. Additionally, study population information was included, such as the number of patients, maternal age, gestational age, BMI, type of cesarean incision, number of patients with preeclampsia, history of chronic hypertension or diabetes and tobacco use. Additionally, prophylactic antibiotics administration, classical hysterotomy, WC, estimated blood loss, blood transfusion, length of postoperative hospital stay and operative time were recorded. Data are presented in Table 3. The definition of WC was based on the respective study’s definition and preserved as such.

We evaluated the quality of the eligible cohort studies using the quality assessment tool of the Newcastle Ottawa scale [18]. The risk of bias in the randomized controlled trial (RCT) was assessed following the Cochrane risk of bias assessment tool; authors’ judgments for bias were segmented as ‘low risk’, ‘high risk’ or ‘unclear risk’ [19] (see Supplementary Appendix 2A & B).

WC and blood transfusion rates were summarized using percentages, with an adjusted odds ratio with a 95% CI, if available. Continuous data were reported as mean ± standard deviation or median (1st–3rd quartile). We pooled results when possible. Pooled estimates were obtained using the RevMan 5.3.5 (The Nordic Cochrane Centre, Copenhagen, Denmark) software for Windows. Heterogeneity was assessed by the I² statistic and chi-square (X²) test. Fixed effects were used when no heterogeneity was detected. We did not assess funnel plot asymmetry for the existence of publication bias, since it is not reliable for <10 pooled studies, according to Egger et al. [20].

Results

Our search identified 1135 records. After 359 duplicates were removed, 776 titles and abstracts were screened to yield 83 studies for full-text assessment. Ten articles met our prespecified inclusion criteria, including a total of 2946 obese pregnant patients who underwent CD (Figure 1). Of these ten publications, nine were retrospective cohort studies, and one was a RCT. No further studies were retrieved from our manual search, which was accomplished through screening the reference sections of the final included articles and trials from ClinicalTrials.gov. Articles meeting review criteria were those published in journals as full-text articles from 2003 to 2019. All included cohort studies were at low risk of bias, with scores varying from 7 to 9 when the Newcastle-Ottawa scale was applied. The RCT (Marrs et al.) trial met a low risk of bias criteria when assessed using the Cochrane tool [27]. The study design, sample size, time of data collection, types of incision and the reported primary outcome for each study are presented in Table 1.

Among the included articles, eight studies discussed the effect of transverse skin incision and vertical skin incision on WCs. Walton et al. compared WCs between low and high transverse skin incision types [29]. Dias et al. addressed infra-panniculus versus supra-panniculus incisions [28]. BMI was relatively increased among patients who had a vertical incision compared with those with a transverse incision. The incidence of diabetes, hypertension and preeclampsia was also higher among patients with a vertical incision, except for the reported findings by Marrs et al. (48% diabetic patients in transverse vs 32% in the vertical group). Sutton et al., Bell et al. and Brocato et al. [21–23] reported that the rates of classical hysterotomy are significantly higher in pregnant patients with a vertical incision compared with a transverse incision, while low transverse uterine incisions were more frequent in transverse incision groups. Other patients’ clinical characteristics and variables are provided in Supplementary Appendix 3.
WCs were more common in pregnant patients with vertical skin incisions when compared with the transverse skin incisions, according to four studies that demonstrated a significant difference [21,24,25]. However, after adjusting for confounders, only Thornburg et al. found a statistically significant difference in WC rates between the two types of incisions [24]. The incidence of WCs in vertical incision groups varied from 14.6 to 55.8%, higher than the transverse incision groups, where the incidence varied from 7.6 to 21.1%. Our pooled analysis of eight studies showed that the transverse incision was associated with a reduced risk of developing WCs from CD (relative risk [RR] = 0.47, 95% CI: 0.37–0.58; p < 0.00001) when compared with vertical incision (Figure 2).

