The effectiveness of transabdominal cerclage placement via laparoscopy or laparotomy: a systematic review and meta-analysis

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OBJECTIVE: Failure or technical impossibility to place a prophylactic transvaginal cerclage in women with cervical insufficiency justifies the need for an abdominal cerclage. In this systematic review and meta-analysis, we studied the obstetrical and surgical outcomes of laparoscopic and open laparotomy abdominal cerclage approaches performed before (interval) or during pregnancy.

DATA SOURCES: We performed a systematic literature search in PubMed, Embase, and the Cochrane Library for studies on laparoscopic and open laparotomy abdominal cerclage placement in February 2022.

STUDY ELIGIBILITY CRITERIA: All studies on laparoscopic or open laparotomy placement of an abdominal cerclage with at least 2 patients that reported on our primary outcomes were included.

METHODS: All included studies were assessed for quality and risk of bias with an adjusted Quality in Prognosis Study tool. Random effects meta-analyses were performed for the primary outcomes, namely fetal survival and gestational age at delivery.

RESULTS: Our search yielded 83 studies with a total of 3398 patients; 1869 of those underwent laparoscopic cerclage placement and 1529 underwent open laparotomy placements. No studies directly compared the 2 cerclage approaches. The survival (overall, 91.2%) and gestational age at delivery (overall, 36.6 weeks) were not statistically different between the approaches. For the procedure during pregnancy, the laparoscopic group showed significantly less blood loss >400 mL (0% vs 3%), a slightly lower procedure-related fetal loss (0% vs 1%), a shorter hospital stay but a longer operation duration than the open laparotomy group. For the interval cerclages, the laparoscopic group showed significantly fewer wound infections (0% vs 3%) and a shorter hospital stay than the open laparotomy group, but showed comparable offspring preterm birth and survival rates.

CONCLUSION: Based on indirect comparisons, the laparoscopic and open laparotomy abdominal cerclage placements at interval or during pregnancy produced similar outcomes in terms of survival and gestational age at delivery. There are some small differences in perioperative care, surgical complications, interventions, and complications during pregnancy. This implies that both methods of abdominal cerclage placement have high success rates and thus we cannot conclude that one of the methods is superior for the placement of an abdominal cerclage.

Key words: abdominal cerclage, cerclage, cervical insufficiency, interval, laparoscopic, open laparotomy, postconceptional, preconceptional, pregnancy, preterm birth

Introduction

Preterm delivery is the direct cause of 35% of all neonatal death.[1] In developed countries, 8.6% of all live born babies are born prematurely.[2] One of the causes of preterm delivery is cervical insufficiency. It complicates 1% of all pregnancies and causes 8% of recurrent miscarriages.[3,4] Cervical insufficiency is characterized by painless dilatation of the cervix without uterine contractions, leading to recurrent second trimester births in an otherwise normal pregnancy. In addition, a short cervical length detected by ultrasound is often seen as an early stage of cervical insufficiency.[5,6] Cervical insufficiency can be treated by placement of a cervical cerclage, which can lead to a prolonged pregnancy and a reduction in preterm birth, neonatal mortality, and morbidity.[6–9]

EDITOR'S CHOICE

In the index pregnancy in which cervical insufficiency is diagnosed, a secondary (ultrasound-indicated) or tertiary (dilatation-indicated) transvaginal cerclage can be placed. For subsequent pregnancies, a prophylactic cerclage can be placed.[9–13] In most cases, a prophylactic transvaginal cerclage (history-indicated) is sufficient to

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AJOG MFM at a Glance

Why was this study conducted?

This systematic review with a meta-analysis aimed to assess the obstetrical and surgical outcomes of laparoscopic or open laparotomy abdominal cerclage approaches performed before (interval) or during pregnancy.

Key findings

Survival and gestational age at delivery were similar for the laparoscopic and open laparotomy approaches. There are some small differences in perioperative care, surgical complications, interventions, and complications during pregnancy. This implies that both methods of abdominal cerclage placement have high success rates and thus we cannot conclude that one of the methods is superior for the placement of an abdominal cerclage.

What does this add to what is known?

This systematic review includes all reported studies on transabdominal cerclages with 2 or more participants and provides an up-to-date overview of the different placement techniques and timing of an abdominal cerclage.

reduce the risk of perinatal death (relative risk, 0.82; 95% confidence interval [CI], 0.60−1.12).[9] However, in case of failure or technical impossibility to place a prophylactic transvaginal cerclage because of a short or scarred cervix, a transabdominal cerclage should be offered.[14−17]

A transabdominal cerclage has been shown to be highly effective in reducing both fetal loss and premature birth.[18−21] It can be placed before (interval) and during pregnancy and by laparoscopic (LC) or open laparotomy (AC) procedure. Since the introduction of minimally invasive surgery, there is an increase in laparoscopically placed cervical cerclages, especially for the interval procedure.[22] Previous meta-analyses showed that both the timing and techniques are associated with an improvement in gestational age at delivery and a high fetal survival rate (>90%). They concluded, however, that because these techniques have never been compared directly by a randomized controlled trial, further research is required to compare the LC with the open AC approach.[23−26]

Objective

This study aimed to provide an up-to-date literature overview of the differences in obstetrical outcomes between the LC and AC procedure for both interval and during-pregnancy placed transabdominal cerclages. In addition, we summarized the differences in perioperative care, surgical complications, interventions, and complications during pregnancy. For this, we performed a systematic review with meta-analyses.

