

Caesarean section surgical techniques: a systematic review and meta-analysis of the closure of peritoneum and uterus

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ABSTRACT

Objective

To compare the effect of different ways of the closure of peritoneum and uterus in caesarean section

Materials and Methods

We searched for studies from the following databases: Pubmed, Cochrane Library, CKNI, and CSPD from Jan 2000 to Jan 2017. χ^2 test was used to test the heterogeneity and it is considered there was heterogeneity if $I^2 > 50\%$, under which circumstance we used the random-effect model rather than the fixed-effect model.

Results

Non-closure of both parietal and visceral peritoneum was associated with shorter operative time (mean difference [MD]=-5.61, 95%CI : -8.14, -3.07, $P < 0.0001$), without the impact on the additional analgesia given (Relative risk [RR]=0.95, 95% confidence interval [CI] : 0.70, 1.15, $P = 0.40$), the days of hospitalization (MD=-0.05, 95%CI : -0.14, 0.04, $P = 0.09$), the risk of postoperative fever (RR=1.03, 95%CI : 0.73, 1.44, $P = 0.88$), wound infection (RR=0.90, 95%CI : 0.79, 1.04, $P = 0.15$), endometritis (RR=1.06, 95%CI : 0.74, 1.52, $P = 0.76$) and adhesion formation (RR=1.44, 95%CI : 0.58, 3.61, $P = 0.43$). Single-layer uterine closure was linked with a significant reduction of the residual myometrial thickness (RMT) (MD=-1.89, 95%CI : -3.02, -0.75, $P = 0.001$) and operative time (MD=-2.03, 95%CI : -2.77, -1.29, $P < 0.00001$) compared to the double-layer closure. There was no difference when it came to the impact of the risk of wound infection (RR=0.81, 95%CI : 0.73, 0.90, $P = 0.09$), endometritis (RR=0.96, 95%CI : 0.74, 1.52, $P = 0.74$), cesarean scar defects (RR=1.93, 95%CI : 0.12, 30.43, $P = 0.64$) and uterine scar dehiscence (RR=1.82, 95%CI : 0.56, 5.91, $P = 0.32$) in next pregnancy.

Conclusions

There was no significant difference in the short-term effect between the different ways of the closure of the peritoneum and uterus

KEYWORDS: Cesarean section, Closure, Peritoneum, Uterus, Meta-analysis

INTRODUCTION

Cesarean section is one of the most common operations in the world and also the most important procedure when doctors facing peripartum emergencies. The rate of cesarean delivery in the USA of 2015 was 25.8% [1] while the rate in China of

2010 was 52.5% [2]. Although every obstetrician should master the craft of doing a cesarean section, the procedures of the caesarean section have not been completely unified. There are many discussions on the impact of different practices during the procedure, especially the step of closing the uterus and the peritoneum.

The conventional view is that closure of both parietal and visceral peritoneum is necessary to restore the anatomical structure. The Chinese expert consensus published in 2018 [3] also suggested suturing both two layers using a continuous simple pattern. However, whether the closure of peritoneum is indeed beneficial for women has not been determined yet. A prospective cohort study [4] based on 474 women even showed that suturing the visceral peritoneum could lead to a significant increase in blood accumulation in the uterovesical pouch, and was more likely to cause a peritoneal hematoma, postoperative fever and to prolong hospital stay. The Chinese guideline made in 2014 [5] suggests suturing the peritoneum depending on the circumstances.

There are also numerous debates on the way to suture the uterus. It is generally believed that double-layer uterine closure can reduce the occurrence of scar defects and the risk of uterine rupture during the next pregnancy, which is preferred by the Chinese expert consensus [3] too. However, the role of a single vs double layer closure for reducing the subsequent uterine rupture remains controversial [6]. In addition, evidence-based studies showed that there was no significant difference in postpartum short-term complications including surgery duration, postoperative infection, and volume of blood transfusion between the two groups of single vs. double layer uterine closure. A meta-analysis done in 2014 showed [7] the intraoperative blood loss in the single-layer closure group was low, but this result was highly heterogeneous.

Thus, we performed a systematic review and meta-analysis in closure vs. non-closure of the peritoneum (Part I) and single vs. double layer uterine closure (Part II) during C-section. The aim of this article is to study the impact of different ways for the closure of peritoneum and uterus respectively, hoping to give more evidence-based recommendations on how to do the C-section.

MATERIAL AND METHODS

Search strategy

We searched for studies from the following databases: Pubmed, Cochrane Library, CKNI, and CSPD from Jan 2000 to Jan 2017. We used “Caesarean section” (“C-section”, “Cesarean section”) and “peritoneum closure” (“Peritoneum”, “Closure”, “suture”) for Part I, “Caesarean section” (“C-section”, “Cesarean section”), and “uterine closure” (“Uterine”, “Myometrium”, “Closure”, “suture”) for Part II as the search terms.

Study selection

Two authors gathered the data independently. After the authors screened the titles and the abstracts, the duplicates, editorials, retrospective studies, unrelated studies, and letters were excluded. We obtained the full text of the remaining articles to evaluate in detail.

Accepting criteria:

- (1) The randomized control trials (RCTs) on closure vs. non-closure of the peritoneum or single vs. double layer uterine closure during C-section
- (2) Containing observation targets
- (3) Language in Chinese or English.

Exclusive criteria:

- (1) Retrospective studies, Cohort studies, letters or editorials
- (2) Crucial data missed or unclear
- (3) Full text cannot be obtained after we contacted the author.

Quality evaluation

We used the Jadad score [8] to evaluate the selective articles. The total score was 5 and the articles of which the score is higher than 3 are considered high-quality articles.

The evaluation contained following aspects:

- (1) Randomization

- (2) double-blinding
 (3) Withdrawals and dropouts.