Five studies reported that vertical type incisions are associated with higher estimated blood loss to compare with transverse type incision [22,23,25–28]; however, only three of those have reached statistically significant differences. Similarly, five studies stated that the transfusion rates were higher in the vertical group when compared with transverse group incision [21–23,26,27]; however, none of the respective studies reached statistical significance after adjusted comparison.

The length of hospital stay after delivery was reported in seven studies, with no difference between the vertical and transverse incision groups [21–23,25,27–29]. Total operative time was longer in those with a vertical skin incision; only three of the five studies reporting this notion demonstrated a statistically significant difference (Table 2) [22,23,28]. Interestingly the Dias et al. study reported very prolonged operative times compared with all of the included studies (97 ± 31 vs 143 ± 41) [28]. This study was performed in two maternity hospitals of Scotland, in women with very severe obesity (BMI ≥40 kg/m²); this is in contrast with the rest of the studies, which have been performed in the USA. The results of this study may also represent slightly different CD techniques used in the United Kingdom. However, prolonged operative time did not increase the WC rate in either group for the Dias et al. study (22.2 vs 27.7%) [28].
Table 1. Characteristics and validity of included studies.

| Study (year), country | Study design | Dates of data collection | Inclusion criteria | Sample size, n | Types of incision | Primary outcome; definition | Ref. |
|-----------------------|-------------|--------------------------|--------------------|---------------|--------------------|-----------------------------|------|
| Sutton et al. (2015), USA | Retrospective cohort | 2010–2013 | Primary or repeated CD GA ≥34 weeks BMI ≥40 kg/m² | 423 | Transverse, subpannicular | Vertical | WC, any of cellulitis, abscess, hematoma, seroma or fascial dehiscence | [22] |
| Bell et al. (2011), USA | Retrospective cohort | 2004–2006 | Primary or repeated CD GA ≥35 kg/m² | 424 | Low transverse, irrespective of distance from the pubic bone superior border | Vertical, longitudinal incision, infra or supraumbilical | Wound infection and/or breakdown; wound separation and/or purulent discharge with or without cellulitis or fever | [21] |
| Alans et al. (2010), USA | Retrospective cohort | 2005–2009 | Primary or repeated CD GA 20–44 weeks BMI ≥50 kg/m² | 194 | Transverse, Pfannenstiel except one subumbilical | Vertical, paramedian or midline above or below the umbilicus | WC, wound disruption or wound cellulitis | [26] |
| Brocato et al. (2013), USA | Retrospective cohort | 2007–2011 | All women underwent CD BMI ≥40 kg/m² | 133 | Transverse, Pfannenstiel | Vertical, supraumbilical | WC, superficial and deep surgical site infection, wound dehiscence or requiring take back to the operating room | [23] |
| Walton et al. (2017), USA | Retrospective cohort | 2010–2015 | Primary or repeated CD GA ≥23 weeks GA BMI ≥40 kg/m² | 128 | High transverse | Low transverse | WC, wound seroma, hematoma, dehiscence, requiring take back to the operating room, reopening, debridging or vacuuming the incision | [29] |
| Marrs et al. (2019), USA | RCT | 2013–2017 | Primary or repeated CD GA ≥24 weeks BMI ≥40 kg/m² | 91 | Transverse, Pfannenstiel | Vertical, midline, sub or supraumbilical | WC, surgical site infection, cellulitis, seroma, hematoma or separation up to 6 weeks postpartum | [27] |
| Dias et al. (2019), UK | Retrospective cohort | 2010–2015 | Primary or repeated CD GA ≥37 weeks BMI ≥40 kg/m² | 453 | Transverse, infra-umbilicus; supraumbilical Pfannenstiel or modified Cohen’s | Transverse, supra-umbilicus; above the pannus | Wound infection; purulent drainage with/without laboratory confirmation, pain, tenderness, redness or heat | [28] |
| Thornburg et al. (2012), USA | Retrospective cohort | 1994–2008 | Primary CD BMI was ≥35 kg/m² | 623 | Low transverse, subpannicular | Vertical | WC, wound separation, spontaneous or indicated as result of seroma or wound infection/cellulitis | [24] |
| McLean et al. (2011), USA | Retrospective cohort | 1998–2005 | CD with BMI ≥30 kg/m² | 238 | Transverse | Vertical | Wound separation; partial or complete wound separation | [44] |
| Wall et al. (2003), USA | Retrospective cohort | 1994–2000 | Primary CD BMI was ≥35 kg/m² | 239 | Transverse | Vertical | WC, cellulitis, purulent wound discharge, seroma or hematoma or any need to open the incision | [25] |

