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Total hip arthroplasty after pelvic osteotomy: a meta-analysis

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Several studies suggested that total hip arthroplasty (THA) was more technical demanding following previous pelvic osteotomy (PO), resulting in poor outcomes compared with primary THA. However, the other studies regarding this topic had reported contradictory results. Therefore, we conducted this meta-analysis to compare the clinical results and other parameters between total hip arthroplasty following pelvic osteotomy and primary total hip arthroplasty. We systematically searched PubMed, the Cochrane Library, EMBASE, Web of Science, Scopus, EBSCO and Web of science from inception to September 2020. This study compared the outcomes between THA following previous PO and primary THA with respect to operative time, blood loss, Harris hip score (HHS), revision rates, complication rates, cup position, cup size, cup coverage and hip joint center. 14 studies with 3913 participants were included. The THA after PO group had longer operative time (MD, 13.8 mins; 95% CI, 4.73 to 22.87 mins; P=0.003), greater blood loss (MD, 82.21 ml; 95% CI, 27.94 to 136.48 ml; P=0.003), worse HHS (MD, -2.79 points; 95% CI, -4.08 to -1.50 points; P<0.00001), smaller acetabular anteversion angle (MD, -3.98°; 95% CI, -6.72 to -1.24°; P=0.004), larger cup size (MD, 1.52 mm; 95% CI, 0.75 to 2.28 mm; P=0.0001), more lateral (MD, 2.83 mm; 95% CI, 1.22 to 4.43 mm; P=0.0005) and superior (MD, 2.26 mm; 95% CI, 1.11 to 3.40 mm; P=0.0001) hip joint center. No statistically significant differences were demonstrated between the THA after PO group and primary THA group in revision rates, complication rates, acetabular abduction angle, cup coverage. THA after pelvic osteotomy was associated with inferior intraoperative outcomes, lower functional scores and worse inferior positioning of acetabular component compared with primary THA. Due to the alerted anatomical structure after PO, the findings of current study implicated that preoperative assessment such as computed tomography scan should be conducted in order to achieve satisfactory results.

Keywords: Pelvic osteotomy, Total hip arthroplasty, revisions, complications, Meta-analysis.

INTRODUCTION

Total hip arthroplasty (THA) remains as widely accepted treatment of end-stage hip diseases, boasting exceptional long-term outcomes and a high success rate. THA is effective in pain relief, mobility enhancement, and joint function restoration. The percentage of THA being conducted on patients is increasing annually[1]. The treatment of early-stage pre-arthritic hip disorders is challenging due to significantly changeable structural deformities and a potential risk for progression of osteoarthritis[2,3]. Pelvic osteotomy (PO) is the optimal management that is developed to readjust the acetabulum positioning for symptomatic hip conditions when osteoarthritis is not present[4,5]. Although many patients with hip disorders benefit from pelvic osteotomy, this surgical technique is unable to prevent the progression of osteoarthritis (OA) of the hip completely. Some patients finally need a conversion total hip arthroplasty (THA) for development of symptomatic OA[6]. A study involved 4862 patients showed that the THA conversion rate was 8.3% with a mean conversion time of 5.8 years after undergoing PO[7]. At 20-year follow-up, the THA conversion rate following PO was 13%[8]. Hence, it is crucial to understand whether the previous pelvic osteotomy affect the outcomes of subsequent THA. To date, the debate regarding this topic is inconclusive. Some researchers suggested that these conversion THA are more technically challenging than primary THA and may jeopardize clinical outcomes with higher revision rates, comparing to primary THA theoretically[9-11]. However, there were several studies reported the results of THA after a previous PO, which had controversial outcomes[12,14].

Yusuke et al.[15] (reported that the clinical outcomes and positioning of acetabular component for THA after PO were worse compared to those of primary THA. However, Parvizi et al.[16] suggested that previous periacetabular osteotomy did not compromise the results of total hip arthroplasty. It is necessary to conduct a meta-analysis for resolving these discrepancies. A previous meta-analysis published in 2018 showed comparable results between THA following PO and primary THA with the respect to functional outcomes and radiographic parameters[17]. Nevertheless, a weakness of the study was that absence of complication rate and revision rates could not provide sufficient and direct information for comparing the outcomes of THA following previous PO with those of primary THA. Therefore, an updated and detailed meta-analysis was carried out to evaluate if previous PO affect the outcomes of conversion THA compared with primary THA. We hypothesized that the outcomes of THA after PO was inferior compared with primary THA.

MATERIALS AND METHODS

This systematic review has been performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Prisma) guidelines[18]. We searched PubMed, the Cochrane Library, EMBASE, Web of Science, Scopus, EBSCO and Web of science from inception to September 2023 for comparative studies involving the clinical efficacy of THA following previous pelvic osteotomy. The search strategy comprised the following keywords, free text terms and MeSH terms relevant to pelvic osteotomy, hip, replacement, arthroplasty and THA. Medical Subject Headings were used in all searches since it was accessible. Moreover, we searched the involved studies and their reference lists to obtain any potentially related articles. Two reviewers finished all the searches individually.

We selected studies if they met the following inclusion criteria: (1) comparative study design; (2) patients undergoing hip replacement following PO and patients undergoing primary THA; (3) reported at least one outcome of operative time, intraoperative blood loss, Harris hip score, complications, revision rates and radiographic parameters.