Data synthesis and analysis

We used RevMan 5.3 software to analyze all the data. χ^2 test was used to test the heterogeneity and it is considered there was heterogeneity if $I^2 > 50\%$, under which circumstance we needed to use the random-effect model rather than the fixed-effect model.

RESULTS

Closure vs. Non-closure of the peritoneum

We gathered 881 articles totally after searching the databases, including 224 articles in English and 637 articles in Chinese. After removing the articles that did not accord with the inclusion criteria, we read the full text of the left 55 articles. 19 articles were included (n=35743). 16 studies [9-24] (n=32166) focused on Closure vs Closure of only parietal peritoneum and visceral peritoneum, 4 studies [19, 25-27] (n=3636) focused on Closure of both parietal and visceral peritoneum vs. Non-closure of only visceral peritoneum. Among these studies, there was one study focusing on both (Figure 1). The characteristics of the articles were listed in Table 1. The quality assessment of the selected articles was showed in Table 2. Only one study [9] discussed the long-term impact of the closure of the peritoneum on pregnant women, while others focused more on the short-term influence, such as the operative time, postoperative infection, adhesion, etc.

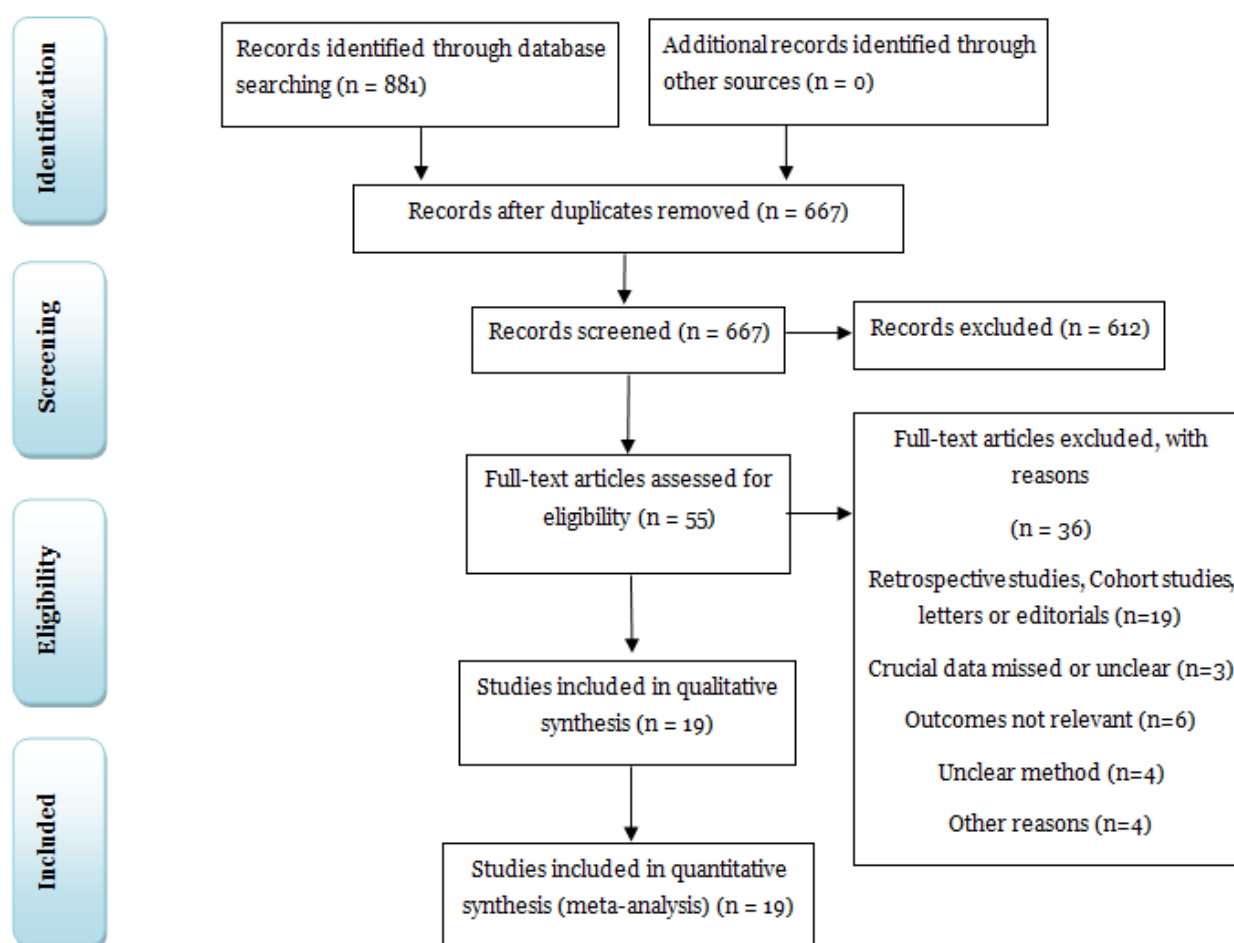


Figure 1: The study selection process in Part I

Study	Area	n			
		Total	NC of both P&V	NC of V	C of both P&V
CORONIS 2016 ^[9]	Argentina, Chile, Ghana, India, Kenya, Pakistan, and Sudan	13153	4087	None	4036
Fahmy 2015 ^[10]	Egypt	80	40	None	40
Rui 2014 ^[11]	Chine	254	124	None	130
CORONIS 2013 ^[13]	Argentina, Chile, Ghana, India, Kenya, Pakistan, and Sudan	15935	4851	None	4824
Tabasi 2013 ^[12]	Iran	100	50	None	50
Kapustian 2012 ^[14]	Israel	535	256	None	277
Ghongdemath 2011 ^[15]	India	200	100	None	100
CAESAR 2010 ^[25]	Britain	3033	None	1515	1512
Ahmed 2010 ^[26]	Egypt	582	None	285	297
Anteby 2009 ^[16]	Israel	533	256	None	277
Malvasi 2009 ^[27]	Italy	112	None	58	54
Zareian 2006 ^[17]	Iran	45	21	None	24
Komoto 2006 ^[18]	Japan	124	54	None	70
Weerawetwat 2004 ^[19]	Thailand	360	120	120	120
Tuncer 2003 ^[20]	Turkey	80	40	None	40
Rafique 2002 ^[21]	Britain	100	50	None	50
Lianxiang 2001 ^[16]	China	139	160	None	158
Galaal 2000 ^[24]	Saudi Arabia	60	30	None	30
Lijuan 2000 ^[23]	China	318	160	None	158
		35743	10399	1978	12247