CD: Cesarean delivery; GA: Gestational age; RCT: Randomized controlled trial; WC: Wound complication.

Figure 2. Forest plot of risk ratios for wound complication events.
| Author (year) | Patients (n) | Wound complication | Blood loss (ml) | Transfusion | Length of stay (day) | Operative time (min) | Ref. |
|--------------|--------------|--------------------|----------------|-------------|---------------------|---------------------|-----|
| Sutton et al. (2015) | 364 in Subpannicular transverse | 54 (14.8) p = 0.03 | 1.7 (0.7–4.1) | 900 (800–1000) p < 0.001 | 7 (1.9) p = 0.048 | 4.2 (0.9–19.0) | 4 (3–4) p = 0.6 | 55 (44–65) p < 0.001 [22] |
| 57 in Vertical | 15 (26.3) | 1000 (900–1000) | 4 (7.0) | 4 (3–4) | 73 (58–107) |
| Bell et al. (2011) | 383 in Low transverse | 29 (7.6) p = 0.03 | 1.91 (0.57–6.44) | NA | 6 (1.6) p = 0.01 | 2.78 (0.42–18.40) | 4 (2–25) p = 0.02 | NA [21] |
| 41 in Vertical | 6 (14.6) | 4 (9.8) | 4 (2–45) |
| Alanis et al. (2010) | 90 in Pfannenstiel | 19 (21.1) | NA | 23 (25.6) p = 0.007 | 9 (10) p = 0.92 | NA | NA | 58.5 (49.0–73.0) p < 0.001 [26] |
| 104 in Vertical | 39 (37.5) | 46 (44.2) | 10 (9.6) | 71.0 (61–90.5) |
| Brocato et al. (2013) | 90 in Pfannenstiel | 7 (8) p = 0.08 | NA | 11 (12) p = 0.005 | 5 (6) p = 0.056 | NA | 59 (66) p = 0.1912 | 68 ± 30 p < 0.0001 [23] |
| 43 in Suprapubic | 8 (19) | 14 (33) | 7 (16) | 97 ± 38 |
| Walton et al. (2017) | 32 in High transverse | 5 (15.63) p = 0.24 | NA | NA | NA | 3.0 (2.0–4.0) | 0.13 | NA [29] |
| 96 in Low transverse | 26 (27.08) | 2.0 (2.0–3.0) |
| Marrs et al. (2019) | 50 in Pfannenstiel | 8 (18.6) p = 0.71 | NA | 800 (700–1000) p = 0.13 | 4 (8) p = 0.87 | NA | 68 ± 32 p = 0.57 [27] |
| 41 in Vertical | 8 (21.1) | 1000 (800–1000) | 3 (7) | 3.5 ± 4.1 | 69 ± 21 |
| Dias et al. (2019) | 406 in infra-panniculus transverse | 90 (22.2) p = 0.40 | NA | 705.1 ± 424.5 p = 0.004 | NA | 3.4 ± 2.4 | 0.02 | 97 ± 31 p < 0.001 [28] |
| 47 in Supra-panniculus transverse | 13 (27.7) | 1044.5 ± 744.8 | 3.9 ± 1.8 | 143 ± 41 |
| Thornburg et al. (2012) | 588 in Low transverse | 68 (11.6) p < 0.001 | 6.5 (3.2–13.4) | NA | NA | NA | NA | [24] |
| 35 in Vertical | 16 (45.7) |
| McLean et al. (2011) | 213 in Transverse | 22 (10) p = 0.15 | NA | NA | NA | NA | NA | [44] |
| 25 in Vertical | 5 (20) |
| Wall et al. (2003) | 213 in Transverse | 20 (9.4) p = 0.001 | NA | 909 ± 316.7 p = 0.92 | NA | 4.4 ± 2.2 | 0.16 | 68 ± 22.0 p = 0.16 [25] |
| 26 in Vertical | 9 (34.6) | 915 ± 249.3 | 5.0 ± 1.3 | 74 ± 19.2 |