Material and Methods

This systematic review and meta-analysis were conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines for systematic reviews.[27] The study protocol was registered with the International Prospective Register of Systematic Reviews (registration number CRD42022343682).[28]

Eligibility criteria, information sources, search strategy

We performed a systematic search for relevant studies in which a transabdominal cerclage was placed either via a LC or AC approach using PubMed, Embase, and the Cochrane Database of Systematic Reviews. From inception to February 2022, these databases were searched to find studies with the keywords "abdominal cerclage" or "transabdominal cerclage" or "laparoscopic cerclage" or "open laparotomy cerclage" or "cervical stitch." The complete search strategy is included in Appendix B. No restrictions were set on pregnancy type, age, weight, ethnicity, gravidity, parity, indication for the transabdominal cerclage, and year of publication

Study selection

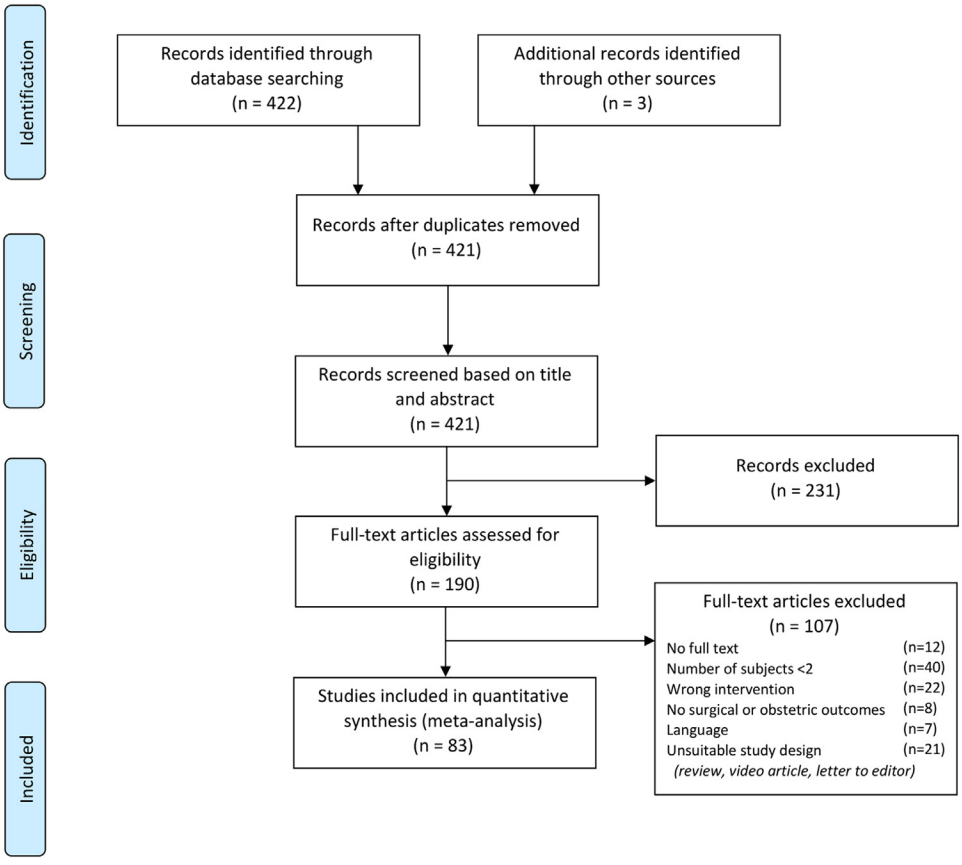
Studies were evaluated for inclusion by following a 2-phase selection process as illustrated in the Figure. All obtained studies were independently screened by title and abstract by 3 authors (C.C.H., A.H., and H.W.). Articles that passed by mutual agreement were subsequently evaluated completely by the same authors to assess eligibility for inclusion based on the inclusion and exclusion criteria. A study was included if it contained original data on transabdominal cerclage placement, and our primary outcomes of fetal survival and gestational age at delivery were reported. We included cohort studies and case reports containing at least 2 patients. Abstracts and studies with an unsuitable study design, such as reviews or letters to the editor, were excluded.

Data extraction

Study characteristics, obstetrical, and surgical outcomes were extracted from the selected studies. Extracted study characteristics consisted of author, year of publication, study design, sample size, type of transabdominal cerclage, population description, time point and gestational age at placement of the cerclage, and follow-up period. The following subject characteristics were obtained: age, gravidity, parity, number of previous pregnancies, gestational age in previous pregnancy, fetal survival of previous pregnancy, and previous vaginal cerclage.