NC: Non closure; C: closure; P: Parietal peritoneum; V: Visceral peritoneum

Table 1: Characteristics of included studies in Part I

Study	Randomization	Blinding	Follow-up	Total score
CORONIS 2016 ^[9]	2	0	1	3
Fahmy 2015 ^[10]	1	0	0	1
Rui 2014 ^[11]	1	0	0	1
CORONIS 2013 ^[13]	2	0	1	3
Tabasi 2013 ^[12]	2	0	0	2
Kapustian 2012 ^[14]	2	2	1	5
Ghongdemath 2011 ^[15]	2	2	0	4
CAESAR 2010 ^[25]	1	0	1	2
Ahmed 2010 ^[26]	2	2	0	4
Anteby 2009 ^[16]	2	2	1	5
Malvasi 2009 ^[27]	1	0	0	1
Zareian 2006 ^[17]	1	0	1	2

Komoto 2006 ^[18]	1	0	1	2
Weerawetwat 2004 ^[19]	1	2	0	3
Tuncer 2003 ^[20]	1	2	0	3
Rafique 2002 ^[21]	2	1	0	3
Lianxiang 2001 ^[16]	1	0	0	1
Galaal 2000 ^[24]	1	0	1	2
Lijuan 2000 ^[23]	1	0	0	1

Table 2: Methodological quality assessment of included studies in Part I

Compared with the closure group, non-closure of both two layers of the peritoneum was associated with shorter operative time (MD=-5.61, 95%CI : -8.14, -3.07, P<0.0001), without the impact on the need of additional analgesia given (RR=0.95, 95%CI : 0.70, 1.15, P=0.40) and the days of hospitalization (MD=-0.05, 95%CI : -0.14, 0.04, P=0.09). For short term complications, no difference was found between two groups on the risk of postoperative fever (RR=1.03, 95%CI : 0.73, 1.44, P=0.88), wound infection (RR=0.90, 95%CI : 0.79, 1.04, P=0.15) and endometritis (RR=1.06, 95%CI : 0.74, 1.52, P=0.76). When given repeat cesarean section, the risk of adhesion remains the same no matter closing the peritoneum or not in previous time (RR=1.44, 95%CI : 0.58, 3.61, P=0.43). The results are in (Figure 2-5). Four trials [19, 25-27] discussed the difference between the closure of both two layers of the peritoneum and closure of only parietal peritoneum (Figure 6). We observed no statistically different impact on the operative time (MD=-5.64, 95%CI : -12.11, 0.83, P=0.09) between two groups, as well as the risk of complications, like postoperative fever (RR=0.93, 95%CI : 0.54, 1.59, P=0.78), endometritis (RR=1.14, 95%CI : 0.80, 1.62, P=0.78) and postoperative adhesion (RR=0.55, 95%CI : 0.17, 1.75, P=0.31), CORONIS trial [9] made the follow-up interviews via telephone 3 years after the surgery. The results showed that the way of the closure of peritoneum had no significant influence on the risk of pelvic pain, bowel obstruction, ectopic pregnancy, involuntary infertility, etc.

