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A meta-analysis of modified Stoppa approach and ilioinguinal approach in open reduction and internal fixation of Pelviacetabular fractures

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Abstract
Background: The two common approaches to operate pelviacetabular fractures are Modified Stoppa Approach (MSA) and Ilioinguinal Approach (IA). The advantage of one approach over the other is debatable. Thus, this meta-analysis was undertaken to compare both the approaches and establish which approach is superior.
Methods: A literature search was conducted using PubMed database for articles comparing MSA and IA for pelviacetabular fractures. Articles were included after thorough perusal by 2 trained authors in accordance with the Cochrane Handbook for potential risk. The articles were rated based on Jadad scale for quality assessment. The data extracted from the articles was evaluated and compared for operative time, intraoperative blood loss, reduction quality, clinical outcome, and complications.
Results: Eventually only 5 articles fitting the inclusion criteria were included in the meta-analysis. Total patients in the MSA group were 186 and that in the IA group were 219. The advantage of MSA over IA was found in the significantly shorter operative time (p=0.0002), better reduction quality (p=0.03) and decreased intra operative blood loss (p=0.002). No difference was found in clinical outcome (p=0.63) and complication rates (p=0.34).
Conclusion: Through this meta-analysis it was established that MSA does offer superior approach in treating pelviacetabular fractures in terms of operative time, reduction quality and intra operative blood loss but shows no difference when it comes to clinical outcome and complications.

Keywords: Pelviacetabular fractures, modified Stoppa approach, ilioinguinal approach, meta-analysis, operative time, complications, blood loss, clinical outcome, reduction quality

1. Introduction
Pelvic ring and acetabular fractures are linked with a high risk of morbidity and mortality due to the substantial haemorrhage and injury to the visceral organs [1]. Acetabular fractures are one of the most troublesome fractures to treat because of the complexity of anatomy, and is considered one of the most challenging surgery for orthopaedic surgeons [2]. The work of Robert Judet and Émile Letournel began our comprehension of surgical approaches, reduction techniques, complications, and results. The anterior ilioinguinal approach (IA) as reported by Letournel (figure 1) in 1961 is the approach of choice for the exposure, reduction, and fixation of fractures involving the anterior column of the acetabulum and the inner surface of the innominate bone [4-9]. It can provide many advantages such as good exposure of acetabular fracture, low sciatic nerve injury rate, easy-to-hide postoperative scar, and swift recovery. The anatomical reduction rate was reported to reach 45% to 74% [10-12].

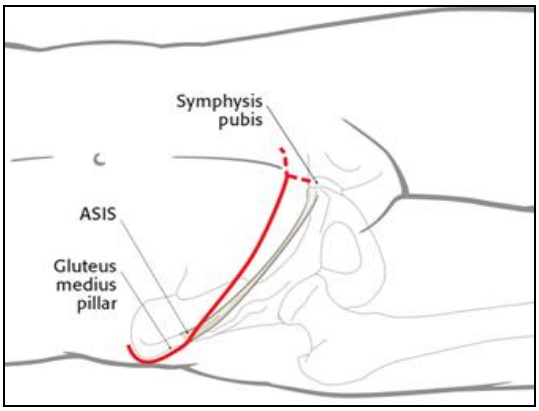

Fig 1: Ilioinguinal Approach

However, it is a laborious and difficult exposure with an innate danger to the neurovascular structures of external iliac and femoral vessels due to their closeness to the surgical plane during the approach [13, 14].

To overcome this Hirvensalo and later Cole described an extra peritoneal Stoppa approach (figure 2) through the rectus abdominis muscle as a substitute approach for internal fixation of fractures of the pelvic ring or acetabulum [15, 16].