The primary outcomes were mean gestational age at delivery and fetal survival rate. Fetal survival rate was defined as the number of neonates surviving 6 weeks after delivery divided by the total number of fetuses, including first trimester losses. A corrected fetal survival was calculated after excluding first trimester losses, taking into account that the etiology of first trimester losses is different from those of cervical insufficiency. Subsequent pregnancies were only included if the authors reported fetal survival rate or mean gestational age at delivery for every pregnancy. Secondary pregnancy outcomes were period of delivery (<28, <30, <34, and >34 weeks of gestation) and fetal loss

FIGURE
PRISMA flow diagram of the systematic review selection procedure



PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

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(first trimester, second trimester, third trimester). The following surgical outcomes and complications were registered: operation time, duration of hospitalization, perioperative blood loss >400 mL, blood transfusion, wound infection, and perioperative fetal loss. Interventions and complications during pregnancy were use of tocolysis, use of antibiotics, use of progesterone, premature rupture of membranes, chorioamnionitis.

Assessment of risk of bias

All included studies were independently assessed on quality and risk of bias by 3 authors (C.C.H., A.H., and H.W.). In accordance with the purposes of this systematic review, we used a self-adjusted set of items as reported in the Quality in Prognosis Study (QUIPS) tool depicted in Appendix A.[29] The adjusted QUIPS tool consists of 4 domains, namely study participation, study attrition, variable measurements, and data reporting. Each item was scored with a plus or a minus. As in the original QUIPS tool, all domains in the self-adjusted tool were considered to be of equal importance and contributed equally to the total score. A score of ≥60% was defined as high quality, a score of ≥30% and <60% as moderate quality, and a score of <30% as low quality.

Data synthesis

To compare the LC with the AC approach, independent of time point (ie, LC/AC total), random-effects meta-analyses were performed for the primary and secondary outcome parameters. Subgroup analyses were performed to compare the LC approach with the open AC approach in terms of the timing of the procedure. The subgroups consisted of studies in which cerclages were placed before pregnancy (LC/AC interval), studies in which cerclages were placed during pregnancy (LC/AC pregnancy), and studies in which studies did not differentiate between timing of placement (LC/AC undefined).

The weighted proportion with corresponding 95% confidence intervals (95% CIs) were calculated for all groups to assess the association between the type and timing of abdominal cerclage placement and fetal survival. A random intercept logistic regression model was used, with a maximum-likelihood estimator for tau,[2] a logit transformation, Clopper-Pearson confidence intervals for individual studies, and a continuity correction for 0.5 in studies with 0 frequencies (only used to calculate

individual study results). To assess the association between abdominal cerclage and gestational age at delivery, weighted means with corresponding 95% CIs were calculated for all groups using an inverse variance method with the DerSimonian-Laird estimator for tau.[2] I^2 and 95% prediction intervals were used as a measure of heterogeneity. An I^2 value of >50% was considered to be suggestive of statistical heterogeneity.[30] Funnel plots, in combination with Egger's regression test for funnel plot asymmetry, were used to evaluate for the possible presence of publication bias.[31]

Sensitivity analyses were performed to evaluate the effect of publication year, participant number, and pregnancy type on both of the primary outcomes. We assessed the effect of publication year because differences in neonatal healthcare over the years might impact the outcomes. We used the year 2000 as a cutoff value, considering that neonatal healthcare has not improved substantially between the year 2000 and the present. We evaluated the effect of participant number, because small case series might introduce publication bias, whereas large studies might have a favorable effect on these outcomes because of expertise. We evaluated thresholds of 10 and 15 participants. We assessed the effect of pregnancy type, considering that singleton and multifetal pregnancies might differ in etiology and management of cervical insufficiency. We evaluated studies that only included singleton pregnancies by excluding studies on multifetal pregnancies or those in which no distinction was made in the outcomes of singleton or multifetal pregnancies.

The statistical analyses were performed with the statistical software R (version 4.1.3) (R Core Team, Vienna, Austria) using the meta-package (version 5.2-0).[32,33]

Results

Study selection

Our literature search delivered 425 potentially relevant articles (Figure). After duplicate removal, we screened the title and abstract of 421 articles, which led to 190 articles deemed eligible for full-text reading. Subsequently, based on our inclusion and exclusion criteria, 107 full-text articles were excluded. This left 83 eligible studies containing 3398 patients.[14,15,17–22,34–107]

Study characteristics

Table 1 presents the baseline characteristics. A total of 3398 patients underwent placement of a transabdominal cerclage via LC (n=1869) or AC (n=1549). In the LC group, 675 patients underwent an interval procedure, and 489 patients received the cerclage during pregnancy. In the open AC group, this was 183 and 1010, respectively. For the other patients, the timing was not reported. Three patients underwent 2 operations because of unexpected pregnancies after removal of the abdominal cerclages. Most baseline characteristics were not significantly different between the groups. Parity was slightly lower in the LC total group than in the open AC group. The overall fetal survival rate of previous pregnancies was 19.3%. For the interval procedure, this was slightly higher in the LC group than in the open AC group.

Risk of bias of included studies

The results of the quality assessment of the included studies are presented in Appendix A. A total of 70 studies were of high quality, 13 were of moderate quality, and 0 were of low quality. The mean quality score was 73% (range, 33%–94%). The mean quality score for the LC group was 72% (range, 33%–94%), with 7 studies of moderate quality. For the open AC group, the mean quality score was 75% (range, 40%–94%), with 6 studies of moderate quality.

