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Case Report

Comparison of Relapse Rates, Postoperative Infections and Operation Time between BSSO and DO: A Meta-analysis

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Abstract

Purpose: Differences in common complications and operation times suggest that complications after mandibular advancement surgery for Class II mandibular hypoplasia using bilateral sagittal split ramus osteotomy (BSSO) and distraction osteogenesis (DO) require further evaluation. The aim here is to compare relapse and postoperative infection incidences and operation times by meta-analysis to provide information for surgeons in selecting the appropriate surgical method and to inform patients about the complication risks of both.

Method: A comprehensive search using Medline, PubMed, Web of Science, Cochrane Library, EBSCO, CQVIP, CBA, CNKI, and SinoMed and the Internet until February 2017 was performed. Only randomized controlled trials (RCTs), controlled clinical trials (CCTs), and retrospective studies (RS) were included. We performed study selection, data extraction, and risk of bias assessment and meta-analyses with fixed and random effects models based on statistical heterogeneity. Data were combined using Review Manager software.

Results: In total, 388 articles were retrieved; 8 met our inclusion criteria: 4 RCTs, 1 CCT, and 3 RSs. Five of the included articles were analyzed regarding horizontal and vertical relapse. Although horizontal relapse was not significantly different between treatment options (P=0.65), vertical relapse was (P=0.03). Three and 2 studies were included in analyses of postoperative infections and of operation time; both showed significant differences between treatment options (P=0.0009 and P=0.006, respectively).

Conclusion: This analysis revealed lower incidence rates of vertical relapse and postoperative infections after BSSO, with the operation time also being significantly shorter. More high-quality RCTs are needed for a more reliable and convincing conclusion.

Keywords: bilateral sagittal split ramus osteotomy (BSSO); distraction osteogenesis (DO); relapse; postoperative infections; operating time; meta-analysis

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Introduction

Since Trauner and Obwegeser [1] described the bilateral sagittal split osteotomy (BSSO), it has become one of the most commonly used orthognathic surgical techniques for the treatment of Class II mandibular hypoplasia, and it has a high success rate [2]. However, BSSO still has some disadvantages such as increased blood loss, neurosensory disturbance (NSD) of the inferior alveolar nerve (IAN) and relapse, which are the main complications of this procedure despite several modifications [3-8]. The reasons for relapse may be associated with the acute stretching of the soft tissues, including muscles and tendons, the slippage of the osteotomy segments, the condylar sag and changes in the morphology of the condylar head [9-11]. In 1973, Snyder introduced distraction osteogenesis (DO) for the treatment of dentofacial orthopedics, and subsequently, DO has been commonly used in orthognathic surgery [12]. DO may have unique advantages for the treatment of mandibular advancement surgery for Class II mandibular hypoplasia that could overcome the drawbacks of BSSO [13]. However, complications such as long stability, postoperative infections, and injury of the IAN with DO are still controversial [14-16]. The results of comparisons between BSSO and DO are also conflicting in clinical studies [17,18]. Baas and Wijbenga found no significant differences between BSSO and DO in NSD of the IAN or skeletal relapse [19-21] during mandibular advancement surgery. However, Schreuder found that DO had certain advantages over BSSO [13]. Differences in common complications, such as relapse and postoperative infections, and in operation times suggest that complications after mandibular advancement surgery for the treatment of Class II mandibular hypoplasia using BSSO and DO have not been adequately evaluated. It is important that surgeons inform their patients about the advantages and disadvantages of BSSO and DO when choosing between these two surgical procedures.

To date, two meta-analyses have been performed to compare the NSD of the IAN and relapse between BSSO and DO [17,18]. However, no meta-analysis has assessed the differences in postoperative infections or operation time between the two treatment options. Higher rates of postoperative infection and longer operation time are the main shortcomings of DO, and a need exists to compare these factors with BSSO. No new clinical studies of NSD have been performed. The aim of this systematic review and meta-analysis was to evaluate, using an evidence-based approach, the current bibliographic data from published randomized controlled trials (RCTs), prospective controlled clinical trials (pCCTs) and retrospective studies (RS) comparing BSSO and DO in terms of relapse, postoperative infections and operation time (but not NSD) for mandibular advancement surgery to provide information to allow clinicians to choose the best method.