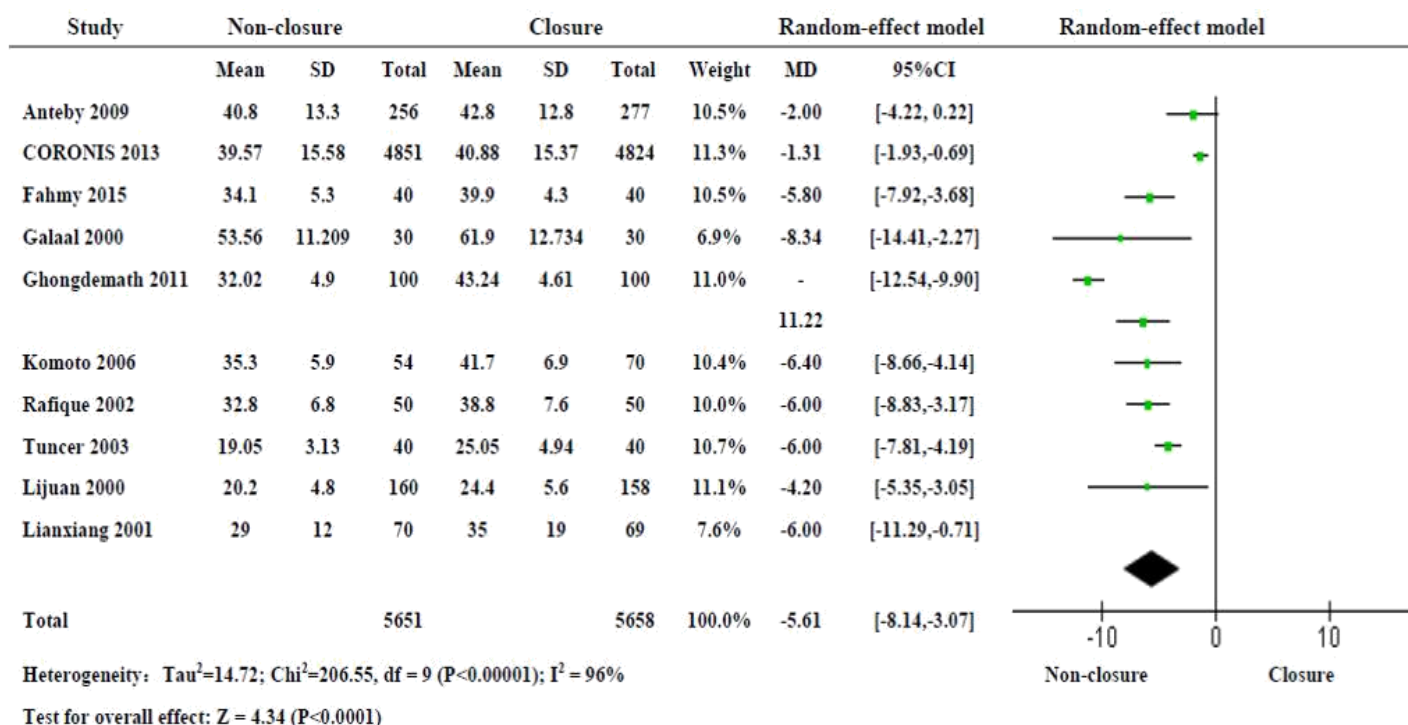
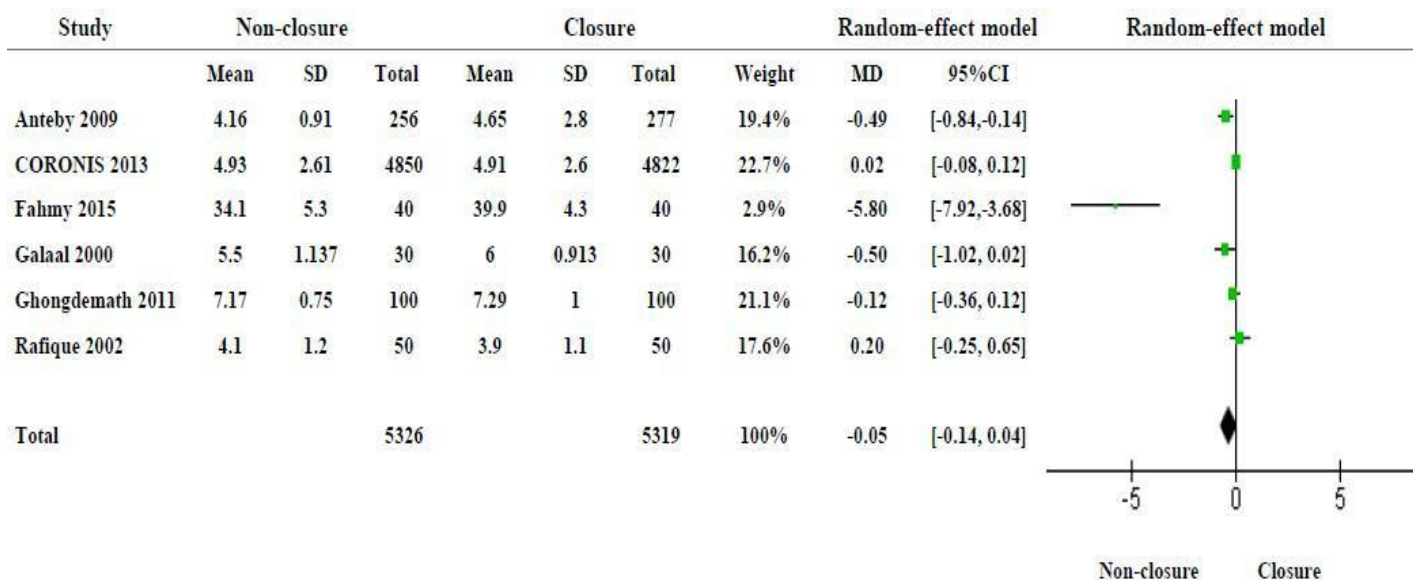


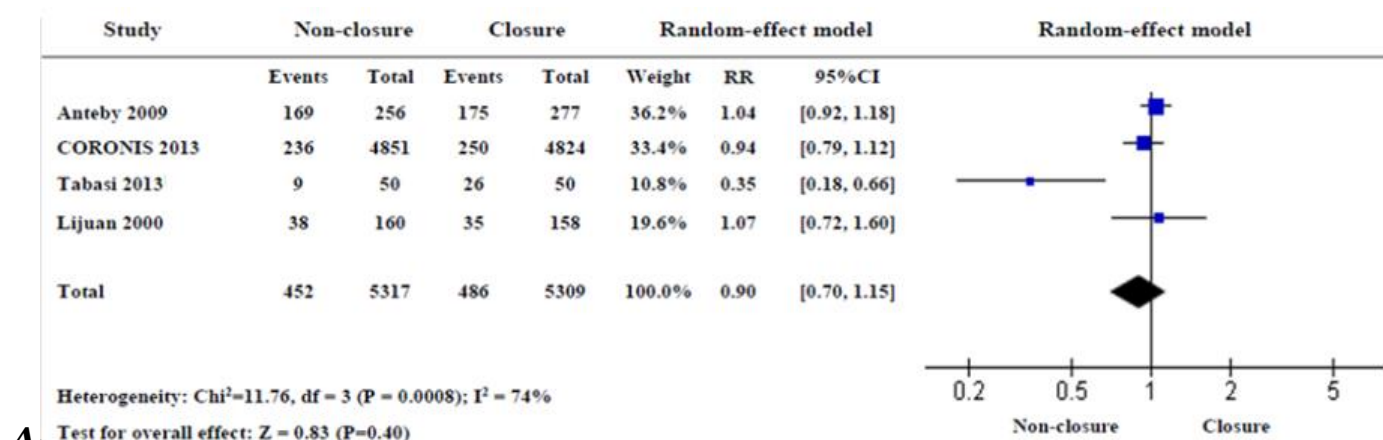
Figure 2: Forest plot for different operative time (minutes) after closure vs. non-closure of the peritoneum. MD, mean difference; RR, relative risk; CI, confidence interval