We excluded studies based on the following criteria: (1) duplicate references; (2) letters, comments, meeting abstract and practice guidelines; (3) data was deficient or inaccessible. Two reviewers separately filtered the titles and abstracts to recognized possibly relevant studies. Full-text papers of include studies were acquired to evaluate additionally after filtering the titles and abstracts of the identified articles. Decision was draw by third senior reviewer as long as disagreement presented. Finally, 49 articles were eliminated after reviewing full-text literature. For example, the trial published Osawa et al in 2017 included the data of total hip arthroplasty following femoral osteotomy was excluded. Similarly, the finding of Fahri et al was excluded due to the data is related with femoral osteotomy.

Data was extracted from the finally included studies by two reviewers. A well-designed data extraction excel database was used for data collection. The recorded items were as follow: general characteristics (first author, publication year, number of participants, age and other baseline characteristics), type of osteotomy, and outcomes of interest (operative time, intraoperative blood loss, Harris hip score, complications, revision rates, cup inclination, cup anteversion, cup size, cup coverage and joint center following THA). We estimated the qualities of the studies with the application of Newcastle-Ottawa scale (NOS)[19] (Tab. II). Three domains were evaluated, and the maximal possible score was nine points. Disagreements between the two authors were resolved by third senior author's decision (Table II).

Data analyses were conducted through RevMan software (version 5.3, Cochrane Collaboration, Oxford, UK). If there were continuous data, the weighted mean difference (WMD) was calculated to evaluate the efficacy of intervention. If there were dichotomous data, we calculated relative risks (RR) and 95% confidence intervals (CI) for each outcome. I2 statistics were applied to identify the presence of heterogeneity among studies. Substantial heterogeneity was measured when I2 value was 50% or higher. A fixed-effects model was performed if the heterogeneity examination presented no statistical significance ($I2<50\%$, $P>0.1$). Or else, the random-effects model was used. We considered $P< 0.05$ as statistically significant. Publication bias was assessed using funnel plots. Sensitivity analysis was conducted to assess the effect of a separate study by eliminating in a random sequence.

RESULTS

According to comprehensive search, 1368 articles were identified. 402 duplicates were excluded and 903 studies were removed after screening the titles and abstracts. In terms of inclusion and exclusion criteria, 49 articles were eliminated after reviewing full-text literature. Eventually, 14 trials were included into our

Table I. — Characteristics of the included studies

Study/year	Country	Cases: previous PO group/ control group	Age: previous PO group/ control group (year)	Female: previous PO group/control group	Type of pelvic osteotomy	Study design	Outcomes
Amanatullah, 2014	USA	23/23	38/38	17/17	PAO	Case-control study	ABCEFG
Fukui, 2015	Japan	22/30	53.6/55.8	18/26	RAO	Case-control study	ABCGHI
Hashemi, 2002	UK	28/50	45/39	17/28	Chiari	Case-control study	DEIJ
Ito, 2015	Japan	44/58	55.6/56.2	40/56	RAO	Case-control study	ABDEFHI
Migaud, 2014	France	78/271	52.2/57.6	72/216	Chiari, Salter, Shelf	Case-control study	C
Minoda, 2006	Japan	10/20	55.4/56.3	10/20	Chiari	Case-control study	ABFGHI
Osawa, 2016	Japan	52/104	56.5/57	46/94	RAO, ERAO	Case-control study	ABCDFGHI
Peters, 2001	USA	13/13	37/41	9/9	Triple Innominate Osteotomy	Case-control study	ABDEJ
Slavkovic, 2013	Serbia	46/47	53.5/55.7	45/47	Chiari	Case-control study	CFH
Tamaki, 2016	Japan	22/2475	56.8/NA	22/NA	RAO	Case-control study	AB
Tokunaga, 2011	Canada	52/51	41/47	43/40	Salter, Chiari	Case-control study	CDF
Yacovelli, 2020	USA	49/147	38/41.7	43/125	Ganz, Shelf, Pemberton, Steel, Dega	Case-control study	ABDEFGI
Yuasa, 2015	Japan	24/24	57.1/59.8	18/19	RAO	Case-control study	ABCDE
Yusuke, 2016	Japan	57/80	56.4/56.7	51/72	PAO	Case-control study	ABCFGH

PO, pelvic osteotomy; RAO, rotational acetabular osteotomy; PAO, periacetabular osteotomy; ERAO, eccentric rotational acetabular osteotomy. A: operative time; B: intraoperative blood loss; C: Harris hip score; D: complications; E: revision; F: cup inclination; G: cup anteversion; H: joint center; I: cup size; J: cup coverage

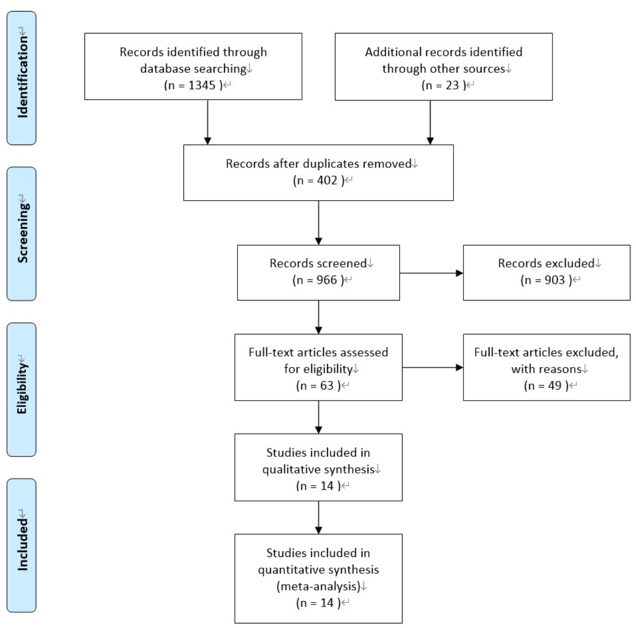

Figure 1.