Data are in n (%), mean ± SD and median (1st–3rd quartile).
† Blood loss >1000 ml, n (%).
‡ Length of stay >3 days, n (%).
aOR: Adjusted odds ratio; NA: Not available; SD: Standard deviation.
Table 3. Clinical characteristics of study population for each included study.

| Author (year) | Patients (n) | Age (year) | Gestational age (week) | BMI (kg/m²) | Chronic HTN | Diabetes | Tobacco use | Preeclampsia | Antibiotics prophylaxis | Tubal ligation | Classical hysterotomy | Ref. |
|---------------|--------------|------------|------------------------|-------------|-------------|----------|-------------|--------------|------------------------|---------------|------------------------|------|
| Sutton et al. (2015) | 364 in Subpannicular transverse | 28.1 ± 6.3 | 38.7 ± 1.5 | 47.6 ± 6.2 | 101 (27.8) | 104 (28.7) | NA | NA | NA | NA | 28 (7.7) | p < 0.001, aOR 4.8 (95% CI: 2.2–10.4) |
| Bell et al. (2011) | 57 in Vertical | 31.4 ± 5.4 | 38.0 ± 1.5 | 54.5 ± 12.1 | 26 (45.6) | 35 (62.5) | NA | NA | NA | NA | 28 (7.7) | p < 0.001 |
| Alanis et al. (2010) | 90 in Pfannenstiel | 28.0 (24–33) | 39.0 (36–39) | 52.8 (51.1–57.1) | 37 (41.1) | 17 (18.9) | 11 (12.2) | 20 (22.2) | 65 (72.2) | NA | 8 (8.9) | p < 0.001 |
| Brocato et al. (2013) | 90 in Pfannenstiel | 26 ± 6 | 38.3 ± 3 | 56 ± 6 | 39 (43) | 8 (9) | 10 (11) | 31 (34) | 90 (100) | NA | 7 (8) | |
| Walton et al. (2017) | 32 in High transverse | 32.8 ± 4.3 | 36.8 ± 2.9 | 49.9 ± 9.0 | 18 (56.25) | 15 (46.88) | 7 (21.88) | NA | NA | NA | NA | |
| Marrs et al. (2018) | 50 in Pfannenstiel | 30 ± 7 | 37 ± 2.2 | 50 ± 8 | 24 (48) | 3 (6) | NA | 49 (98) | 17 (34) | NA | NA | |
| Dias et al. (2019) | 406 in Infra-panniculus transverse | 30.6 ± 5.7 | 39.3 ± 2.07 | 43.3 ± 3.3 | NA | 89 (21.9) | 68 (16.7) | NA | NA | NA | NA | |
| Thornburg et al. (2012) | 588 in Low transverse | 29.0 ± 6.0 | 37.3 ± 3.8 | 39.4 ± 6.7 | NA | 106 (17) | NA | 27 (4.3) | 623 (100) | NA | NA | |
| McLean et al. (2011) | 213 in Transverse | 29.9 ± 6.0 | 39 (37–39) | 36 (32–40) | 55 (26) | 49 (23) | 44 (21) | 28 (13) | NA | NA | NA | |
| Wall et al. (2003) | 213 in Transverse | 28.9 ± 6.2 | 37.6 ± 3.9 | 41.2 ± 4.8 | NA | 40 (18.8) | 38 (18) | 44 (20.7) | 187 (87.8) | NA | NA | |

aOR: Adjusted odds ratio; HTN: Hypertension; NA: Not available; OR: Odds ratio.
There was a trend that high transverse and suprapannicular incisions are associated with a lower risk of WCs compared with low transverse and infrapannicular incisions described in Walton et al. and Dias et al., respectively [28,29]; however, there was no statistically significant difference between the groups.