Materials and methods

Information sources and search strategy

We performed a comprehensive search for our topic in Medline, PubMed, Web of Science, Cochrane, and EBSCO in English, in CQVIP, CBA, CNKI, and SinoMed in Chinese, and on the Internet up to February 2017. No limit was imposed on language. The search strategy included the terms ((bilateral sagittal split ramus osteotomy) AND (distraction osteogenesis) AND (postoperative infections OR operating time OR relapse OR skeletal stability OR skeletal class II OR retrognathism) AND (limit to clinical trial OR randomized controlled trial)) in English and Chinese. Because the number of the articles in Chinese was not sufficiently large, we changed the search terms to include ((bilateral sagittal split ramus osteotomy) OR (distraction osteogenesis)). The reference lists of the articles eligible for inclusion were also manually reviewed. In total, 388 articles were found, and 15 articles were included after all available titles and abstracts were screened for the inclusion and exclusion criteria. When the information provided by the titles and abstracts was incomplete, the full texts were carefully read and examined to determine whether they were eligible for analysis. Three review articles [17,18,22], 5 RCTs [23-27], 1 CCT [28], 6 RS [12,19-21,29,30], and 4 articles [19-21,23] were excluded because they analyzed nerve disturbance (Fig 1).

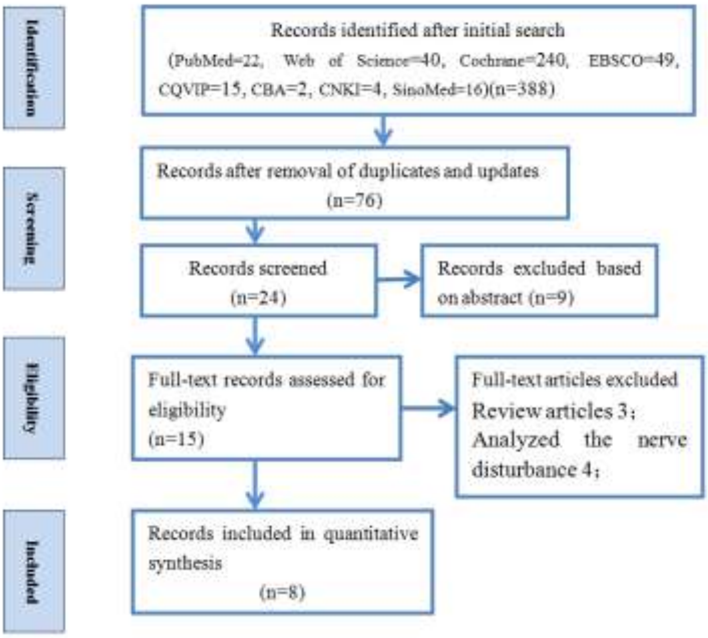


Figure 1 Flowchart of the search and selection procedure

Inclusion and exclusion criteria

The inclusion criteria were based on the patient population or condition, intervention [treatment or test], comparison [group or treatment], outcomes, and setting (PICOS) criteria of the Cochrane Handbook as follows. 1. All patients were without systemic diseases, aged between 14 to 49 years, and had a skeletal diagnosis of Class II mandibular hypoplasia requiring advancement of the mandible to obtain a class I relationship. All patients were treated in the dental hospital by residents undergoing training in oral and maxillofacial surgery. 2. All surgeries in each study were performed by one staff surgeon together with one resident. Cephalographs were obtained preoperatively, postoperatively, and post-distraction; the last study measurement was traced by one person, by hand, and the preoperative orthodontics were also performed by one dentist in all studies. 3. The outcomes included horizontal and vertical relapse, postoperative infections and operation time for BSSO and DO. 4. All studies were clinical studies including RCTs, CCTs and RSs.