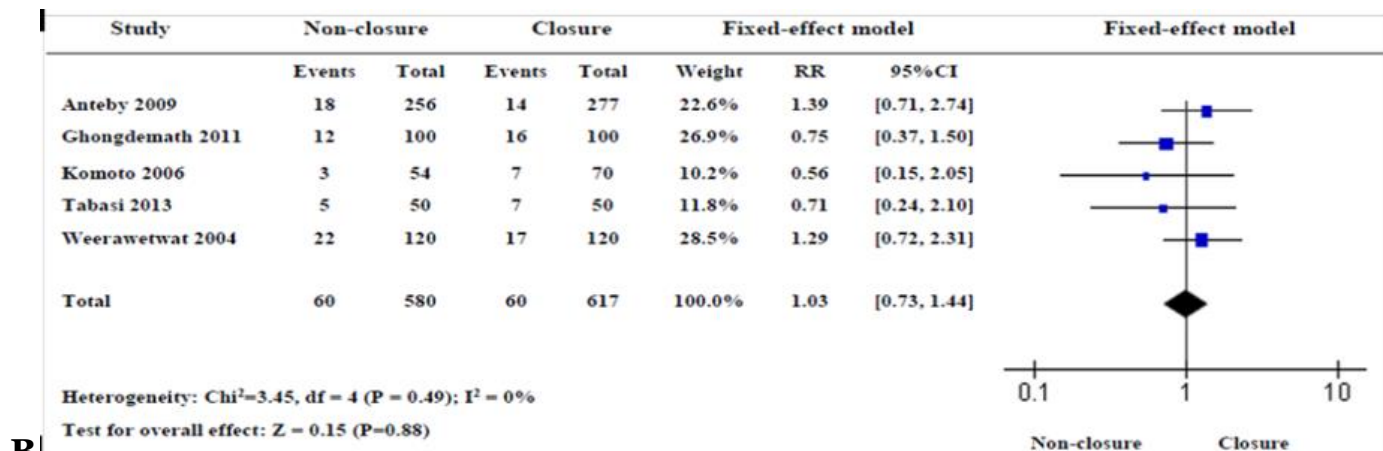
Heterogeneity: $\tau^2=0.17$; $\chi^2=40.63$, $df = 5$ ($P<0.00001$); $I^2 = 88\%$

Test for overall effect: $Z = 1.68$ ($P=0.09$)

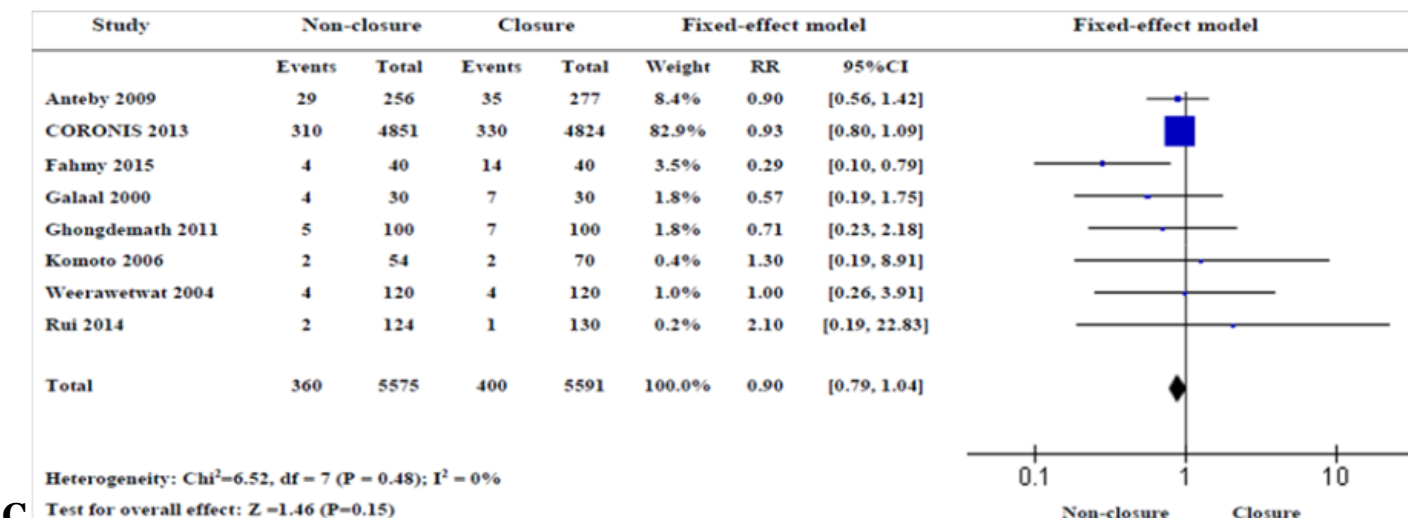
Figure 3: Forest plot for different duration of hospital stay after closure vs. non-closure of the peritoneum. MD, mean difference; RR, relative risk; CI, confidence interval



