Indonesian Journal of Global Health Research
Volume 5 Number 2, May 2023
e-ISSN 2715-1972; p-ISSN 2714-9749
http://jurnal.globalhealthsciencegroup.com/index.php/IJGHR

CLINICAL AND FUNCTIONAL OUTCOME BETWEEN ALL ARTHROSCOPIC VS. MINI-OPEN SURGERY IN ROTATOR CUFF INJURY: A META-ANALYSIS

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ABSTRACT

Rotator cuff tear portrays a frustrating experience with shoulder dysfunction and disability. Surgical repair showed satisfactory results when conservative treatment failed or not-indicated. Along with the surgical advancement, mini-open and arthroscopic surgery have a growing preference with minimal scarring, desirable pain relief, and functional improvement. To date, there are inconclusive results on which type of surgery is superior. Functional outcome and complication rates are equally balanced between the two surgeries, while some studies favor arthroscopic repair. The aim of study is to compare the clinical and functional outcome between arthroscopy and mini-open surgery for rotator cuff repair according to recent publications. This study conducted a thorough search for relevant scientific reports on multiple medical databases, including PubMed, Embase, and Google Scholar, using a combination of keywords such as "arthroscopic surgery," "mini-open surgery," and "rotator cuff repair". The search was performed in March 2013-2023, resulted in 576 studies. Two reviewers (SA, SL) independently screened the abstracts and reference lists, with any discrepancies resolved through consensus, concluding 3 included studies. The review aimed to answer the research question by comparing the clinical and functional improvements achieved with each treatment option. Three studies included studies are included with a total 469 patients consisting of 235 patients undergoing all arthroscopic and 234 patients undergoing mini-open rotator cuff repair. At 24 months follow-up, there are similar satisfactorily significant clinical and functional outcomes, including VAS score, range of motion, DASH and Constants score. Arthroscopic and mini-open surgeries serve equally balanced excellent options for rotator cuff repairs, providing pain relief, restoration of ROM, and improved functional outcomes.

Keywords: arthroscopy;mini-open surgery; rotator cuff injuries; shoulder

First Received	Revised	Accepted
08 April 2023	18 April 2023	20 April 2023
Final Proof Received		**Published**
30 April 2023		16 May 2023

How to cite (in APA style)
Christian, S. A., & Limena, S. (2023). Clinical And Functional Outcome Between All Arthroscopic Vs. Mini-Open Surgery in Rotator Cuff Injury: A Meta-Analysis. *Indonesian Journal of Global Health Research*, *5*(2), 279-290. https://doi.org/10.37287/ijghr.v5i2.1645.

INTRODUCTION

Rotator cuff tear is a common condition that can cause significant discomfort and disability in the shoulder. Conservative treatments such as physiotherapy and medications are usually the first line of management. However, if these treatments fail, surgical repair may be necessary (Ryösä et al., 2017). In recent years, mini-open and arthroscopic surgery have become increasingly popular due to their minimal scarring, desirable pain relief, and functional improvement. Mini-open surgery addresses the primary issue of deltoid takedown in open rotator cuff repair. A newer minimal invasive all-arthroscopic technique proposed lower risk of complications, including: stiffness, infection, and trauma to the deltoid. Nevertheless, there is still no clear consensus on which type of surgery is superior (Deprés-tremblay et al., 2016; Karjalainen et al., 2019).

Studies have shown that both mini-open and arthroscopic surgery have similar functional outcomes and complication rates (Longo et al., 2021). However, some studies have suggested that arthroscopic repair may be more effective. Arthroscopic surgery allows for a more detailed view of the joint, enabling surgeons to perform more precise repairs with minimal scarring and quick recovery time (Kasten et al., 2011). Nevertheless, both surgeries are generally considered safe and effective, and the choice of surgery should be made on a case-by-case basis, considering patient needs and surgeon preferences. We conduct a meta-analysis study to compare arthroscopy and mini-open surgery for rotator cuff repair according to recent publications.

METHOD

Search Strategy

The research was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guideline statement. A systematic search was carried out to identify studies that were potential for inclusion in this study from March 2013 to 2023. The databases used are PubMed, Embase, and Google Scholar. Two reviewers (SA and SL) independently screened the abstracts and reference lists. Disagreements between reviewers regarding whether to include or exclude a study will be resolved by consensus, and if applicable, consultation with a third reviewer. Randomized controlled studies that compare all-arthroscopic and mini-open rotator cuff repairs, uses English, and have full-text will be included in this research. The focus in this meta-analysis is to compare the clinical and functional outcome between all-arthroscopic and mini-open surgical repair on rotator cuff tears.