Animal studies, in vitro studies, other non-clinical studies, and case reports were excluded.

Risk of bias and quality assessment in individual studies

Two reviewers independently assessed the quality of collected articles, and a third reviewer resolved any possible disagreements through discussion. The risk of bias of the included RCTs was assessed with the Cochrane Collaboration's risk of bias tool, and RSs and pCCTs were assessed with the Newcastle-Ottawa Scale (NOS). For each included RCT, the following domains were considered: random sequence generation, allocation sequence concealment, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other sources of bias. The risk of bias for each domain was categorized as low risk, high risk, or unclear risk. Each RCT was assigned an overall score: low risk (low for all key domains), high risk (high for ≥1 key domain), and unclear risk (unclear for ≥1 key domain). The assessment of articles of non-randomized controlled trials was based on 3 broad perspectives: selection of the study groups, comparability of the groups, and ascertainment of the outcome of interest. The total score on the NOS could be up to 9 stars, and if a study had more than 5 total stars, it was deemed as high quality. Otherwise, it was considered a low-quality study. All included studies were of high quality according to the assessments.

Data extraction

Two reviewers independently extracted the information from each included study, and differences were resolved by consensus. The following information was extracted: investigator, year of publication, study design, age of patients, patient sex (male/female), follow-up period, loss to follow-up, measurements and outcomes, advancement of surgery (Table 1).

Statistical procedures

We used Review Manager software, version 5.3, to combine the data (http://www.cochrane.org). The chi-square Q statistic and the I^2 statistic were used to assess heterogeneity. A value of 0% indicated no observed heterogeneity, 25% indicated low observed heterogeneity, 50% indicated moderate heterogeneity, and 75% indicated high heterogeneity. Meta-analyses were performed based on the value of the chi-square Q and I^2 tests, and fixed and random effects models were used for cases of less than or greater than 50% heterogeneity, respectively.

Results

Horizontal skeletal stability

Five articles [12,24,25,28,29] analyzed horizontal skeletal stability, and 185 patients (BSSO: 93; DO: 92) were included, with a mean age of 21.21 (BSSO: 22.94; DO: 19.49) years. In these studies, the follow-up period was 8-95 months, 33 patients were lost to follow-up (21 in the BSSO and 12 in the DO group), and the mean advancement resulting from surgery was 7.823 mm (BSSO: 7.06 mm; DO: 8.588 mm). Cephalographs were obtained preoperatively, postoperatively, and post-distraction, and the last study measurement in each included study measured the horizontal and vertical relapse. The sensitivity analysis showed a mild difference among these studies with a chi-square value of 10.80 (df=4, P=0.03, I^2=63%). Due to the high heterogeneity, a random effects model was used to analyze these data. The meta-analysis showed no significant difference in horizontal relapse between the BSSO and DO group (Z=0.46, P=0.65, mean=0.12, 95% CI [-0.39,0.63], Table 2). No difference was observed in horizontal skeletal stability after mandibular advancement surgery between the BSSO and DO group.