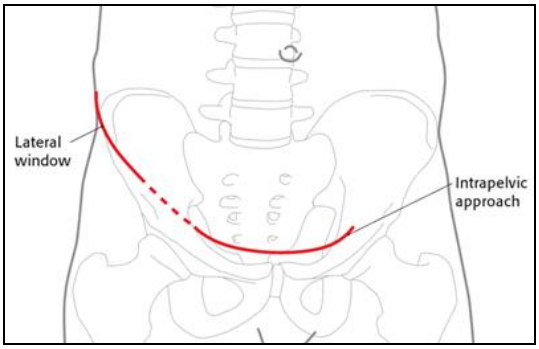

Fig 2: Modified Stoppa Approach.

However, the modified Stoppa approach (MSA) needs much more intricate dissection in the cases with intrapelvic adhesions [17].

Therefore, purpose of this study was to compare and differentiate the Ilioinguinal and Modified Stoppa approach in management of acetabular fractures by performing a meta-analysis.

2. Methods

2.1 Study design

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) and also the Cochrane handbook for systematic reviews of Interventions. The most recent article search of this meta-analysis was up to August 10, 2020.

2.2 Eligibility criteria

2.2.1 Inclusion criteria

1. Target patients of acetabular fracture requiring internal fixation using Ilioinguinal or modified Stoppa approach.
2. Studies comparing the results of modified Stoppa approach with ilioinguinal approach.
3. One or more end result of interest.
4. Articles written in English language.

2.2.2 Exclusion criteria

1. Articles that did not utilize Modified Stoppa Approach or Ilioinguinal Approach.
2. Articles from which data could not be extracted.
3. Articles that did not include one or more end result of interest such as operative time, intraoperative blood loss, reduction quality, clinical outcomes and complications.
4. Articles written in languages other than English.

2.3 Quality assessment

First step was to include studies that met the inclusion and exclusion criteria. The second step was done where the included studies were scrutinized individually based on the Cochrane Collaboration Handbook for potential risk, including selection, performance, detection, attrition, reporting, or other biases.

The quality of incorporated studies was assessed by Jadad scale.

2.4 Data extraction and statistical analyses

Standardized extraction forms were used by experienced authors. Reviewers were not blinded to authors, journal, or any source of financial support or conflict of interest. Difference in opinion was resolved by consensus or by the senior author.

All statistical analysis was executed by review manager 5.3 software. Lack of consistency between studies was methodically tested with a standard chi square test. Continuous data were measured as mean differences, with 95% confidence intervals (CIs). Dichotomous variables were presented as risk ratios (RRs) with 95% confidence intervals (CIs), The associated 95% confidence intervals (CIs) were calculated for each incorporated study, and the statistically significant difference was set at $P \leq .05$.

3. Results

3.1 Literature and study characteristics

As per the analysis 58 studies were identified through the PUBMED data base. After removing the duplicate studies 23 remained. These 23 studies were subjected to the inclusion and exclusion criteria and eventually 18 studies were excluded and only 5 [18-22] studies remained that fit the criteria. The literature data search and screening method are illustrated in figure 3. Table 1 Summarizes the characteristics of each included study. All the included articles had longer than 12-month follow-up. Table 2 Depicts the outcomes measured in each of the included studies.

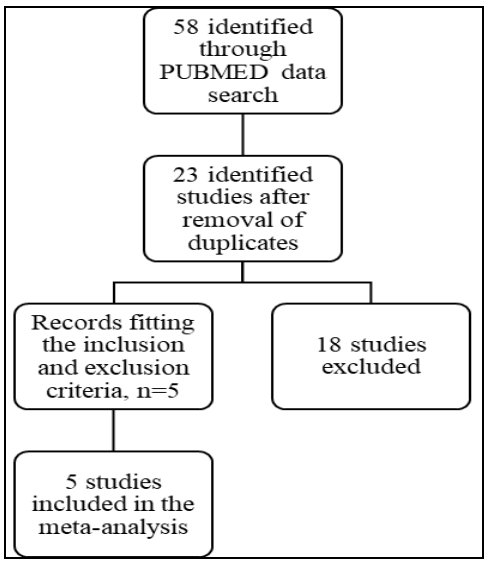

Fig 3: Literature data search and screening.

Table 1: Characteristics of studies included.