meta-analysis (Fig. 1). The THA after PO group had longer operative time (MD, 13.8 mins; 95% CI, 4.73 to 22.87 mins; P=0.003), greater blood loss (MD, 82.21 ml; 95% CI, 27.94 to 136.48 ml; P=0.003), worse HHS (MD, -2.79 points; 95% CI, -4.08 to -1.50 points; P<0.00001), smaller acetabular anteversion angle (MD, -3.98°; 95% CI, -6.72 to -1.24°; P=0.004), larger cup size (MD, 1.52 mm; 95% CI, 0.75 to 2.28 mm; P=0.0001), more lateral (MD, 2.83 mm; 95% CI, 1.22 to 4.43 mm; P=0.0005) and superior (MD, 2.26 mm; 95% CI, 1.11 to 3.40 mm; P=0.0001) hip joint center.

These 14 studies enrolled a total of 3913 patients. Of these patients, 520 patients received THA after previous pelvic osteotomy, and the other 3393 patients received primary THA. The baseline characteristics of included trials were summarized in Table I. Four researches study THA following previous rotational acetabular osteotomy (RAO) versus primary THA. In addition, Chiari osteotomy, previous periacetabular osteotomy, Salter osteotomy and triple innominate

Table II. — Newcastle-Ottawa scale

Study, year	Slection	Comparability	Exposure
Amanatullah, 2014	**	*	**
Fukui, 2015	**	*	***
Hashemi, 2002	**	*	**
Ito, 2015	**	*	**
Migaud, 2014	**	*	***
Minoda, 2006	**	*	**
Osawa, 2016	**	*	**
Peters, 2001	**	*	**
Slavkovic, 2013	**	*	***
Tamaki, 2016	**	*	**
Tokunaga, 2011	**	*	***
Yacovelli, 2020	**	*	***
Yuasa, 2015	**	*	**
Yusuke, 2016	**	*	**

osteotomy were carried out before THA in 5, 2, 2 and 1 studies respectively (Table I).

The methodological quality of the included studies was evaluated in terms of the Newcastle-Ottawa Scale (NOS). For all included studies, results of methodological quality assessment based on

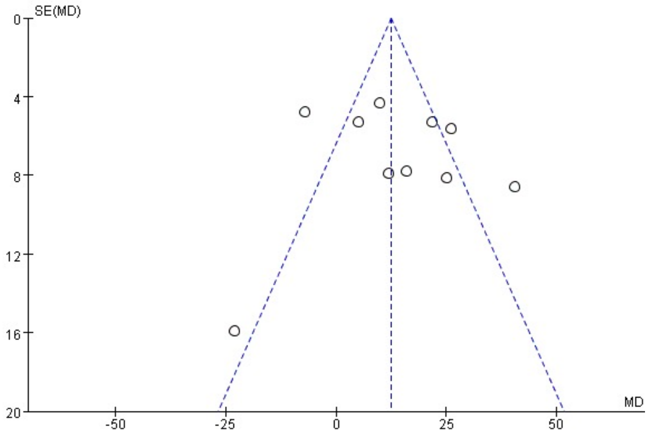

Fig. 2.

Newcastle-Ottawa Scale were summarized in Table II. In the selection domain and in the comparability domain, all studies were awarded two stars and one star respectively. Finally, in the exposure domain, five studies were awarded three stars, and the rest of studies were awarded two stars.

Funnel plot was used to evaluate the publication bias of operative time, which displaced that most studies were within 95% CIs, leaving 4 studies outside the edge. Approximately symmetry was also showed in

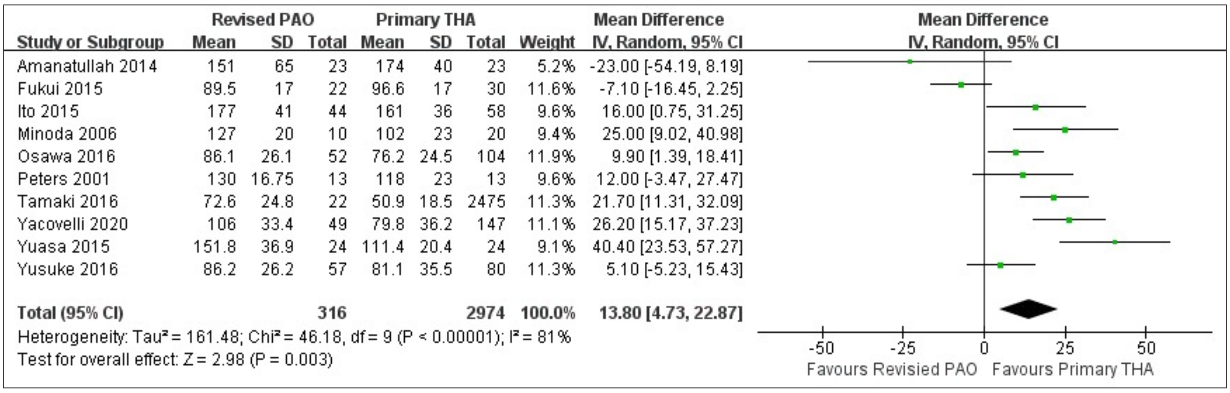

Fig. 3.