Surgical outcome

Table 2 provides an overview of the perioperative outcomes and complications within 2 weeks after surgery. The mean gestational age at surgery was significantly lower in the LC group than in the open AC group. The mean duration of surgery was significantly longer for the LC procedures (interval, 81 minutes; during pregnancy, 135 minutes) than for the open AC during-pregnancy procedure (58 minutes). There were no studies that reported the surgical duration of an interval open AC cerclage. Hospital stay was significantly shorter for the LC procedure than for the open AC procedure (1.3 vs 6.1 days, respectively). The use of antibiotics perioperatively was reported in several studies but did not differ significantly between all groups. A total blood loss of >400 mL blood was uncommon in all groups but was significantly lower in the LC than in the open AC procedure during pregnancy (0% vs 3%). Wound infection was also rare, but significantly lower in the LC group than in the open AC interval group (0% vs 3%). The amount of procedure-related fetal losses was slightly lower in the LC group than in the open AC group (0.4% vs 0.8%). More surgical outcomes are depicted in Appendix C.

Interventions and complications during pregnancy

Table 3 presents all reported interventions and complications during pregnancy after placement of the abdominal cerclage. Supplementation with 17-hydroxyprogesterone was reported in several studies but did not differ significantly between the groups. Overall, tocolysis was less frequently used in the LC group (7.2%) than in the open AC group (49.4%). The prevalence of preterm prelabor rupture of membranes and chorioamnionitis was not significantly different between the groups. Other complications during pregnancy were rare, <5%, and are shown in Table 3.

Pregnancy outcome

Table 4 shows the pregnancy outcome variables based on a total of 2825 pregnancies (including first trimester losses). The mean gestational age at delivery was slightly higher in the LC group than in the AC group (37.0 vs 36.1 weeks). This can, to a great extent, be explained by the lower gestational age in the open AC interval procedure (32.0 weeks, based on only 2 studies), whereas the open AC pregnancy procedure shows a mean gestational age at delivery of 36.3 weeks (comparable to both the

TABLE 1
Baseline characteristics of women according to the different procedures of placement of an abdominal cerclage

Characteristics	Total	LC Preg	LC Int	LC Total	AC Preg	AC Int	AC Total	*P* value LC-AC Preg	*P* value LC-AC Int	*P* value LC-AC Total
Studies/ participants	83/ 3418	10/489	18/675	45/1869	25/1010	6/183	45/1549			
Demographic data										
Age (y)	32.4 (31.8–32.0)	30.9 (28.7–33.0)	32.8 (31.3–34.4)	32.6 (31.8–33.5)	32.2 (31.3–33.2)	34.6 (28.3–41.0)	32.2 (31.4–32.9)	.25	.59	.46
Gravidity (number per subject)	3.7 (3.2–4.2)	3.9 (2.43–5.23)	2.9 (2.1–3.6)	3.5 (2.9–4.1)	4.3 (3.6–5.1)	3.04 (0.1–6.2)	4.3 (3.3–5.4)	.57	.91	.10
Parity (number per subject)	1.45 (1.2–1.8)	2.1 (0.2–4.0)	1.1 (0.6–1.6)	1.1 (0.8–1.5)	1.1 (0.9–1.3)	1.8 (1.0–2.5)	1.9 (1.3–2.4)	.74	.96	.03[a]
Obstetrical history										
Previous fetal survival (%)	19.3 (15.9–23.2)	22.2 (6.9–52.5)	21.3 (10.0–39.8)	23.1 (14.8–22.0)	15.9 (12.7–19.7)	9.6 (4.9–18.1)	18.2 (14.8–22.0)	.56	.11	.34
GA previous births (wk)	21.4 (20.4–22.5)	23.0 (19.8–26.2)	22.6 (20.0–25.1)	21.7 (20.6–22.8)	18.3 (15.5–21.1)	21.05 (15.7–25.5)	20.3 (16.7–23.9)	.48	.03[a]	.48
Surgical history										
Previous vaginal cerclage (number per subject)[b]	0.7 (0.60–0.75)	0.7 (0.5–0.8)	0.7 (0.5–0.8)	0.7 (0.6–0.7)	0.8 (0.6–0.9)	0.64 (0.22–0.96)	0.7 (0.6–0.8)	.54	.86	.44
Previous cervical surgery (%)	24.5 (18.2–32.2)	27.8 (9.3–59.0)	26.8 (15.1–42.9)	25.9 (17.7–36.2)	18.0 (10.6–28.9)	80.9 (5.0–99.7)	23.5 (14.6–35.6)	.45	.28	.74

Data are presented as proportion (95% CI) or mean (95% CI) as obtained from the random-effects meta-analyses. In each column, not all studies are represented based on available data.

AC, open laparotomy; *CI*, confidence interval; *GA*, gestational age; *Int*, interval; *LC*, laparoscopic; *LC/AC total*, total number of patients with reported data on LC or AC, regardless of timing of surgery (ie, LC/AC pregnancy+LC/AC interval+articles that did not report data on AC/LC separately for interval and pregnancy); *NA*, not applicable; *Preg*, pregnancy.

[a] A p-value of ≤ 0.05 was considered statistically significant; [b] Data are presented for the number of previous cerclages per patient (one or multiple per patient).