Inclusion Criteria

The following were the criteria for including studies: 1) prospective or retrospective RCT comparative English studies comparing arthroscopic vs. mini-open rotator cuff repair in patients with rotator cuff injury, and 2) reporting outcomes measurements such as the Visual analog Scale (VAS), range of motion (ROM) flexion and external rotation, Disabilities of Arm, Shoulder, and Hand (DASH) Score, and Constant-Murley score at 24 months follow-up. Studies involving patients with associated adhesive capsulitis, degenerative arthritis of the glenohumeral joint, and prior surgery were excluded (Table 1).

Table 1.
PICO Criteria for Inclusion Study

	Inclusion	Exclusion
Population	Patient with rotator cuff injury	Patient with associated adhesive capsulitis, degenerative arthritis of the glenohumeral joint, and previous history of surgery
Intervention	Patients treated with all-arthroscopic rotator cuff repair	Patients treated with conservative measures and surgery of other technique other than all-arthroscopic or mini-open rotator cuff repair
Control	Patients treated with mini-open rotator cuff repair	Patients treated with conservative measures and surgery of other technique other than all-arthroscopic or mini-open rotator cuff repair

	Inclusion	Exclusion
Outcome	VAS score, ROM flexion, ROM external rotation, DASH score, and Constant score at 24 months follow-up	Outcomes not clearly mentioned Outcome with other parameter than our inclusion criteria.
Design	Randomized controlled trials (RCT)	Case report, case series, cross-sectional study, cohort study, systematic review or meta-analyses

Quality Evaluation

Two reviewers (SA, SL) independently reviewed each article. Any noticed discrepancies resolved by consensus and comprehensive discussion. Included RCTs will be assessed in terms of quality by the same two independent reviewers based on 7-item of Cochrane's criteria for judging risk of bias in the 'Risk of bias' assessment tool, including: selection bias, performance bias, detection bias, attrition bias, reporting bias and other bias (Figure 1, 2).

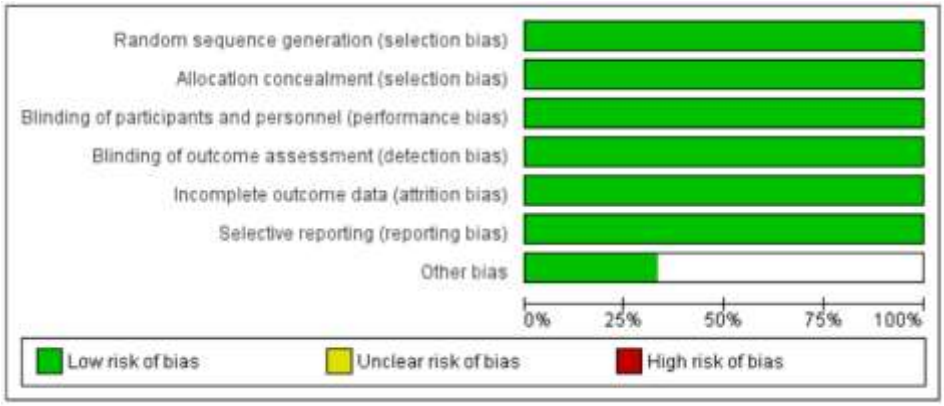

Figure 1. Risk of Bias Graph (Higgins et al., 2011)

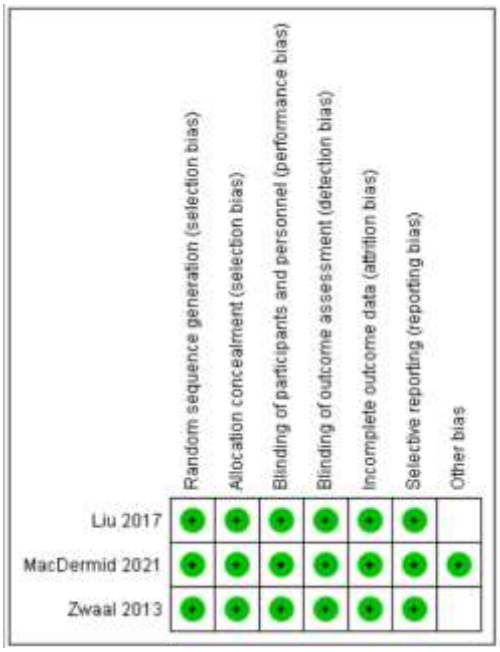

Figure 2. Risk of Bias Summary

Data Synthesis

Data extraction was collected under basic characteristics and outcomes using designated tables in Microsoft Excel (Microsoft Corp., Redmond, WA, USA) for all identified and included studies. When the data were available, quantitative analysis was performed using Review Manager (RevMan, computer program ver. 5.3, the Cochrane Collaboration, 2014; The Nordic Cochrane Center, Copenhagen, Denmark). Outcomes were presented in the form of forest plots. In each study, the mean difference for continuous outcome and odds ratio for dichotomous outcome with a 95% confidence interval (CI) was calculated. A fixed-effects model was used when the heterogeneity (I2) was <50%, whereas a random-effects model was used when the heterogeneity was >50%.