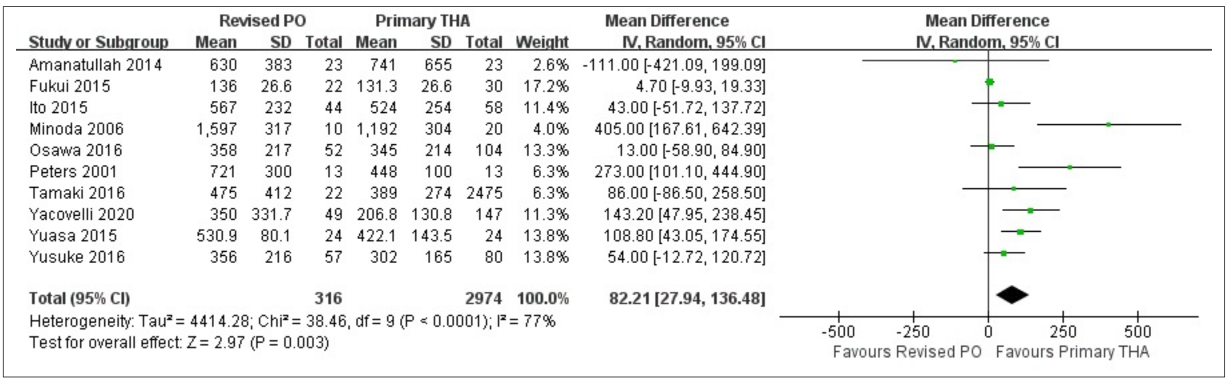

Fig. 4.

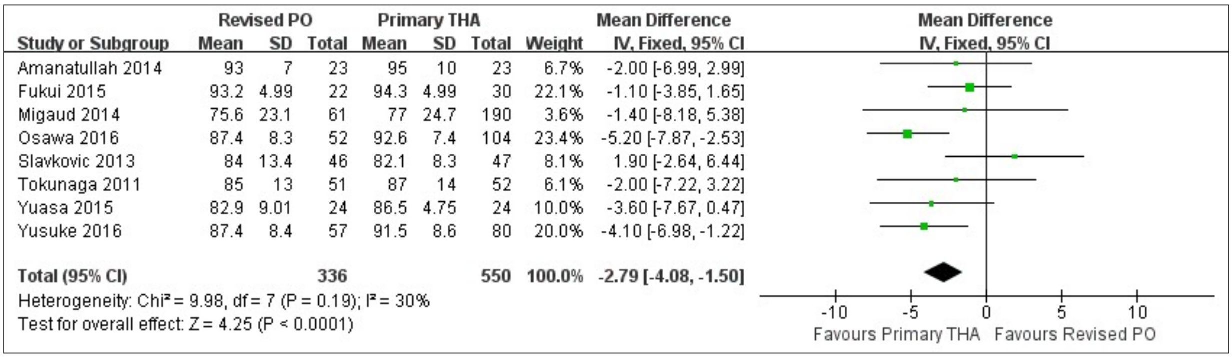

Fig. 5.

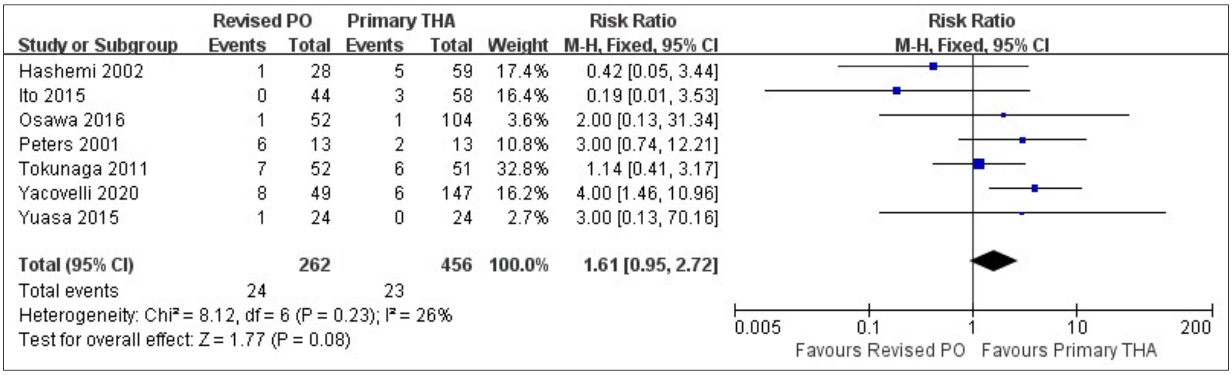

Fig. 6.

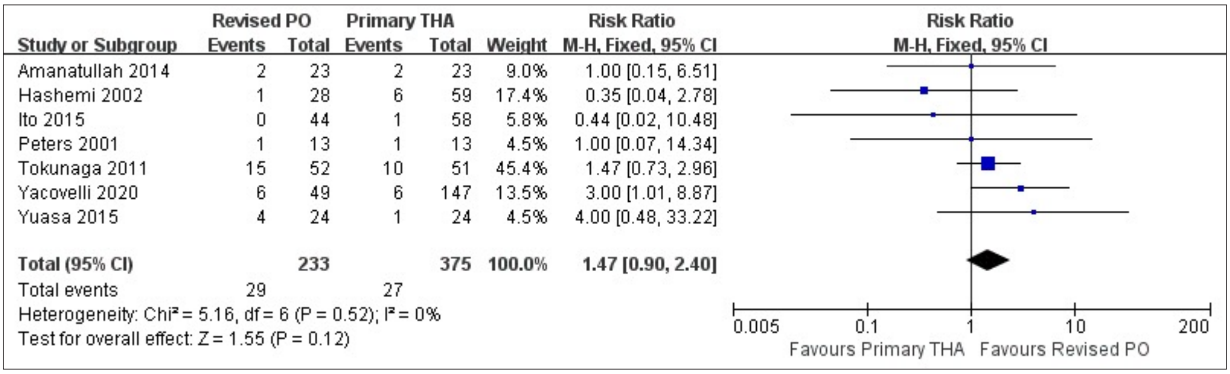

Fig. 7.

the funnel plot which indicated minimal publication bias (Fig 2). The sensitivity analysis was consistent by eliminating separate study in a random sequence and indicated no significant impact on the results.