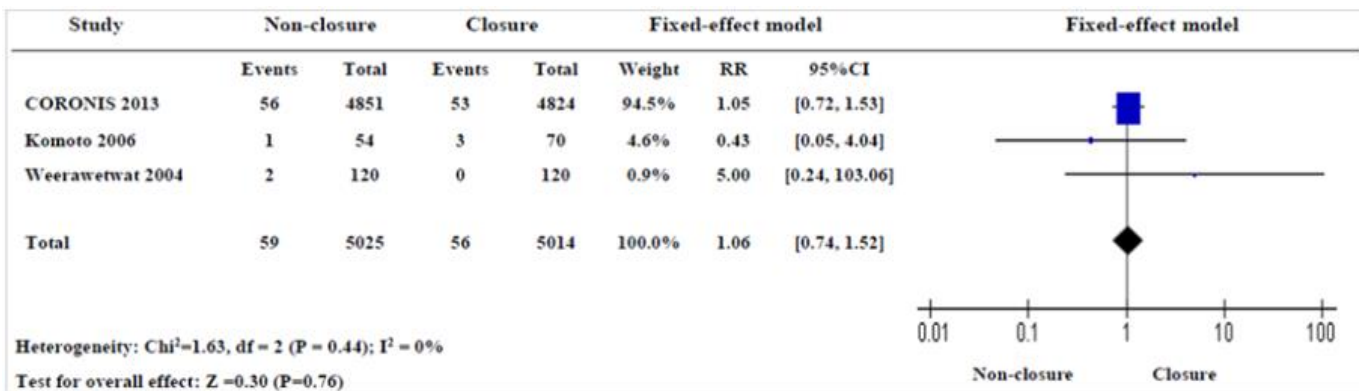
A



B



C



D

Figure 4: Forest plot for short-term complications for closure vs. non-closure of the peritoneum. (a) Need for additional analgesia after the surgery, (b) postoperative fever, (c) wound infection, (d) endometritis. MD, mean difference; RR, relative risk; CI, confidence interval

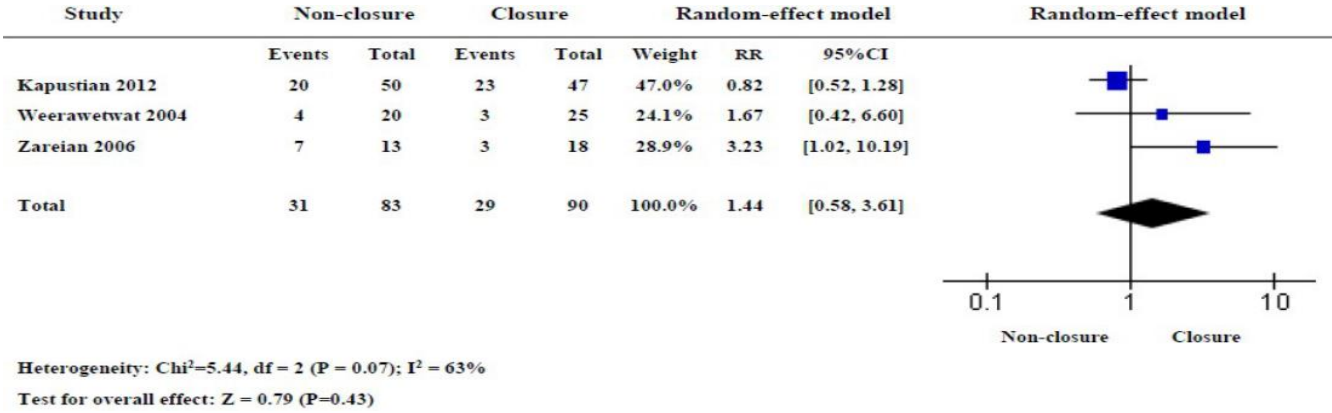


Figure 5: Forest plot for the difference in adhesion formation in next pregnancy after closure vs. non-closure of the peritoneum. MD, mean difference; RR, relative risk; CI, confidence interval

Outcome	Studies (n refs)	Participants (n)	RR or MD (95%CI)	I ²	P Value
Operative time	2 [16,25]	3107	-5.64[-12.11,0.83]	88%	0.09
Postoperative fever	2 [19,25]	3235	0.93[0.54,1059]	0%	0.78
Endometritis	2 [19,25]	126	1.14[0.80,1.62]	0%	0.78
Adhesion	2 [19,27]	49	0.55[0.17,1075]	58%	0.31

Figure 6: Outcomes in randomized controlled trials comparing closure of both two layers of the peritoneum and closure of only parietal peritoneum. MD, mean difference; RR, relative risk; CI, confidence interval

Single vs. Double-layer uterine closure

477 articles were retrieved searching initially. After we excluded repetitive articles, 76 articles were obtained. We read the full text of these articles and included 11 articles [9, 13, 25, 28-35] to analyze (Figure 7). The characteristics of the articles were shown in Table 3. The quality assessment of the selected article was showed in Table 4.