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interval and pregnancy LC procedures). The mean fetal survival rate was 91.6% in the LC group and 90.6% in the open AC group. Fetal survival was significantly higher in the LC (90.1%) than in the open AC (79.2%) interval procedure. After excluding first trimester losses, fetal survival was 96.2% in the LC group and 93.7% in the open AC group and did not differ significantly between the groups. Of all viable fetuses, 91.8% were delivered ≥34 weeks' gestation. We did not detect significant or clinically relevant differences with delivery ≥34 weeks in terms of viable fetuses between the LC and open AC (both interval and pregnancy) groups. Of all pregnancies, on average, 8.6% ended in fetal loss. This was significantly lower in the LC (9.7%) than in the open AC (21.1%) interval procedure. The total fetal loss was further differentiated into first, second, and third trimester loss. First trimester loss was comparable between the LC and the open AC interval procedure. Further differentiation of first, second, and third trimester losses is shown in Table 4. The birthweight of surviving neonates did not differ significantly between the groups.

The forest plots of the fetal survival and corrected fetal survival are depicted in Appendix D for both the LC and open AC placement. The forest plots show small to moderate degrees of heterogeneity between the studies within the subgroups in terms of I^2, varying from 0% to 53%. The 95% prediction intervals are, however, relatively wide, especially for the open AC interval group, which reflects considerable differences across the studies. The forest plots of the gestational age at delivery are depicted in Appendix D for the LC and open AC placement, showing heterogeneity with an I^2 of between 43% and 97% and relatively wide 95% prediction intervals. Funnel plots for both primary outcomes are presented in Appendix E. Funnel plot of the survival in the total LC group, and plots of the gestational age at delivery for both the total LC and total open AC groups have slight indications of publication bias, which was statistically confirmed by the

TABLE 2
Perioperative care and complications within 2 weeks after the different procedures of placement of an abdominal cerclage

	Total	LC Preg	LC Int	LC Total	AC Preg	AC Int	AC Total	*P* value		
								LC-AC Preg	LC-AC Int	LC-AC Total
GA at surgery (wk)	12.8 (12.5–13.2)	12.2 (11.5–13.0)	NA	11.7 (10.9–12.4)	13.5 (13.1–13.9)	NA	13.5 (13.1–13.9)	.00[a]	NA	.00[a]
Surgical duration (min)	94.0 (75.1–92.9)	134.9 (77.6–192.1)	81.0 (47.7–114.4)	88.6 (78.3–98.9)	57.6 (50.3–64.8)	NA	66.4 (56.3–76.4)	.01[a]	NA	.00[a]
Hospital stay (d)	2.5 (1.9–3.2)	1.9 (1.1–2.6)	0.9 (0.4–1.4)	1.3 (1.0–1.6)	8.4 (7.0–9.8)	7.0 (6.9–7.1)	6.1 (3.1–9.1)	.00[a]	.00[a]	.00[a]
Use of antibiotics perioperative (%)	46.7 (19.4–75.1)	53.6 (6.2–96.8)	56.1 (0.0–100.0)	65.5 (23.9–96.2)	39.8 (3.7–84.9)	11.1 (0.0–68.8)	29.8 (2.6–70.2)	.72	.52	.23
Blood loss >400 mL (%)	0.6 (0.1–1.4)	0.0 (0.0–0.3)	0.1 (0.0–0.4)	0.0 (0.0–0.2)	3.3 (0.6–8.0)	0.4 (0.0–4.4)	1.9 (0.4–4.3)	.00[a]	.59	.00[a]
Wound infection (%)	0.2 (0.1–0.6)	0.0 (0.0–0.2)	0.1 (0.0–0.6)	0.1 (0.0–0.3)	0.5 (0.0–2.2)	3.1 (0.6–7.5)	1.5 (0.5–2.9)	.10	.01[a]	.00[a]
Procedure-related fetal loss (%)	0.6 (0.2–1.3)	0.0 (0.0–0.8)	NA	0.4 (0.1–1.2)	0.9 (0.2–2.1)	NA	0.8 (0.2–1.8)	.08	NA	.48

Data are proportion (95% CI) or mean (95% CI), resulting from random-effects meta-analyses. In each column, not all studies are represented based on available data.

AC, open laparotomy; *CI*, confidence interval; *GA*, gestational age; *Int*, interval; *LC*, laparoscopic; *LC/AC total*, total number of patients with reported data LC/AC, regardless of timing of surgery (ie, LC/AC Pregnancy+LC/AC Interval+articles that did not report data on AC/LC separately for interval and pregnancy); *NA*, not applicable; *Preg*, pregnancy.

[a] A p-value of ≤ 0.05 was considered statistically significant.

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Egger's regression test for funnel plot asymmetry. Funnel plots of the subgroups of both the LC and open AC procedure (interval, pregnancy, undefined) are very little to not at all indicative of publication bias. Forest plots of all secondary outcomes are depicted in Appendix G.