Table 1 Basic information of the included articles

Investigator	Year	Study Design	Age	Patients (Male/Female)	Follow-up Period	Lost to Follow-up	Measure, Outcome	Advancement (mm)
E. M. Baas [29]	2012	RS	BSSO: 28 (17~50) DO: 20 (14~41)	BSSO: 17 (3/14) DO: 18 (10/8)	46~95 Months	BSSO: 9; DO: 9	SNB, X-B, Y-B	BSSO:7.06 (4~9) DO: 7.94 (5~12)
E. M. Baas [24]	2015	RCT	BSSO: 18.6 (14.3~26.7) DO: 21.3 (14.7~34.8)	BSSO: 29 (12/17) DO: 34 (16/28)	11~50 Months	BSSO: 3; DO: 0	SNB, X-B, Y-B	BSSO:7 (4~12) DO: 7.3 (5~12)
A. Ow, L. K. Cheung [25]	2010	RCT	≥16 Years	BSSO: 8 DO: 6	1 Year	Not mentioned	B-Sny B-Snx Operation time	BSSO: 7.5 (6~10) DO: 7.46 (6~10)
M. D. Vos [12]	2009	RS	BSSO: 28 (17~50) DO: 19 (14~42)	BSSO: 26 (4/22) DO: 27 (14/13)	10~49 Months	BSSO: 9; DO: 3	SNB, X-B, Y-B	BSSO: 7.23 (4~9) DO: 7.81 (5~12)
Jee-Ho Lee [28]	2012	CCT	BSSO: 24.08 (19~34) DO:21.14 (11~29)	BSSO: 13 (4/9) DO: 17 (5/2)	8~12 Months	Not mentioned	X-C, Y-C	BSSO: 6.51 (2~15) DO: 12.43 (7~17)
E. M. Baas [26]	2015	RCT	BSSO: 18.6 (14.3~26.7) DO:21.3 (14.7~34.8)	BSSO: 29 (12/17) DO: 34 (16/18)	9 Days	BSSO: 2; DO: 0	Postoperative infections, Operating time	BSSO: 7.0 (4~12) DO: 7.3 (5~12)
A. Ow, L. K. Cheung [30]	2010	RS	BSSO: 26.5 DO: 25.3	BSSO: 12 (3/9) DO: 11 (2/9)	6~12 Months	Not mentioned	Postoperative infections	BSSO: 7.71±2.19 DO: 8.00±2.4
Ow, L. K. Cheung [27]	2009	RCT	Not mentioned	BSSO: 7 DO: 7	Not mentioned	Not mentioned	Postoperative infections	6~10

Vertical skeletal stability

The basic information was the same as in the horizontal skeletal stability analysis. The sensitivity analysis showed minor differences among these studies, with a chi-square value of 4.67 (df=4, P=0.32, I^2=14%). Due to the low heterogeneity, a fixed effects model was used to analyze these data. The meta-analysis showed statistically significant differences vertical relapse between the BSSO and DO groups (Z=2.20, P=0.03, mean=-0.17, 95% CI [-0.33, -0.02], Table 3). A greater vertical relapse was found after DO advancement surgery, and BSSO produced more vertical skeletal stability than DO.

Postoperative infections

Three studies [26,27,30] that included 100 patients (BSSO: 48, DO: 52) with a mean age of 22.93 (BSSO: 22.55; DO: 23.3) years were analyzed. The follow-up period ranged from 9 days to 49 months, 2 patients were lost-to-follow-up, and the mean advancement resulting from surgery was 7.75 mm. When the heterogeneity was assessed, the chi-square value was 3.14 (df=2, P=0.21, I^2=36%). A fixed effects model was used for the analysis. Statistically significant differences in postoperative infections were observed between the BSSO and DO groups (Z=3.33, P=0.0009, RR=0.20, 95% CI [0.08,0.52], Table 4). The incidence of postoperative infections after DO was 5 times that after BSSO.

Table 2 Horizontal relapse

	BSSO			DO				Mean Difference
Study or Subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, Random, 95% CI**
A. Ow, L. K. Cheung 2010	-1.52	1.77	8	-0.4	1.99	6	5.6%	-1.12 [-3.13, 0.89]
E. M. Baas 2012	0.09	0.38	17	0.09	0.37	18	36.5%	0.00 [-0.25, 0.25]
E. M. Baas 2015	0.448	0.7716	29	-0.324	1.0932	34	30.2%	0.77 [0.31, 1.23]
Jee-Ho Lee 2012	0.56	1.43	13	0.53	1.56	7	10.1%	0.03 [-1.36, 1.42]
M. D. Vos 2009	-0.4	1.8	26	-0.1	1.6	27	17.6%	-0.30 [-1.22, 0.62]
Total (95% CI)			**93**			**92**	**100.0%**	**0.12 [-0.39, 0.63]**