S. No.	Study	Year	Type of study	No. of patients		Male:female		Mean age (years)		Follow up (months)	Jadad score
				MSA	IA	MSA	IA	MSA	IA		
1.	Ma *et al.* [18]	2013	RCT	30	30	20:10	17:13	41(33-65)	42(31-62)	34	4
2.	Shazar *et al.* [22]	2014	Retrospective study	103	122	89:14	93:29	41.88 ±15.7	41.4 ±15.4	24	-
3.	Elmadag *et al.* [21]	2014	CC	17	19	14:3	13:6	49.3	52.1	29.6	-
4.	Hammad *et al.* [20]	2015	Retrospective review	21	33	15:6	22:11	32.14 ±13.53	32.12 ±11.29	12	-
5.	Ismail *et al.* [19]	2017	Retrospective study	15	15	10:5	9:6	35.13 ±8.82	32.13 ±15.09	12	-

RCT: Randomized Control Trial
CC: Case Control study
MSA: Modified Stoppa Approach
IA: Ilioinguinal Approach

Table 2: Outcomes measured in different studies.

S. no.	Study	Operative time	Blood loss	Reduction quality	Clinical outcome	Complication rate
1.	Ma *et al.* [18]	+	+	+	+	+
2.	Shazar *et al.* [22]	+	-	-	-	+
3.	Elmadag *et al.* [21]	-	+	-	+	+
4.	Hammad *et al.* [20]	+	-	-	+	+
5.	Ismail *et al.* [19]	+	+	+	-	+

+: Parameter included in study
-: Parameter not included in study

3.2 Quality Assessment

Every included study was assessed as per the Cochrane Collaboration Handbook for potential risk. The risk of bias summary is shown in table 3. The Jadad (fig 4) decision algorithm [23] was used to assess the quality of the studies. Ma *et al.* [18] scored 4 points (maximum: 5), and other articles [19-22] scored 1. This means that among these 5 studies, 1 study was of higher quality.

Item	Maximum Points	Description
Randomization	2	1 point if randomization is mentioned 1 additional point if the method of randomization is appropriate Deduct 1 point if the method of randomization is inappropriate
Blinding	2	1 point if blinding is mentioned 1 additional point if the method of blinding is appropriate Deduct 1 point if the method of blinding is inappropriate
Withdrawals	1	1 point if the number and the reasons for withdrawal in each group are stated

Fig 4: Jadad Scale

Table 3: Bias summary

BIAS	TYPE	Ma *et al.* [18]	Shazar [19]	Elmadag [20]	Hammad [21]	Ismail [22]
Selection Bias	Random sequence generation	+	-	-	-	-
	Allocation sequence	+	?	?	?	?
Attrition Bias	Incomplete outcome data	?	+	+	+	+
Surveillance Bias/detection	Blinding of outcome assessment	+	-	-	-	-
Reporting bias	Selective reporting	+	+	+	+	+
Performance Bias	Blinding of participants and personnel	+	-	-	-	-

+: Low risk of bias.
?: unknown risk of bias
-: High risk of bias

3.3 Functional outcome

Three of the included studies reported on the comparable clinical outcomes. No significant differences were found between these two groups; RR 0.96 (0.80 to 1.150.02 (-0.13 to 0.16), p=0.83, I2 =0%) (Figure 5)

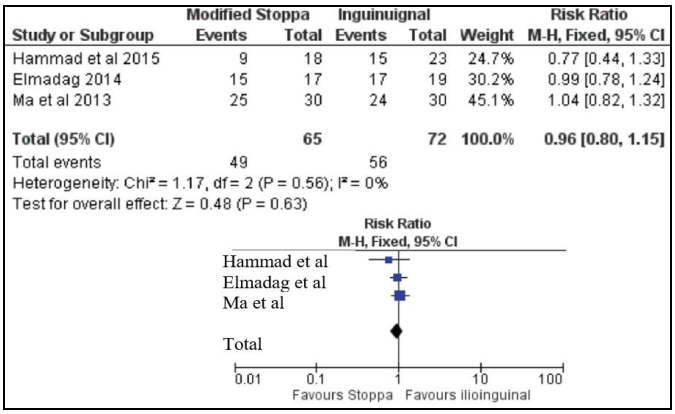

Fig 5: Depicts no difference in the functional outcomes of the said groups

3.4 Complication rate

This meta-analysis suggests no statistically significant difference between the MSA and IA groups (P = .34; 95% CI: 0.28–1.55; figure 6).