Sensitivity analyses

We performed 3 sensitivity analyses for both primary outcomes, namely fetal survival and the gestational age at delivery (Appendix F). We observed a small effect of publication date (published in or after the year 2000) on the outcomes in the open AC group when compared with the main analysis. Gestational age at delivery remained similar, whereas corrected fetal survival did, nonsignificantly, improve for both the pregnancy procedures (from 92.8% to 94.5%) and, consequently, for the total open AC group (from 93.5% to 94.6%). This sensitivity analysis was only performed for the studies on abdominal cerclages placed via AC, because there were no articles on abdominal cerclages placed via LC published before the year 2000. We also observed a small effect of study participant number (number of participants ≥10) on both primary outcomes. For the open AC abdominal cerclage group, we did not see any notable differences on the outcomes, although heterogeneity decreased, when compared with the main analysis. Outcomes did, nonsignificantly, improve for the open AC interval procedure in both the corrected survival rate (from 96.6% to 98.2%) and the gestational age at delivery (from 32.0 to 36.5 weeks). For the laparoscopically placed abdominal cerclage group, corrected fetal survival did, nonsignificantly, improve for the during-pregnancy procedure (from 96.8% to 100.0%), however, it nonsignificantly declined for the interval procedure (from 97.0% to 95.3%). These results did not differ when the threshold for the number of study participants was enlarged to 15. We also did see a small effect of pregnancy type (studies that included only singleton pregnancies) on both primary outcomes. For the open AC abdominal cerclage group, we did

TABLE 3
Interventions and complications during pregnancy after the different procedures of placement of an abdominal cerclage

	Total	LC Preg	LC Int	LC Total	AC Preg	AC Int	AC Total	*P* value		
								LC-AC Preg	LC-AC Int	LC-AC Total
Interventions										
17-hydroxy-Progesterone (%)	21.2 (3.3–48.7)	7.5 (0.0–54.8)	46.1 (0.0–100.0)	4.8 (0.0–17.2)	75.1 (0.3–100.0)	18.4 (0.0–92.3)	34.6 (3.4–77.2)	.18	.73	.10
Tocolysis (%)	30.6 (13.0–51.7)	10.6 (0.0–82.8)	0.6 (0.0–3.5)	7.2 (0.0–27.7)	51.0 (16.1–85.3)	67.9 (46.1–86.3)	49.3 (23.8–75.0)	.31	.00[a]	.01[a]
Complications										
PPROM (%)	6.9 (4.9–9.3)	5.5 (0.3–16.4)	5.2 (2.2–9.4)	5.5 (2.5–9.4)	6.3 (4.3–8.6)	22.1 (1.2–58.4)	7.8 (5.2–10.8)	.86	.19	.33
Chorioamnionitis (%)	0.3 (0.1–0.8)	1.9 (0.5–4.4)	0.0 (0.0–0.7)	0.4 (0.1–1.1)	0.1 (0.0–0.9)	4.9 (0.0–44.4)	0.3 (0.0–1.2)	.06	.40	.97
Other pregnancy complications (%)	3.9 (1.7–7.1)	24.0 (2.7–57.3)[b]	3.5 (0.4–9.4)[b]	2.1 (0.5–4.8)[b]	4.7 (0.4–13.4)[c]	3.0 (0.0–17.1)[c]	4.3 (1.0–9.5)[c]	.13	.93	.31

Data are proportion (95% confidence interval), resulting from random-effects meta-analyses. In each column, not all studies are represented based on available data.

AC, open laparotomy; *GA*, gestational age; *Int*, interval; *LC*, laparoscopic; *LC/AC total*, total number of patients with reported data LC/AC, regardless of timing of surgery (ie, LC/AC Pregnancy+LC/AC Interval+articles that did not report data on AC/LC separately for interval and pregnancy); *NA*, not applicable; *Preg*, pregnancy.

[a] A p-value of ≤ 0.05 was considered statistically significant; [b] Chromosomal abnormalities, maternal disease, placental abnormalities or insufficiency, vaginal blood loss, fetal distress and uterine rupture; [c] Congenital abnormalities, maternal disease, placental abnormalities or insufficiency, fetal distress and uterine rupture.

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not see any notable differences, when compared with the main analysis, on the outcomes, although heterogeneity decreased or remained similar. For the open AC interval procedure, gestational age at delivery nonsignificantly declined (from 32.0 to 26.9 weeks). For the LC placed abdominal cerclage group, no notable differences were observed and the heterogeneity remained similar when compared with the main analysis. Corrected fetal survival and gestational age at delivery for studies that reported on twin or triplet pregnancies and for studies that did not differentiate between the different pregnancy types in their outcomes are depicted in Appendix F.

Comment

Main findings

An abdominal cerclage is often the last resort treatment for women with cervical insufficiency. We performed a systematic review and meta-analysis to provide an up-to-date literature overview of the differences in obstetrical and surgical outcomes between LC and open AC placement for interval and during-pregnancy placed transabdominal cerclages. Although there is a lack of studies with direct comparisons between the different placement methods, we observed similar survival rate and gestational age at delivery for the LC and open AC interval and during-pregnancy groups. In addition, only small differences were seen in perioperative care, surgical complications, interventions, and complications during pregnancy. This suggests that there is no definitive superior method for placing an abdominal cerclage. The overall success rate of abdominal cerclage, independent of technique chosen, is generally high (>90% fetal survival).