Heterogeneity: Tau² = 0.17; Chi² = 10.80, df = 4 (P = 0.03); I² = 63%

Test for overall effect: Z = 0.46 (P = 0.65)

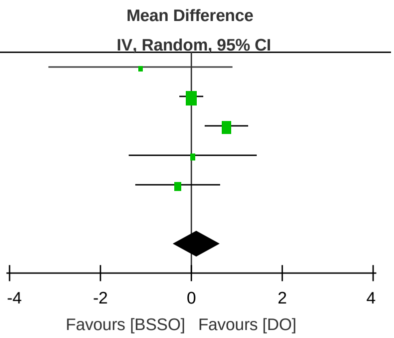


Table 3 Vertical relapse

	BSSO			DO				Mean Difference
Study or Subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, Fixed, 95% CI**
A. Ow, L. K. Cheung 2010	-0.01	1.38	8	0.16	1.09	6	1.4%	-0.17 [-1.46, 1.12]
E. M. Baas 2012	-0.22	0.31	17	0.06	0.25	18	68.8%	-0.28 [-0.47, -0.09]
E. M. Baas 2015	-0.034	0.4988	29	-0.074	0.6977	34	27.4%	0.04 [-0.26, 0.34]
Jee-Ho Lee 2012	0.72	1.61	13	0.56	1.75	7	1.0%	0.16 [-1.40, 1.72]
M. D. Vos 2009	-0.5	2.3	26	-1.1	2.7	27	1.3%	0.60 [-0.75, 1.95]
Total (95% CI)			**93**			**92**	**100.0%**	**-0.17 [-0.33, -0.02]**

Heterogeneity: Chi² = 4.67, df = 4 (P = 0.32); I² = 14%

Test for overall effect: Z = 2.20 (P = 0.03)

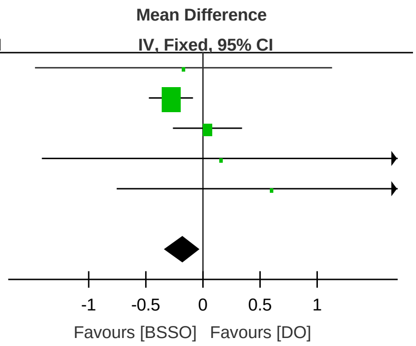
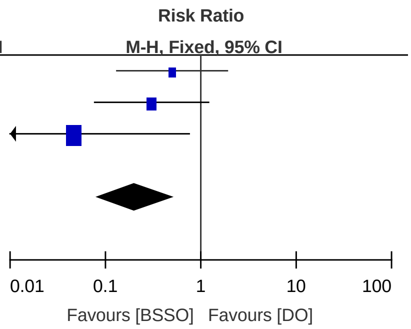


Table 4 Postoperative infections

Study or Subgroup	BSSO Events	BSSO Total	DO Events	DO Total	Weight	Risk Ratio M-H, Fixed, 95% CI
A. Ow, L.K. Cheung 2009	2	7	4	7	18.3%	0.50 [0.13, 1.90]
A. Ow, L.K. Cheung 2010	2	12	6	11	28.7%	0.31 [0.08, 1.21]
E. M. Baas 2015	0	29	12	34	52.9%	0.05 [0.00, 0.76]
Total (95% CI)		**48**		**52**	**100.0%**	**0.20 [0.08, 0.52]**
Total events	4		22			

Heterogeneity: Chi² = 3.14, df = 2 (P = 0.21); I² = 36%

Test for overall effect: Z = 3.33 (P = 0.0009)