Meta-analysis of 10 trials with 3290 patients revealed that operative time used for the previous PO group was significantly longer than that used for the primary THA group (MD, 13.8 mins; 95% CI, 4.73 to 22.87 mins; P=0.003) (Fig 3).

Of these 14 trials, 10 trials compared intraoperative blood loss between THA with and without previous PO. Pooled analysis showed that the previous PO group had greater intraoperative blood loss than the primary THA group (MD, 82.21 ml; 95% CI, 27.94 to 136.48 ml; P=0.003) (Fig 4).

Eight studies (N=886) provided the postoperative HHS data. the pooled results indicated that the primary THA group owned a better HHS than the previous PO group (MD, -2.79 points; 95% CI, -4.08 to -1.50 points; P<0.00001) (Fig 5).

Comparison between the groups for complications was recorded in Table III. After acquiring data from 7 studies, we found that 24 of 262 (9.16%) patients in the previous PO group and 23 of 456 (5.04%) patients in

Table III. — Complications following total hip arthroplasty with or without previous pelvic osteotomy

Study	Implant	Number of hips	Dislocation (%)	Fracture(%)	Loosening (%)	Infection (%)	Nerve palsy	VTE
Hashemi	Revised PO	28	0	0	0	0	1(3.6%)	0
	Primary THA	59	0	3(5.1%)	0	0	0	2(3.4%)
Ito	Revised PO	44	0	0	0	0	0	0
	Primary THA	58	0	0	0	1(1.7%)	2(3.7%)	2(3.4%)
Osawa	Revised PO	52	1(1.9%)	0	0	0	0	0
	Primary THA	104	1(0.9%)	0	0	0	0	0
Peters	Revised PO	13	2(15.4%)	3(23.1%)	0	1(7.7%)	0	0
	Primary THA	13	1(7.7%)	1(7.7%)	0	0	0	0
Tokunaga	Revised PO	52	4(7.7%)	1(1.9%)	0	1(1.9%)	1(1.9%)	0
	Primary THA	51	2(3.9%)	3(5.9%)	0	0	0	1(2%)
Yacovelli	Revised PO	49	1(2%)	3(6.1%)	2(4.1%)	2(4.1%)	0	0
	Primary THA	147	4(2.7%)	0	2(1.4%)	0	0	0
Yuasa	Revised PO	24	0	0	0	1(4.2%)	0	0
	Primary THA	24	0	0	0	0	0	0

VTE: venous thromboembolism.

the primary THA group suffered from complications. The forest plot indicated that there was no significant difference between two groups (RR, 1.61; 95% CI, 0.95 to 2.72; P=0.08) postoperatively (Fig. 6).

Data on revisions of THA with and without previous PO were pooled in meta-analysis. Of the 14 studies, 7 studies with 608 patients recorded revision details. The revision rate in the previous PO group (29/233, 12.4%) were higher than in the primary THA group (27/375, 7.2%). However, the pooled analysis indicated that there was no significant difference between two groups (RR, 1.47; 95% CI, 0.9 to 2.4; P=0.12) (Fig. 7).

The radiographic results consist of cup abduction, cup anteversion, cup size, cup coverage and joint center (Fig. 8, 9, 10, 11). Meta-analysis of 6 trials indicated that the primary THA group had greater cup anteversion than the previous PO group (MD, -3.98°; 95% CI, -6.72 to -1.24°; P=0.004). Pooled results showed that cup size was greater in the previous PO group (MD, 1.52 mm; 95% CI, 0.75 to 2.28 mm; P=0.0001). The