Comparison with existing literature

Preterm delivery is accompanied by both high mortality and morbidity. We observed that the survival rate and gestational age at delivery are not statistically different between the methods. Related to this, gestational age at delivery in almost all groups was around 36 to 37 weeks, probably because most

TABLE 4
Pregnancy outcomes of the different procedures of placement of an abdominal cerclage

	Total	LC Preg	LC Int	LC Total	AC Preg	AC Int	AC Total	*P* value LC-AC Preg	*P* value LC-AC Int	*P* value LC-AC Total
GA at delivery (wk)	36.6 (36.3–37.0)	37.2 (36.3–38.2)	37.0 (36.4–37.6)	37.0 (36.5–37.5)	36.3 (35.6–37.0)	32.0 (22.6–41.4)	36.1 (35.5–36.7)	.10	.30	.01[a]
Fetal survival rate (% of total fetus)	91.2 (89.2–92.8)	90.1 (83.3–94.3)	90.1 (83.7–94.2)	91.6 (88.5–93.9)	92.1 (89.0–94.4)	79.2 (67.4–87.4)	90.6 (87.8–92.9)	.48	.04[a]	.67
Corrected fetal survival rate (% of total fetus)[b]	94.7 (93.2–95.9)	96.8 (89.2–99.1)	97.0 (94.1–98.5)	96.2 (93.9–97.6)	93.0 (90.2–95.0)	96.6 (80.0–99.5)	93.7 (91.5–95.3)	.23	.86	.08
- GA ≥34 wk (% of viable fetus)	91.8 (87.1–94.8)	90.4 (81.2–95.4)	91.3 (84.8–95.2)	91.9 (88.4–94.3)	91.9 (85.8–95.5)	90.7 (74.3–97.0)	91.9 (87.6–94.8)	.72	.91	.99
- GA <34 wk (% of viable fetus)	7.9 (5.9–10.5)	9.6 (4.6–18.8)	8.7 (4.8–15.2)	8.0 (5.6–11.4)	8.1 (4.5–14.2)	9.3 (3.0–25.7)	8.1 (5.2–12.4)	.72	.91	.96
- GA <30 wk (% of viable fetus)	0.9 (0.4–2.4)	2.1 (0.3–13.4)	1.0 (0.1–6.6)	1.5 (0.7–3.5)	1.6 (0.5–5.2)	0.2 (0.0–42.8)	0.6 (0.1–3.0)	.80	.64	.32
- GA <28 wk (% of viable fetus)	0.8 (0.3–1.8)	0.0 (0.0–100.0)	0.3 (0.0–28.7)	1.5 (0.6–3.7)	0.6 (1.0–3.1)	1.2 (0.1–11.6)	0.4 (0.1–2.3)	1.00	.63	.22
Total fetal loss (% of total fetus)	8.6 (6.8–10.5)	7.5 (3.6–12.8)	9.7 (4.8–16.1)	7.9 (5.4–10.8)	7.7 (5.3–10.5)	21.1 (12.2–31.7)	9.1 (6.8–11.7)	.94	.05[a]	.52
First trimester loss (% of total fetus)	2.1 (1.1–3.3)	1.8 (0.0–6.2)	6.0 (2.0–12.0)	3.1 (1.4–5.4)	0.4 (0.0–1.2)	12.5 (3.6–25.9)	1.3 (0.4–2.7)	.25	.27	.10
Second trimester loss (% of total fetus)	2.1 (1.3–3.0)	1.9 (0.4–4.5)	2.1 (0.8–3.9)	1.9 (1.0–3.0)	3.4 (1.5–6.0)	2.6 (0.0–10.4)	2.5 (1.3–4.1)	.36	.54	.46
Third trimester loss (% of total fetus)	0.0 (0.0–0.1)	0.0 (0.0–0.2)	0.0 (0.0–0.2)	0.0 (0.0–0.1)	0.0 (0.0–0.3)	0.0 (0.0–0.6)	0.1 (0.0–0.2)	.46	1.00	.20
Birthweight survived neonates (g)	2807.2 (2630.4–2984.0)	2825.6 (2624.1– 3027.2)	2916.9 (2708.2–3125.6)	2904.4 (2775.1–3033.7)	2751.8 (2233.7; 3269.9)	2306.1 (1520.8– 3091.4)	2721.7 (2416.5–3027.0)	.79	.14	.28

Data are proportion (95% CI) or mean (95% CI), resulting from random-effects meta-analyses. In each column, not all studies are represented based on available data.

AC, open laparotomy; *CI*, confidence interval; *GA*, gestational age; *Int*, interval; *LC*, laparoscopic; *LC/AC total*, total number of patients with reported data LC/AC, regardless of timing of surgery (ie, LC/AC Pregnancy+LC/AC Interval+articles that did not report data on AC/LC separately for interval and pregnancy); *NA*, not applicable; *Preg*, pregnancy.

[a] A p-value of ≤ 0.05 was considered statistically significant; [b] Fetal survival rate after correction for first trimester losses.