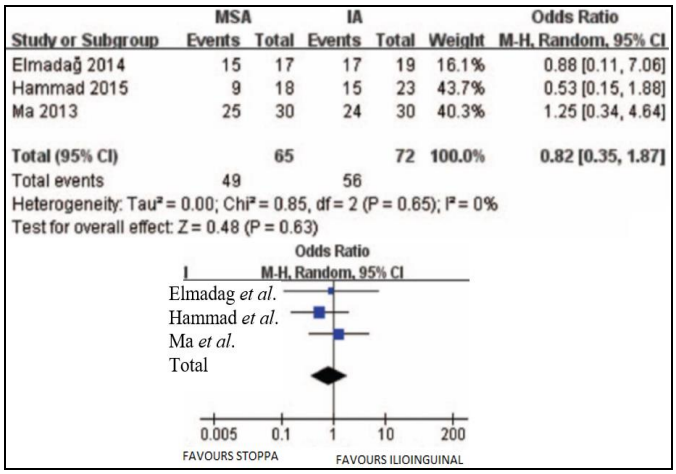

Fig 6: Depicts no difference in complication rates of the 2 groups.

3.5 Operative time

This meta-analysis suggests that the MSA can statistically shorten the operative time as compared with the IA (*P* = .0002; 95% CI: −81.63 to −25.3) as shown in figure 7.

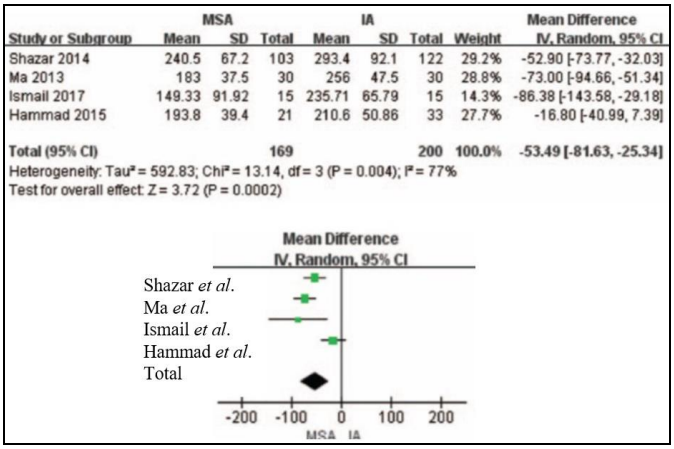

Fig 7: Depicts the shortened operative time in MSA as compared to IA

3.6 Blood loss

The meta-analysis revealed a significant difference between the 2 groups in intraoperative blood loss (*P* = .002; 95% CI: −446.11 to −97.07; figure 8).

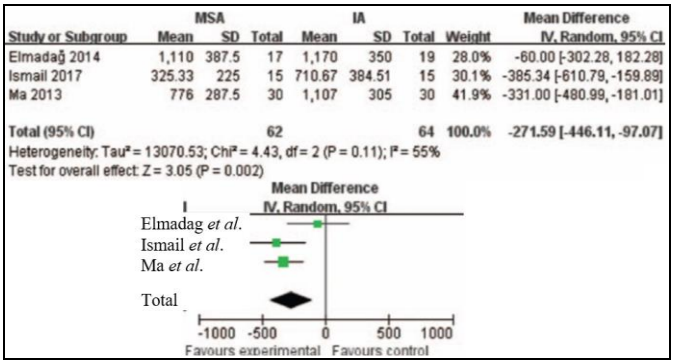

Fig 8: Depicts significant difference in the 2 groups

3.7 Reduction quality

Anatomical (<2 mm of displacement) and satisfactory outcomes (2–3 mm) were considered an excellent quality of reduction. Figure 8 suggests that MSA could attain a better quality of reduction than IA (*P* = .03; 95% CI: 1.08–3.39).