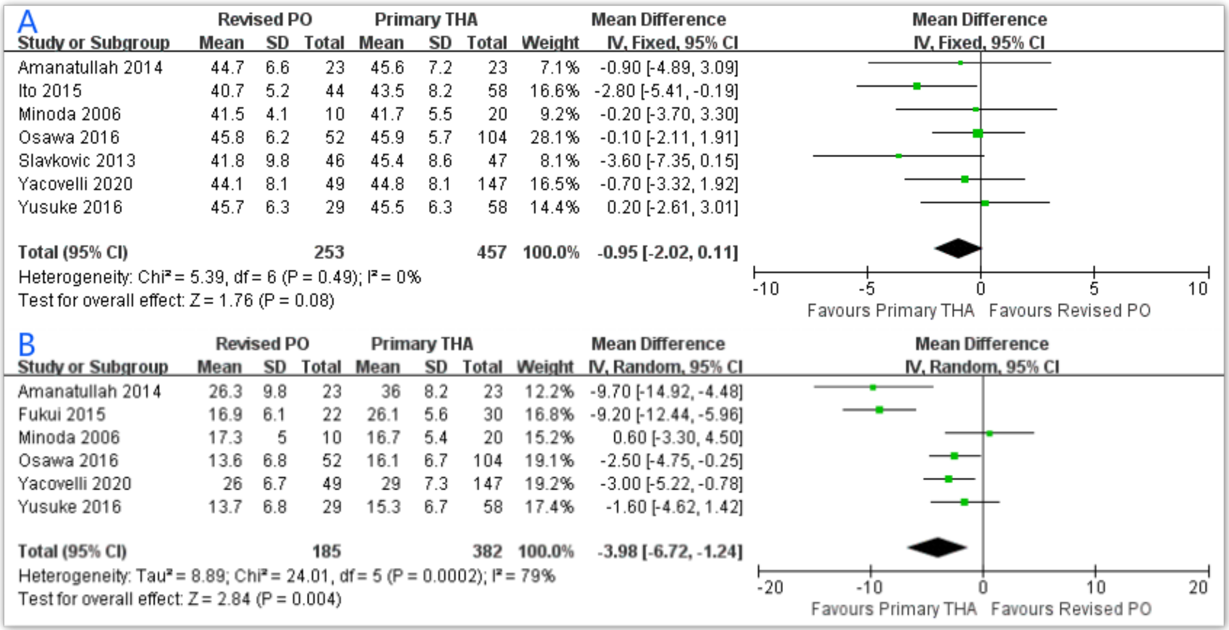

Fig. 8.

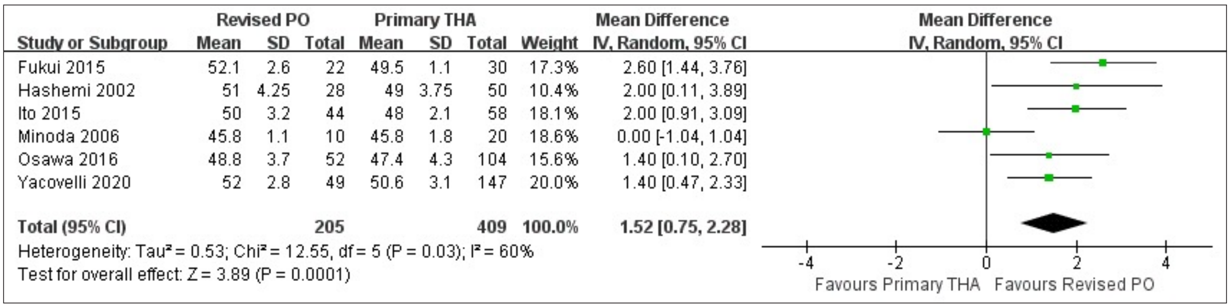

Fig. 9.

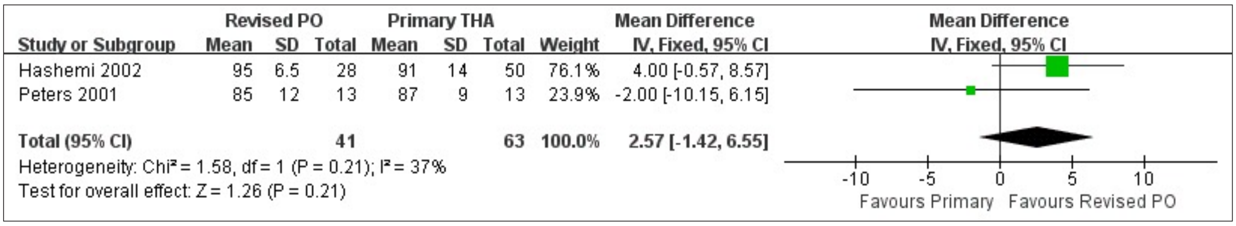

Fig. 10.

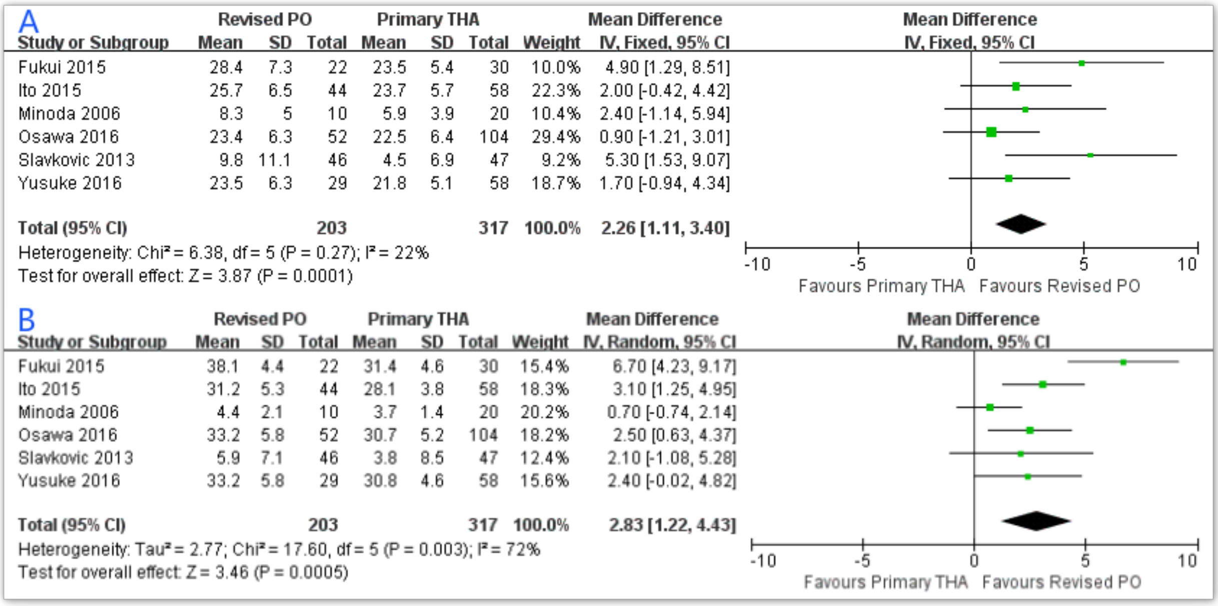

Fig. 11.

pooled data of the vertical and horizontal distance were 2.26 mm (95% CI, 1.11 to 3.40 mm; P=0.0001) and 2.83 mm (95% CI, 1.22 to 4.43 mm; P=0.0005), respectively. These results implied that the joint center of THA following previous pelvic osteotomy was more proximal and lateral compared with primary THA. No significant differences were found between the previous PO group and the primary THA group in terms of cup abduction (MD, -0.95°; 95% CI, -2.02 to 0.11°; P=0.08) and cup coverage (MD, 2.57%; 95% CI, -1.42 to 6.55%; P=0.21).