Discussion

Our main finding was that there is a lower risk of WCs in obese pregnant patients undergoing CD with a transverse skin incision compared with a vertical skin incision (RR = 0.47, 95% CI: 0.37–0.58; p < 0.00001). The results of our study coincide with findings described by Mccurdy et al. where vertical incisions were associated with a RR of 2.07 (95% CI: 1.61–2.67) for WCs compared with transverse incisions; however, significant possible confounders were present [30].

Multiple techniques have been studied to diminish the risk of infectious complications among pregnant patients undergoing CD, including adjunctive intravenous azithromycin to standard antibiotic prophylaxis for c-section in labor or after membrane rupture [31], vaginal preparation with povidone-iodine before cesarean section and undergoing CD, including adjunctive intravenous azithromycin to standard antibiotic prophylaxis for c-section and suprapannicular incisions described in Walton et al.

Wound dressing technique demonstrated no benefit in preventing surgical site infection in the obese population [32]. However, neither adjunction of azithromycin nor vaginal cleansing was investigated regarding prevention infections complications in obese parturients. Application of a negative wound dressing technique demonstrated no benefit in preventing surgical site infection in the obese population [32].

Other investigators addressed the influence of surgical technique on the risk of CD surgical site infection. Low transverse type of skin incision, or Pfannenstiel, or infrapannicular in obese parturient performed under pannus irrespective of the distance from the pubic bone poses significant technical difficulties and remains an issue of debate due to the presence of the subpannicular skin fold. In light of the above, a midline vertical skin incision is more frequently suggested for obese patients [21,33]. This is despite the higher risk of postoperative pain, superficial and fascial wound dehiscence, and postoperative atelectasis associated with midline vertical skin incisions [25].

High transverse skin incision theoretically reduces WCs because a higher abdominal wall incision avoids the need to incise through the pannus and has the added advantage of transverse incision such as good tensile strength. High transverse skin incision in obese parturient or suprapannicular, describes transverse incision performed above the pannus or suprapannicular. Since pannus retraction is not necessary, less thoracic compression and resultant hypotension are noted. High transverse skin incisions are also associated with reduced postoperative pain, lower rates of dehiscence and the possible risk of infection or bleeding [29]. Despite the aforementioned research, insufficient definitive guidance is available to assist obstetricians in the selection of the best incision type to use for obese patients undergoing CD.

Given the observed increase in the risk of WCs with the use of vertical skin incisions, physicians and researchers must attempt to identify further interventions and modifications to the commonly used incisions, including innovative surgical techniques, which can reduce the overall postoperative morbidity in CD [14].

In a national anonymous survey of obstetrics and gynecology (OB/GYN) physicians, when Smid et al. assessed the preferences of obstetricians regarding cesarean incision practices in morbidly obese pregnant patients, the responders stated a preference for Pfannenstiel incision with a taping of the pannus [34]. Another multicenter anonymous survey regarding women’s preference and concerns for cesarean skin incision among pregnant with class III obesity showed that patients prioritize immediate maternal and fetal safety over other concerns including cosmetic outcome [35].

There is potential for reduction of post-CD WCs through surgical techniques such as high transverse incision and suprapannicular incisions described in Walton et al. and Dias et al., respectively [28,29]. Both authors Walton et al. and Dias et al. observed a trend showing a reduction of WC with high transverse and suprapannicular type of skin incision when compared with low transverse and infrapannicular, respectively [28,29]; however, the difference did not reach statistical significance. These data demonstrate the necessity for further investigation of best skin incision techniques in obese parturients.