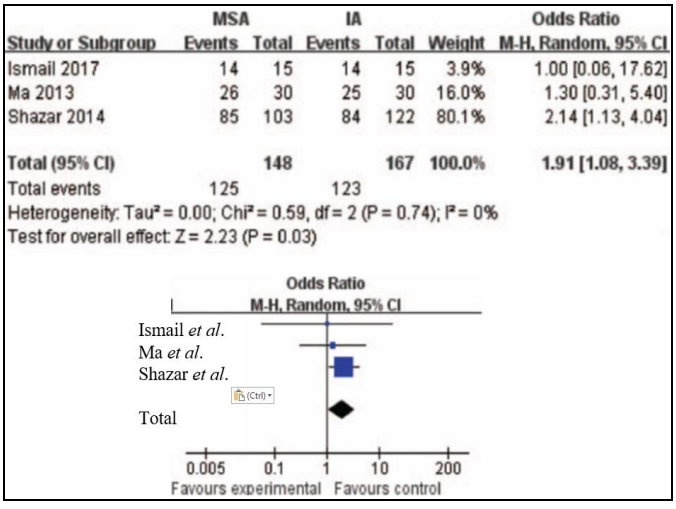

Fig 9: Reduction quality

4. Discussion

This meta-analysis submits that three variables i.e., operative time, blood loss and reduction quality have statistically significant results when comparing MSA with IA. MSA can significantly shorten operative time (*P* = .0002; 95% CI: −81.63 to −25.34), decrease intraoperative blood loss (*P* = .002; 95% CI: −446.11 to −97.07), and provide better reduction quality (*P* = .03; 95% CI: 1.08–3.39) as compared with IA in the treatment of anterior pelvic ring and acetabular fractures. The other 2 parameters of complications and functional outcome found no differences between the 2 groups (p>0.05).

Ilioinguinal approach has endured to be the mainstay approach for fixation of anterior acetabular fractures (anterior column fractures, anterior wall fractures, anterior column with posterior hemi transverse fractures, most fractures of both columns, partial transverse fractures, and T-type fractures) since its description [24]. Drawbacks include the need to mobilize the external iliac neurovascular bundle, the need to open the inguinal canal, and the limited access to the inner aspect of the posterior column and inferior quadrilateral surface. Moreover, the direct visualization of the acetabular articular surface is not possible through the ilioinguinal approach. Consequently, the quality of the articular reduction relies on the quality of cortical osseous reductions of the innominate bone and the confirmation provided by intraoperative fluoroscopy. Described complications include damage to the external iliac neurovascular bundle, bladder injury, anterior thigh numbness, inguinal hernia, thromboembolism, and infection [6, 7].

Initially, Rives *et al*. and Stoppa *et al*. employed the modified Stoppa approach in inguinal hernia surgery [24]. It is advantageous in treating acetabular fractures with anterior column involvement and even considered a superior alternative to ilioinguinal approach [24, 15].

The MSA to the anterior intrapelvic region (brown) allows visualization of

- The pubic symphysis
- The entire quadrilateral surface
- The entire anterior column when combined with a lateral window (blue)

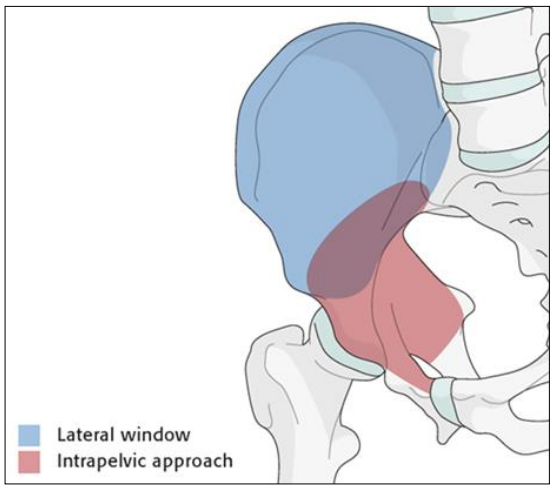

Fig 10: Visualisation in MSA

MSA has its own unique advantages such as it protects the lateral femoral cutaneous nerve and femoral arteriovenous vessels and provides good visualization of the front and inner sides of pelvis and acetabulum.