DISCUSSION

This meta-analysis of studies provided evidence that whether previous PO affect the outcomes of conversion THA compared with primary THA. The major finding was that the THA following previous PO group, compared with control group, reported longer intraoperative time, greater blood loss, worse Harris hip score, greater cup anteversion and cup size, more proximal and lateral joint center. Nevertheless, no statistically significant differences were demonstrated between previous PO group and primary THA group in revision rate, complications, cup abduction and cup coverage. The result that reported on intraoperative time and blood loss during the THA procedures noted increased time and blood loss for the PO group, attributing this result to the difficulty associated with the previous surgery and with complexity of exposure and with the changed anatomy of acetabulum. Above factors may contribute to the worse HHS for the PO group as well. The findings of non-ideal position of acetabular component for the PO group implicated that preoperative CT scan for planning and intraoperative fluoroscopy for identifying hip center are necessary.

Pelvic osteotomy was a proven management used to restore the anatomy of acetabulum, which was effective procedure for preventing progression of osteoarthritis in young patients with dysplastic hips[6,8]. For reasonable selection of patients, outcomes showed that pelvic osteotomy relieve pain and improve hip joint function. However, the effectiveness of pelvic osteotomy wears out over time when a part of patients require conversion to total hip arthroplasty (THA)[20], previous surgical procedure resulted in anatomical modification which were reported to make practice of joint surgery more complex[21,22]. There were conflicting results concerning this topic. Hashemi-Nejad[13] conducted a study that indicated that acetabular component installment is not any more difficult following previous pelvic osteotomy. Ito[14] suggested that functional scores and complication rates were significantly different between THA with and without prior pelvic osteotomy. Therefore, worries were raised that if such PO-THA would show similar outcomes and survival rates compared with primary THA. Only one meta-analysis was performed to explore the effectiveness of THA following previous PO so far[17]. Undeniably, they finished a good job about the analysis. Nevertheless, the absence of outcomes of complications and revisions might be limitations of their study. These limitations were unhelpful for analyzing the influence of prior PO entirely. In addition, a number of studies have been published since then, several of them reported different results and new idea in patients underwent THA following PO[23,24]. In our study, we aimed to conduct a comprehensive and updated comparison between THA following PO and primary THA by investigating complications, revisions, intraoperative, and radiographic results.

For operative time, the pooled outcomes of present study revealed that the operative time of failed PO to THA were significantly greater than that of the primary THAs. Conversion THA after PO may be more technically requiring than primary THA due to the difficulty of changed anatomy of hemipelvis, reception of anterior spur and alerted intraoperative landmarks. Ito[14] reported that removal of osteophytes was[25] needed more frequently in THA following PO. In turn, increased operative time required for THA following PO might be potentially caused by removal of osteophytes compared with primary THA. Furthermore, longer operative time was probably associated with more bleeding volume. The results of our analysis reported a greater intraoperative blood loss in the previous PO group than in the primary THA group.

The Harris Hip Scale (HHS) was often used to assess the results of hip surgery, which was divided into pain domain, function domain and deformity domain (26). Slavkovic[27] stated that the previous PO group had a comparably higher HHS improvement comparing to the primary group. They suggested that similar postoperative functional results could be obtained despite the technical difficulty of anatomical alteration. However, Osawa[15] did not accord with this view. Their study revealed that the outcome of HHS was significantly poorer in THA following PO than that in primary THA. In comprehensive outcomes of present study, the primary THA group yielded superior HHS compared with the previous PO group. This may be due to the surgical complexity, larger volume of blood loss and more significant surgical trauma.

Previous trials have reported contradictory outcomes in terms of revision rate after THA following PO versus that after primary THA[10,11,13,14,20,23,28]. Tokunaga et al.[23] pointed out that revision rates of THA were comparable at a mean follow-up of nearly 8 years between previous PO group and control group (16.7% [PO] compared with 11.6% [control], P=0.09). Yacovelli et al.[24] suggested that alerted anatomy and orientation might lead to more revision cases in prior PO group. However, the evidence of relevant studies was restricted by the limited patient numbers. Hence, the meta-analysis of included studies might be a reliable outcome with relatively high-volume sample size. Results of present study demonstrated that the revision rate of THA following previous PO was no significant difference compared with primary THA. This finding implied that prior PO was not related to worsened survival rate in following total hip arthroplasty. On the other hand, none failure presented in the acetabular side in cases with THA following pelvic osteotomy, supporting the idea that the PO fragment maintains its blood supply and allows porous acetabular components to ingrow[20]. It should be emphasized that pelvic osteotomy was viable method of preserving native hip. Even though for the minority of cases that required conversion to

THA, it did not compromise the long term results of the THA.