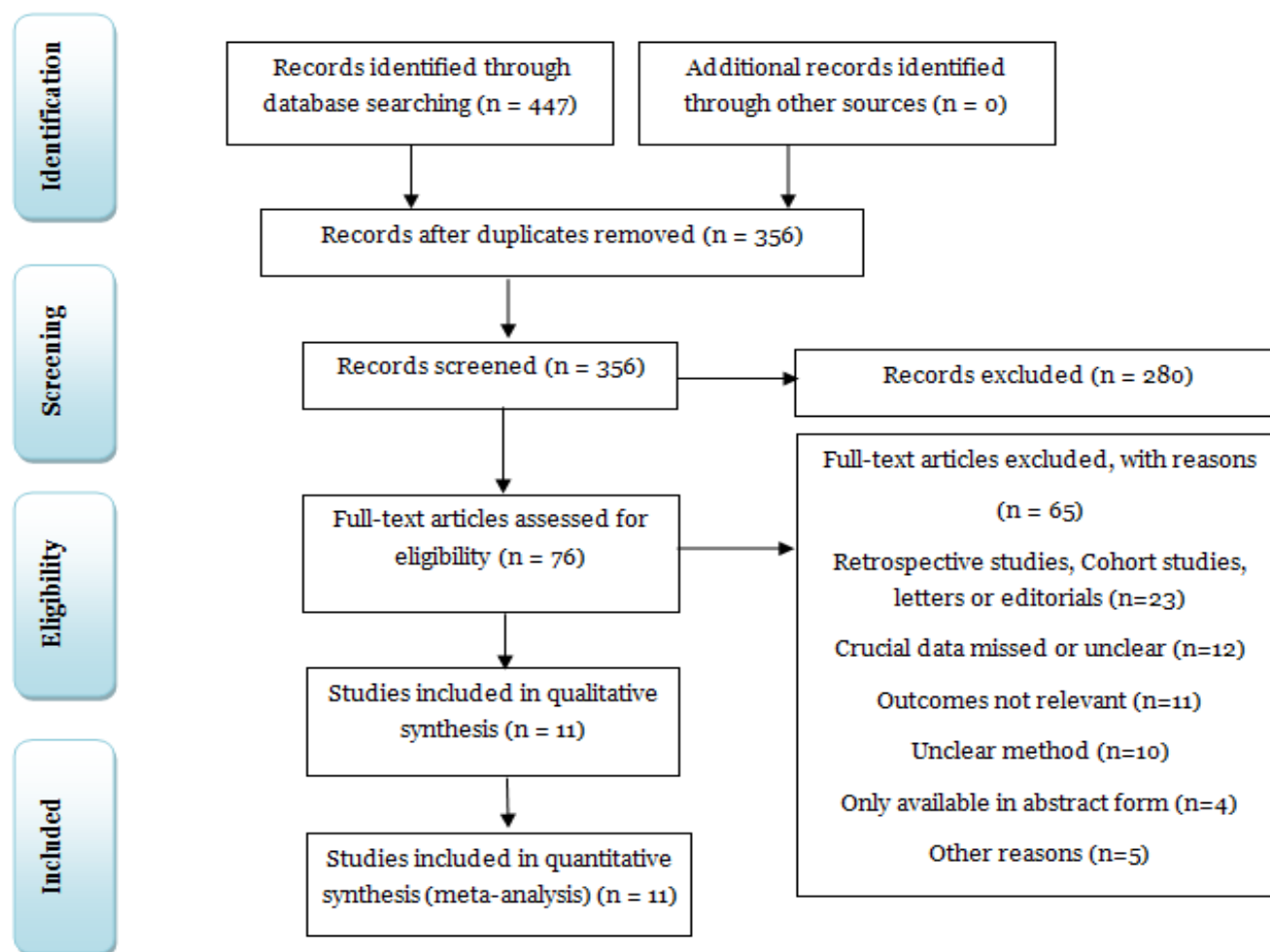


Figure 7: The study selection process in Part II

Study	Area	n	Single Layer	Double Layer
Roberge 2016[28]	Canada	73	Locked	Group A: First layer locked, second layer unlocked, imbricating Group B: First layer unlocked, second layer unlocked
Bennich 2016[29]	Spain	76	Unlocked	First layer unlocked, Second layer unlocked
CORONIS 2016[9]	Argentina, Chile, Ghana, India, Kenya, Pakistan, and Sudan	13153	Not mentioned	Not mentioned
Yan 2015[30]	China	200	Continuous locked	Continuous
Sevket 2014[31]	Turkey	36	Continuous locked	First layer continuous locked, Second layer continuous unlocked
CORONIS 2013[13]	Argentina, Chile, Ghana, India, Kenya, Pakistan, and Sudan	15935	Any accepted technique	any accepted technique
Ling2012[32]	China	200	Continuous	Continuous
Yasmin2011[33]	Pakistan	90	Locked	Group A: First layer locked, second layer continuous unlocked, imbricating Group B: First layer closed by interrupted horizontal mattress sutures, second layer unlocked
CAESAR 2010[25]	UK, Italy	3033	Continuous, locked or unlocked	Continuous, locked or unlocked
Benjamin 2007[34]	USA	60	locked	First layer locked, second layer continuous unlocked, imbricating
Kumar 2005[35]	India	208	Continuous unlocked	Unlocked, imbricating
		18984		

Table 3: Characteristics of included studies in Part II

Study	Randomization	Blinding	Follow-up	Total score
Roberge 2016[28]	2	2	1	5
Bennich 2016[29]	1	0	1	2
CORONIS 2016[9]	2	0	1	3
Yan 2015[30]	1	0	0	1
Sevket 2014[31]	2	0	0	2
CORONIS 2013[13]	2	0	1	3
Ling 2012[32]	1	0	0	1
Yasmin 2011[33]	1	2	0	3
CAESAR 2010[25]	1	0	1	2
Benjamin 2007[34]	1	1	2	4
Kumar 2005[35]	2	0	0	2

Table 4: Methodological quality assessment of included studies in Part II

The RMT at the lower uterine segment is thought to be highly associated with uterine scar defects and uterine rupture [36]. We found that single-layer closure was linked with a significant reduction of RMT (MD=-1.89, 95%CI : -3.02, -0.75, P=0.001) and operative time (MD=-2.03, 95%CI : -2, 77, -1.29, P<0.00001) compared to the double-layer closure. There was no difference between the two groups when it came to the impact of wound infection (RR=0.81, 95%CI : 0.73, 0.90, P=0.09) and endometritis after the surgery (RR=0.96, 95%CI : 0.74, 1.52, P=0.74).

Although single-layer closure was associated with lower RMT, there was a similar incidence of cesarean scar defects (RR=1.93, 95%CI : 0.12, 30.43, P=0.64), as well as uterine scar dehiscence (RR=1.82, 95%CI : 0.56, 5.91, P=0.32) in the next pregnancy. The results were shown in Figure 8. The CORONIS trial [9] also discussed other long-term outcomes including the risk of uterine rupture, placenta praevia, morbidly adherent placenta, abruption, hysterectomy in the next pregnancy. From their data, we did not observe any statistical difference between the two groups (n=1880, P>0.05).