Operation time

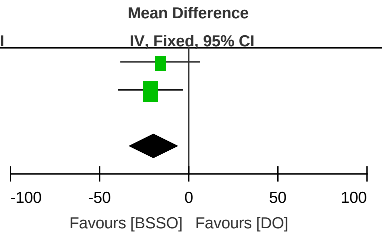
Two articles [26,30] assessed the operation time and included 77 patients (BSSO: 37; DO: 40) with a mean age of 22.93 (BSSO: 22.55; DO: 23.3) years. In these studies, the follow-up period was 8 to 95 months, 33 patients were lost to follow-up (21 in the BSSO and 12 in DO groups), and the mean advancement resulting from surgery was 7.50 mm (BSSO: 7.36 mm; DO: 7.65 mm). The sensitivity analysis showed no differences among these studies with a chi-square value of 0.15 (df=1, P=0.7, I^2=0%). Due to the low heterogeneity, a fixed effects model was used to analyze these data. The meta-analysis showed a statistically significant difference in operation time between the BSSO and DO groups (Z=2.74, P=0.006, mean=-19.36, 95% CI [-33.21, -5.51], Table 5). The operation time was shorter for the BSSO group than for the DO group.

Table 5 Operating time

Study or Subgroup	BSSO Mean	BSSO SD	BSSO Total	DO Mean	DO SD	DO Total	Weight	Mean Difference IV, Fixed, 95% CI
A. Ow, L.K. Cheung 2010	64.13	22.57	8	80.16	19.32	6	39.7%	-16.03 [-38.02, 5.96]
E. M. Baas 2015	78.07	31.23	29	99.62	40.9	34	60.3%	-21.55 [-39.39, -3.71]
Total (95% CI)			**37**			**40**	**100.0%**	**-19.36 [-33.21, -5.51]**

Heterogeneity: Chi² = 0.15, df = 1 (P = 0.70); I² = 0%

Test for overall effect: Z = 2.74 (P = 0.006)



Discussion

The BSSO procedure, which has been continuously improved, has been widely performed in clinics with a curative effect [3,5,31], but it inevitably results in greater rates of soft tissue injury and complications [32,33], especially bad splits, postoperative infections, removal of osteosynthesis material, and NSDs of the lower lip [34]. Sahoo, N found that the mean relapse at the pogonion was

0.2±0.44 mm after mandibular advancement surgery with SSRO [33]. Verweij found that the mean incidence of a bad split was 2.3% per SSO, and the postoperative infection rate was 9.6% per patient [34]. DO has been more widely applied in orthognathic surgery [35] and is a promising treatment that has shown effective improvement, except for the long operation time and other disadvantages [36,37]. DO has a distinct advantage in promoting tissue growth and bone regeneration in mandibular advancement surgery [38,39], but it remains to be further improved in terms of complications [40,41], especially postoperative infections, and long operation time. A review of infections after mandibular DO indicated postoperative infection rates of 6% to 9% [42,43].

Past studies have shown controversial findings regarding the comparison of BSSO and DO after mandibular surgery. Some studies have concluded that DO could be an alternative to BSSO for mandibular advancement for lower skeletal relapse and other complications [39]. However, other studies have concluded that BSSO was more comfortable for patients than DO [26]. Still others studies found no differences between the procedures [12,24]. This systematic review is the first to assess postoperative infections and operation time. A meta-analysis showed that vertical relapse and postoperative infections were lower after treatment with BSSO, and the operation time was significantly shorter with BSSO. Possible explanations for the higher infection rate for DO than for BSSO may involve the open connection between the mouth and the distractor and the longer operation time. Therefore, a modified DO method may include a shortened period after the distraction, resulting in lower infection rates [36,37]. The vertical relapse result in the present study was different from that of Al-Moraissi and Ow, A, who found no difference between BSSO and DO. The reason for this discrepancy may be that new clinical research had been published and was included in our meta-analysis. Al-Moraissi reported that DO reduced the occurrence of NSD of the IAN after mandibular advancement surgery [18]. Our finding regarding horizontal relapse was consistent with the results of Al-Moraissi. It is difficult to draw a conclusion as to which method is better because DO had advantages regarding nerve injury [18], and BSSO had advantages regarding vertical relapse, postoperative infections and operation time. Besides, in the study of Daniel Schneider shown that DO had a highly successful and caused definitive repaire of pharyngeal airway than BSSO, with the airway volumes improved by 6.8 ml with DO and the 5.9 ml with BSSO , and the minimum axial areas of the enlargements by 109.1 mm^2 with DO and 103.1 mm^2 with BSSO ,and the airway areas by 193.8 mm^2 and 185.2 mm^2 [44].