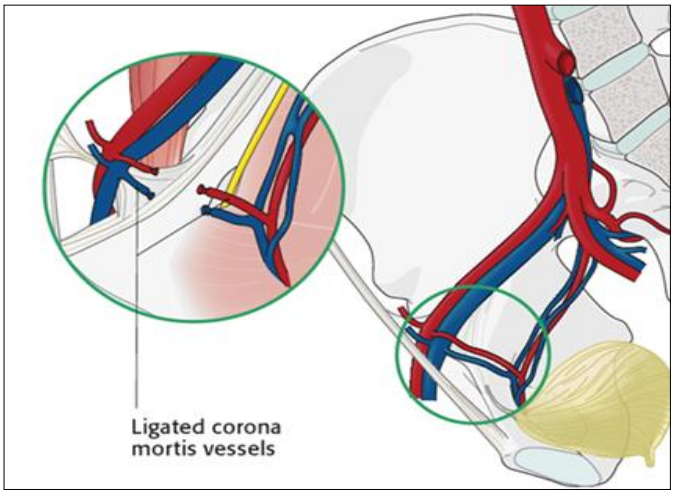

Fig 11: Depicting Corona mortis

Exposing carefully along the medial surface of the superior ramus, the corona mortis vessels are identified and ligated (or clipped) as necessary. These are present in most cases and are usually venous. They can be substantial in some cases.

Recent studies have reported relatively less blood loss and less operative time with Stoppa approach [25]. Otherwise, because MSA needs to expose the corona mortis, the orthopaedic surgeon is required to be fully familiar with the anatomy. Moreover, MSA also has some disadvantages such as neuromuscular injuries [18, 28] (like obturator nerve injury, rectus abdominis atrophy) and peritoneal perforation [10].

Few scholars have conducted systematic reviews or meta-analysis to compare the efficacy between the 2 approaches in the treatment of anterior pelvic ring and acetabular fractures. To the best of our knowledge, only 2 articles [26, 27] have reviewed and analysed the difference between the 2 groups, which included 4 and 5 studies respectively. Meena *et al.* [26] suggested that MSA can provide better reduction quality and lower operative time, which were verified in our research. However, in terms of complication rates, Meena *et al.* suggested that MSA had a lower complication rate than IA, which was different from our results but similar to Wu H. *et al.* [27]. This may be related to the number of articles included and the method of statistical calculations.

This study has several limitations:-

First, only 5 studies with 405 patients were included in this meta-analysis and the sample sizes of the articles were not enough, which may be a potential source of bias.

Second, the details of the operative techniques and preoperative combined injury in each patient were different.

Third, although we searched the most commonly used medical literature databases in strict accordance with the eligibility criteria, this meta-analysis included only 1 randomized controlled trial. Most of the included articles were retrospective studies, which may be a potential source of bias.

Therefore, more high-quality randomized controlled trials are needed to compare the clinical outcomes, radiographic outcomes, and complication rates between MSA and IA in the treatment of anterior pelvic ring and acetabular fractures. Meanwhile, studies with long-term follow-up periods should also be conducted.

5. Conclusion

MSA when compared to IA can:

1. Notably shorten the operative time
2. Reduce the intraoperative blood loss
3. Provide better reduction quality
4. In addition, in terms of clinical outcomes and complications, we found no significant differences between the 2 groups.

High-quality randomized controlled trials with long-term follow-up are needed to verify our results.

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