Outcome	Studies (n ^{refs})	Participants (n)	RR or MD (95%CI)	I ²	P Value
Operative time	2 ^[25,35]	3187	-2.03[-2.77,-1.29]	0%	<0.00001
Wound Infection	3 ^[13,25,35]	12473	0.81[0.73,0.90]	81%	0.09
Endometritis	3 ^[13,25,35]	12473	0.96[0.74,1.24]	55%	0.74
RMT	2 ^[34,34]	66	-1.89[-3.02,-0.75]	19%	0.001
Uterine scar defect	2 ^[28,29]	108	1.93[0.12,30.43]	86%	0.64
Uterine dehiscence	2 ^[33,35]	3260	1.82[0.56,5.91]	0%	0.32

Figure 8: Outcomes in randomized controlled trials comparing single vs. double layer uterine closure. MD, mean difference; RR, relative risk; CI, confidence interval

Sensitivity analysis

Sensitivity analysis was performed to reflect the influence of the low-quality trials. For analysis including more than four trials, we excluded trials with Jadad Score less than 3. In the comparison of closure vs. non-closure of peritoneum, after low-quality trials omitted, the MD (95%CI) changed from -5.61(-8.14, -3.07) to -5.31(-9.82, -0.79) in the study of operative time, -0.33(-0.72, -0.05) to -0.09(-0.32, -0.13) in the study of days of hospitalization. The RR (95%CI) changed from 0.95(0.86, 1.06) to 0.98(0.88, 1.10) in the study of the need of additional analgesia given, 1.03(0.73, 1.44) to 1.13(0.78, 1.64) in the study of postoperative fever, 0.90(0.79, 1.04) to 0.93(0.81, 1.07) in the study of wound infection. The sensitivity analysis showed our results are stable.

DISCUSSION

Closure vs. Non-closure of the peritoneum

The closure of peritoneum has been recognized as a standard step in the traditional way for doing the caesarean section for many years, which was thought to have benefits on the reconstruction of the tissue and wound healing. Some studies [17] showed that it was safer to close the peritoneum during the cesarean section. The anatomic and physiologic changes of pregnancy would alter the healing process of the peritoneum. The enlarged postpartum uterus would destroy the supportive matrix, which made the healing of the peritoneum after pregnancy becomes more complicated [17]. The non-closure of the peritoneum was previously thought to have an association with postoperative adhesion, which carried significant morbidity and mortality, including chronic pelvic pain, bowel obstruction, and infertility. Adhesion formation would also increase the difficulty of repeat cesarean section, leading to bowel perforation, ureteral or bladder injury, and vascular injury.

However, from the late 20th century, more and more surgeons doubted the necessity of this step. Ellis et al [37, 38] proved that the closure of peritoneum had no relationship with wound healing and the peritoneal defect which was left open and vascularized would heal rapidly by fibroblast differentiation into a smooth new serosa. Kadanah et al [39] even showed that non-closure of peritoneum at lymphadenectomy in ovarian cancer would reduce the risk of postoperative adhesion. Later, Stark et al [40] conducted a randomized controlled trial on the pregnant women and proved that non-closure of peritoneum would not increase the risk of postpartum hemorrhage, but reduce the use of additional analgesia and the risk of adhesion formation after the cesarean section.

Our meta-analysis showed that closure of the peritoneum had no help to reduce the risk of short-term complications, including postoperative fever, endometritis, infection and adhesion formation, and it would increase operative time significantly. There were also no significant differences in the long-term effect between the two groups. Although only one

article [9] focusing on a comprehensive follow-up study involved in our study, this is a representative, high-quality, and large-scale randomized controlled study, which is highly reliable.

At present, there is no sufficient evidence that the time and consumables required to suture the peritoneum are meaningful. We still need more strong evidence to support whether the closure of peritoneum will reduce postoperative pain, scar tissue adhesion and infertility.

Single- vs. Double-layer uterine closure

Traditionally, the uterine incision was closed with two layers, which was thought to have an association with a lower risk of uterine rupture in the subsequent pregnancy and fewer scar defects. Some surgeons argued that the single-layer closure would help reduce operative time, cause less ischemia and necrosis and introduce less foreign material into the body, which could improve wound healing. And the double-layer closure was based more on tradition rather than evidence-based study [35].

From our data, we found there was no difference between the two groups when it came to the impact of wound infection and endometritis after the surgery. Single-layer closure was linked with a significant reduction of operative time.

What concerned most of the single-layer closure was that it led to the decrease of RMT, which was always thought to be a prediction of fatal complications including uterine scar, uterine rupture and morbidly adherent placenta during next pregnancy? However, there was a similar incidence of cesarean scar defects and uterine scar dehiscence in the next pregnancy from our meta-analysis. The CORONIS trial [9] showed no statistical difference between the two groups on other long-term outcomes including the risk of uterine rupture, placenta praevia, morbidly adherent placenta, abruption, hysterectomy in the next pregnancy.

There were also limitations to our study. Only a limited number of trials focused on long-term effects. Moreover, some results were limited by the high statistical heterogeneity. Measurement in each trial might be different (including the patient's selected criterion, time for the uterine scar defect and postoperative adhesion test). And for some results, we could not do the sensitivity analysis due to a limited number of the articles included.

In conclusion, based on the meta-analysis we did, there was no significant difference in the effect between the different ways of the closure of the peritoneum and uterus. However, based on the limitation mentioned above, more evidence of multicenter RCTs is needed to confirm the results. We believe that the skillful surgeon might choose the one that is more convenient if without any special condition.

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