Great caution should be exercised regarding publication bias in studies because it could overestimate and bias the results, leading to improper interpretation of certain data and outcomes. We used funnel plots to analyze the publication bias, and the funnel plots in this review indicated that the included studies were largely within the 95% CI (Figs 2,3,4,5). The funnel plots were almost symmetric for operation time (Fig 5), indicating low publication bias. However, the plots for vertical and horizontal relapse and postoperative infections (Figs 2-4) indicated certain publication bias. Those outcomes should be interpreted cautiously because the total number of high-quality studies was low, and the sample size was small. More high-quality RCTs are needed to provide a more reliable and convincing conclusion.

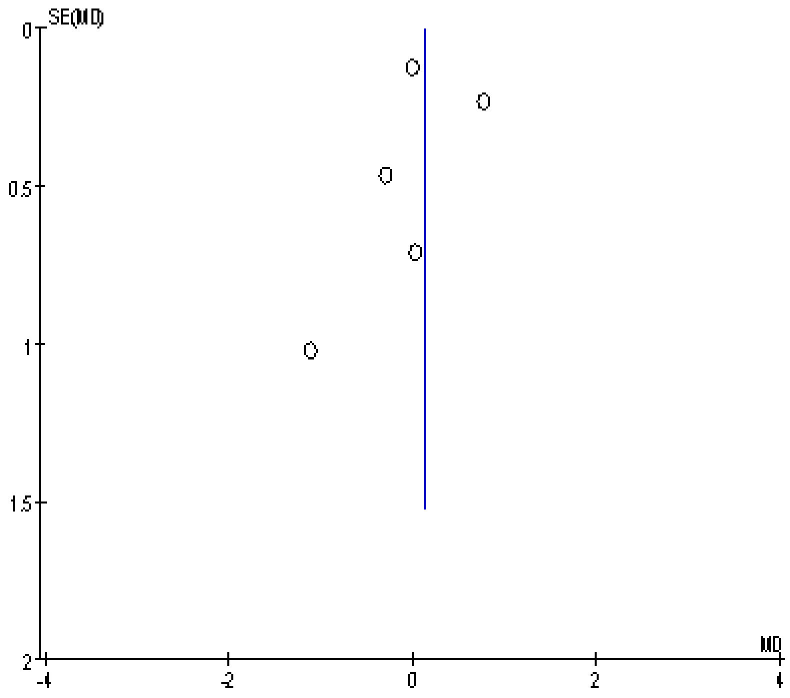


Figure 2 Funnel plot of horizontal relapse

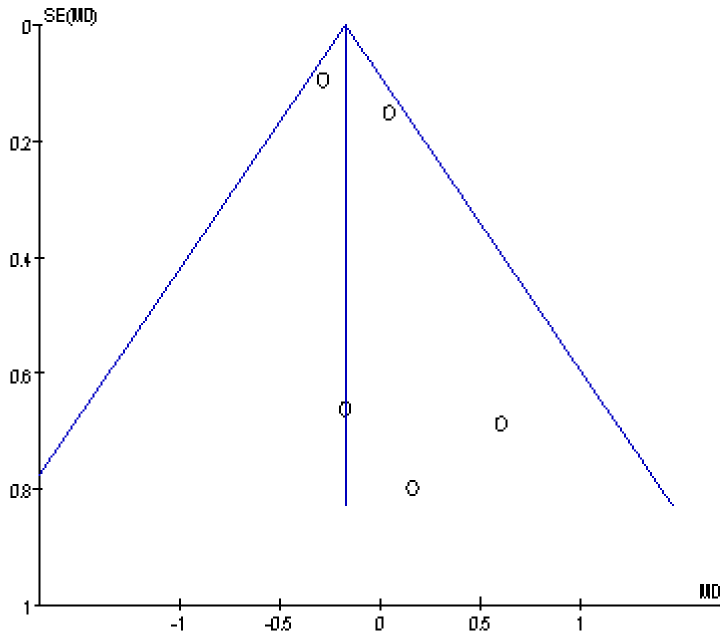


Figure 3 Funnel plot of vertical relapse

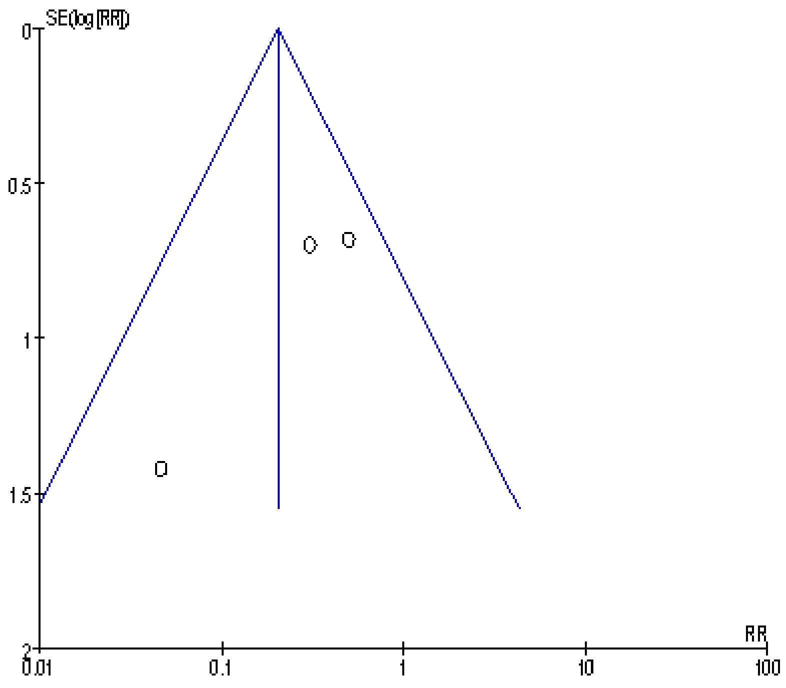


Figure 4 Funnel plot of postoperative infections

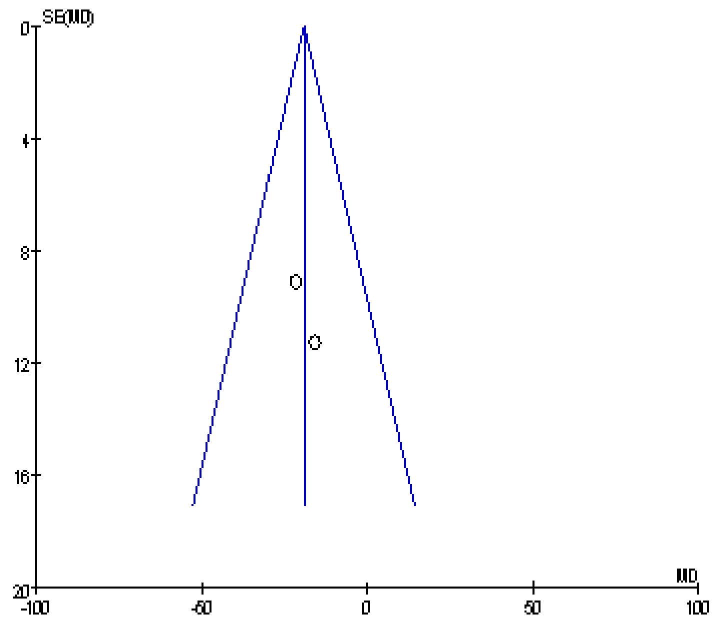


Figure 5 Funnel plot of operation time

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