For the complications, several studies[10,14,23] have proven that the complication rates did not differ between THA following PO and THA without previous PO. Similar to the previous studies, the pooled outcomes of included trials indicated that the incidences of complication were equivalent between two groups. The findings of present study implied that dislocation was most common complication for THA with previous PO (Tab. 3). Parvizi et al.[16] have reported that prior PO may redirect the anatomy of the acetabulum such that retroversion of the acetabular component may occur, raising the risk of dislocation following THA. Preoperative planning is important, and the surgeons should consider the alerted anatomical structure in these hips. It is practical to use contralateral as reference to prevent implant malpositioning. During THA, intraoperative fluoroscopy is an effective way to improve the accuracy of acetabular component positioning[29].

Placement of acetabular component plays a critical role in instability, range of motion, bearing surface wear rates, and survivorship[30,31]. Inappropriate acetabular component positioning can lead to many problems such as dislocation, component impingement, leg length inequality and mechanical failure. Several studies reported that the percentage of optimal cup positioning was inferior in THA following previous PO based on the Lewinnek's safe zone[15,21]. Previous studies demonstrated that PO could result in acetabular retroversion and insufficient posteroinferior wall, which could affect cup alignment[12,15,20]. Fukui et al.[12] found that anteversion of acetabular components in rotational acetabular osteotomy (RAO) group was smaller than in control group, but stated that the mean anteversion in RAO group was still acceptable. Amanatullah et al.[20] demonstrated that no difference in the mean abduction of acetabular componen in the THA following periacetabular osteotomy group, but the mean anteversion was reduced by 17°. This is consistent with our study. We found that although no significant differences were noted regarding cup abduction, significantly smaller anteversion in acetabular component was found in the previous PO group. Consideration of potential iatrogenic retroversion present at the time of THA was beneficial to achieving satisfactory acetabular positioning. Authors recommended that the use of preoperative computed tomography (CT) scan helped to evaluate three-dimensional construction of acetabulum.

Due to the rotation of osteotomized bone fragment, the posterior wall inclined to present defects even after successful pelvic osteotomy[32]. Variable degrees of the posterior wall defects in acetabulum could lead to an instable fixation of the acetabular component to the host bone. To obtain an adequate bone contact area, larger cup size was used to increase contact area between acetabular component and host bone[33]. Hence, preoperative planning using computed tomography scan or three-dimensional planning software was recommended for the patients underwent PO. Our findings stress the need to assess the anatomy of acetabulum, the surgical approach, the positioning and the size of cup, and bone stock of posterior wall before operation. The outcomes of pooled data showed that cup size was significantly larger in the THA after PO than that in the primary THA group. For obtaining satisfactory cup coverage, installment of larger uncemented acetabular component needs greater bone volume. However, the cup coverage was not significantly different between two groups.

Lateralization or elevation of hip joint center in relation to acetabular teardrop was reportedly experienced by patients who underwent THA following previous PO[9,10,12,14,15,27]. Slavkovic et al.[27] reported that the height of hip joint center in patients operated by previous pelvic osteotomy was greater than that in patients with primary THA. Ito et al.[14] showed that the acetabular socket installation in the previous PO group tended to be more lateralized than in the control group. Osawa et al.[15] demonstrated that the hip joint center of patients with THA following PO was positioned 23.4mm vertically and 33.2mm horizontally. In the present meta-analysis, the statistical results found more lateral and more proximal hip joint center in the patients with THA following PO than in the primary THA group. These might be caused by achieving good cup coverage which improved by rising the hip joint center[34]. Also, previous study found that an elevated acetabular position reduced the risk of significant overhang, ninety percentage of cases with overhang ≥12mm displaced reduced overhang ≤ 12mm with elevating cup position by 7mm[35]. Therefore, properly high hip joint center was worth considering when the severe bone defect and significant overhang presented following previous PO.

There were several drawbacks to this meta-analysis. Firstly, THA after prior pelvic osteotomy is an uncommon procedure. Although our meta-analysis has conducted the relatively large sample size for evaluating the efficacy of THA following previous pelvic osteotomy, the outcomes were still restricted by the limited patient numbers of included studies. Secondly, our study could only enroll published trials. Some nonpublished trials with negative results might be neglected and be the potential cause of publication bias. Thirdly, the lack of randomized control studies might lead to potential bias. However, the quality of this study was guaranteed due to involving only case control studies. This selection allowed the comparison within studies, required for an adequate analysis. Finally, there were diversities of surgical technique regarding pelvic osteotomy among included studies. These factors might also potentially influence the pooled outcomes. As noted above, interpreting the findings should be considered with caution.

This meta-analysis of trials reported that longer operative time, greater intraoperative blood loss, worse HHS, more lateral and more proximal hip joint center, smaller acetabular anteversion angle and larger cup size in patients underwent conversion of PO to THA. However, there were no statistically significant differences between the two groups in complications, revision rates, acetabular abduction angle, or cup coverage. Limitation in explaining the results should be considered, and further high-quality studies with large sample sizes are required. The future studies need to focus on long-term outcomes and survivorship of protheses to provide reliable evidence. Furthermore, the more evidence-based quantitative analysis can be conducted with high-quality studies with large sample sizes and long-term follow-up.

CONCLUSION

In summary, the results of THA following previous pelvic osteotomy was not as favorable as expected. The main findings were that the THA following previous PO group had longer intraoperative time, greater blood loss, worse Harris hip score, greater cup anteversion and cup size, more proximal and lateral joint center. The critical factor affecting the operation complexity and acetabular cup position was alerted acetabular morphology after pelvic osteotomy. Therefore, it is recommended that sufficient assessment using CT scan or three-dimensional planning software should be performed before undergoing the conversion THA.

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