The rate of WCs increases with an increase of BMI from 9.2% in women with BMI 30–39.9 kg/m² (aOR: 1.4, 95% CI: 0.99–2.0; p = 0.06), to 16.8% in women with BMI 40–49.9 kg/m² (aOR: 2.6, 95% CI: 1.7–3.8; p < 0.01). The rate of WC in BMI >50 kg/m² is 22.9% (aOR: 3.0, 95% CI: 1.9–4.9; p < 0.01) [36]. Potentially confounding any investigation of postoperative WCs are the medical comorbidities these patients often exhibit. Minor or unreported differences in operative technique or preparation also play a role in the risk for the development of postoperative WCs. Factors such as smoking, chronic medical conditions such as diabetes and hypertension [37], perioperative antibiotic use [31], pre-operative skin preparation [38], tissue closure [39], wound vacuum [32], and the
use of drains [40–43], all increase the risk of postoperative wound infection. Influence of comorbidity and technique confounders required analysis of surgical incision choice and the likelihood of postoperative surgical complications.

Our review's primary strength is that our investigation is a robust systematic review to compare different cesarean skin incision types and evaluate their postoperative effects among obese pregnant patients. Our systematic review utilized several databases to ensure proper coverage of the topic. The search strategy was maximally simplified and transparent, which makes it easily replicable. Additionally, we strictly followed the inclusion criteria that allowed us to focus on the research topic and include only those articles that describe the association between the type of skin incision and WCs in the obese obstetric population. Two independent reviewers performed screening of abstracts. We included only articles available in full text. All of these approaches provide reliable estimates about the effects of incision type on WCs in obese obstetric patients.

Our analysis has several inherent limitations because of the limited available literature addressing this topic. Nine of the ten studies which met the inclusion criteria were retrospective cohort studies. Only one RCT met the inclusion criteria. The predominance of retrospective cohort studies used lowers the level of evidence for this review. We were unable to compute pooled estimates for the cohort studies without access to individual patients’ data. The specific incision technique and outcome definitions were heterogeneous and varied somewhat among the different studies. A half of the reviewed studies has not reported whether prophylactics antibiotics were utilized, which makes generalizability of results limited. Finally, a significant limitation of any retrospective cohort drove review of literature is in type of patient selection. Decision strategies insofar as the choice of the incision are a limitation. Nonetheless, our review is important because its analysis permits the development of a steppingstone for a robust understanding of this topic.

Conclusion
In conclusion, transverse skin incision may be preferable to vertical skin incision in pregnant patients with obesity as it may be associated with lower rates of WCs. Further scientific evaluation of our conclusions and correlations necessitates a prospective randomized trial.

Future perspective
Our vision is that more RCT studies will be performed to describe the best skin incision type for cesarean section in obese patients. Also, more RCTs investigating different types of transverse skin incisions will appear, allowing us to perform systematic reviews and meta-analysis to describe the association between supra and infrapinnacular incision type and WCs in obese patients with CD.

Executive summary

- Insufficient definitive guidance is available to assist obstetricians in the selection of the best incision type to use for obese pregnant patients undergoing cesarean delivery (CD).
- Our systematic review of the literature is consistent with other publications in that transverse skin incision may be preferable to vertical skin incision at CD in pregnant patients with obesity as it may be associated with a lower rate of wound complications.
- Further investigation of best skin incision techniques in obese parturients during CD is still needed.

Supplementary data
To view the supplementary data that accompany this paper please visit the journal website at: www.future-science.com/doi/suppl/10.2144/fsoa-2020-0160

Author contributions
HN Moussa conceived the original idea. D Zoorob, O Zarudskaya and HN Moussa performed literature search and review, and writing of the manuscript. D Zoorob and JV Hook performed editing of manuscript. D Zoorob and O Zarudskaya performed data description. O Zarudskaya performed statistical analyses. HN Moussa supervised the project. All authors discussed the results and contributed to the final manuscript.
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