Hullshoff. Effectiveness of abdominal cerclage: a systematic review. Am J Obstet Gynecol MFM 2022.

women with an abdominal cerclage have planned cesarean deliveries. One study that evaluated the abdominal open AC interval approach showed a very low gestational age at subsequent delivery (26.9 weeks) and a high rate of fetal loss (33.3%), strongly negatively affecting the overall effect estimation of this group.[58] This was shown in the second sensitivity analysis in which this study was no longer included with a relevant improvement in both primary outcomes were observed. Total fetal loss varied between 7% and 21% with a significant difference between the LC (9.7%) and open AC (21.1%) interval procedure. Because second and third trimester losses are similar between these procedures, this significant difference is, to a large extent, because of the high rate of first trimester losses in the open AC interval group. After excluding first trimester losses, the corrected fetal survival was comparable between the approaches and time points. Our findings are in line with earlier systematic reviews by Burger et al[23] and Marchand et al.[24,25] This suggests that none of the approaches in abdominal cerclage placement is superior with regards to the obstetrical outcomes.

Surgery can lead to various perioperative complications sometimes related to the used approach. For the cerclages placed during pregnancy, we observed a lower percentage blood loss (>400 mL) and a slightly lower procedure-related fetal loss, a shorter hospital-stay, but a longer operation duration for the LC group. For the interval cerclages, the LC group showed fewer wound infections and a shorter hospital stay. The significant difference in hospital stay between the open AC and LC groups might be distorted by a very long duration of admission stay of 6 days in the open AC group, caused by a long hospital stay in all included studies in the interval and pregnancy procedure. In our experience, most women leave the hospital within 2 to 3 days after an open AC cerclage. Although we did not find an explanation for the relative long admission stay reported in the studies, the difference between the open AC and LC groups might depend on local protocols rather than a necessity. The above is in line with Burger et al[23] and Marchand et al[24] who also concluded that LC cerclage placement, in general, may lead to slightly less complications than the open AC procedure.[23,25] These observations suggest that an LC approach might have a slight advantage in terms of surgical outcomes.

Strengths and limitations

Our study has several strengths. This systematic review included all reported studies on transabdominal cerclages with at least 2 patients until February 2022. The included studies had a high mean quality score of 74%. In addition, we provided new data, based on the most recent literature, on the different placement techniques and timing of an abdominal cerclage. Burger et al[23] reported that most transabdominal cerclages were placed by AC.[23] This was reflected in the limited number of inclusions in the LC group. With 1869 women in the LC group and 1529 women in the open AC group, our study does not have this limitation.

Along with research, this study also has some potential methodological imperfections that need to be addressed. First, because there were no randomized controlled trials that directly compared an LC approach with an open AC transabdominal cerclage approach, we only included case series and cohort studies. A potential risk for publication bias and selection bias is present, although funnel plot analyses were only slightly to not indicative of publication bias. Nevertheless, our results should be interpreted with caution. Second, some studies did not mention whether first trimester losses were included in the total fetal survival rate. We tried to correct for this by recalculating the fetal survival rate when studies mentioned the first trimester loss separately. However, this might have led to an overestimation of the total fetal survival rates. This is especially relevant in the interval groups for which several studies only reported on the results of ongoing pregnancies. A complication, however, of the interval procedure is the occurrence of first trimester losses or fetal abnormalities that require surgical abortion. Because of the limited available data, we have not been able to take this important factor on timing preference into account. Third, some studies have included only multifetal pregnancies or both singleton and incidental multifetal pregnancies, which might have influenced our results. However, a sensitivity analysis including only the studies on singleton pregnancies showed similar outcomes when compared with both the main analysis and studies on multifetal pregnancies. An apparent decline in gestational age at delivery and survival was nevertheless observed in the open AC interval subgroup. However, this sensitivity analysis included only 1 study in this subgroup, previously discussed as an outlier,[58] thereby explaining the unexpected negative effect that excluding multifetal pregnancies had on this subgroup. Fourth, we included outcomes from both the index and subsequent pregnancies. We were unable to calculate the number of index and subsequent pregnancies. Outcomes were, however, often not mentioned separately, and especially in studies in which interval procedures or interval and pregnancy procedures were not evaluated separately and not all patients became pregnant, we were unable to retrieve this information. This might have influenced our results. Fifth, some evaluations, mainly in the open AC group, were based on a limited number of women. This might have led to extreme results and significant differences that may disappear when more studies become available. Our results need to be evaluated in this perspective. Sixth, some results might be influenced by the heterogeneity in and differences between the groups. This might have a major influence on the success rates. We observed some differences in the baseline characteristics between the groups. However, to do a valid analysis for this problem, one needs to have individual patient data. Finally, for some secondary parameters, the documentation in the included studies was poor. For instance, we had limited information on timing, drugs used, and

dosage. It is therefore difficult to draw conclusions about these specific results.

Conclusion and implications

Our systematic review and meta-analysis show that although direct comparisons are not available, the LC and open AC abdominal cerclage placed at interval or during pregnancy groups have a similar survival rates and gestational age at delivery. There are only small differences in perioperative care, surgical complications, interventions, and complications during pregnancy. Despite a tremendous amount of additional data, albeit in line with previous meta-analyses, our study cannot conclude that one of the methods are superior for the placement of an abdominal cerclage.[23–25] The preferred method of placement should be determined based on individual patient characteristics and surgical expertise. Our data can help clinicians and their patients in the counseling process on the different approaches of abdominal cerclages. ■

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.ajogmf.2022.100757.

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