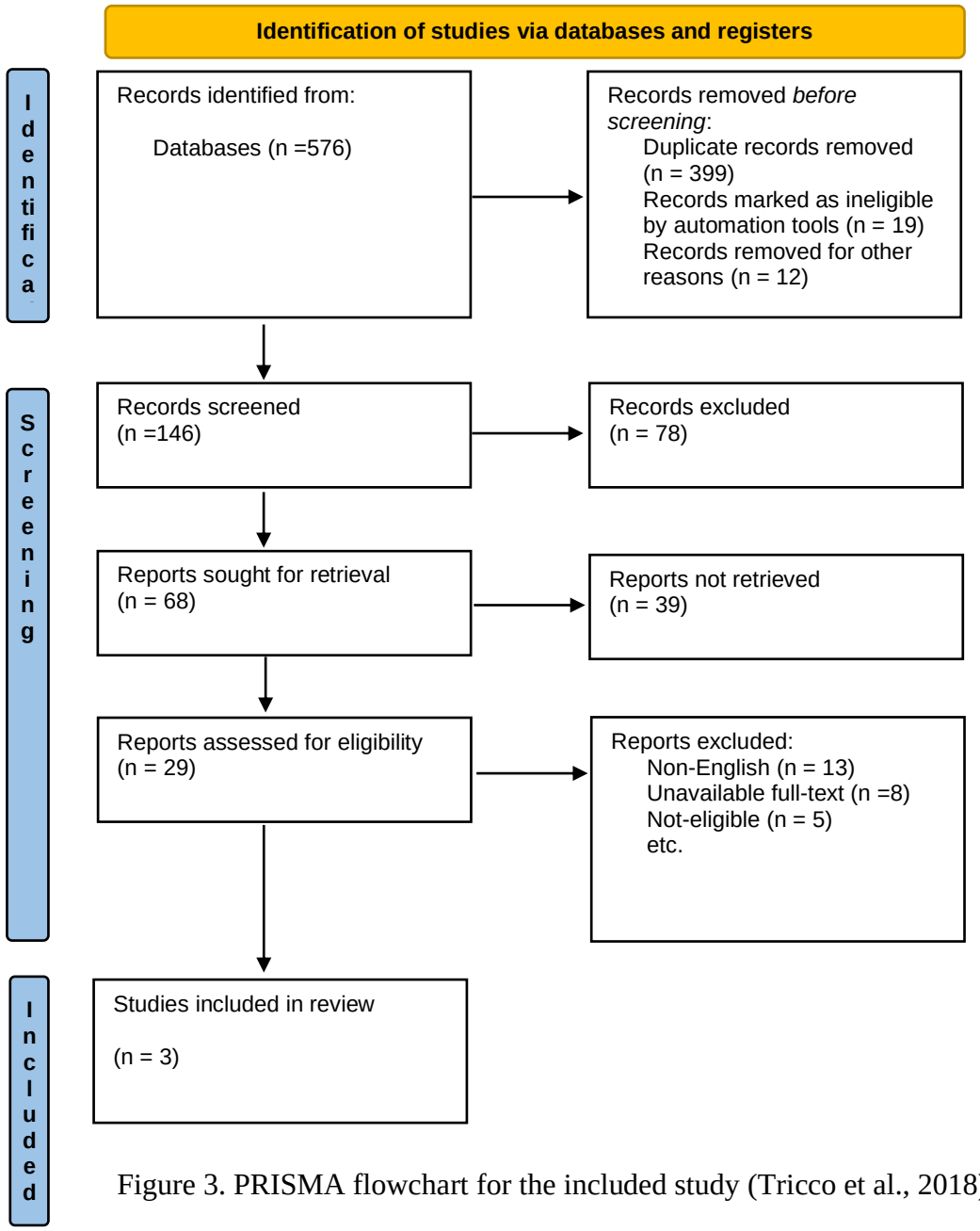

Figure 3. PRISMA flowchart for the included study (Tricco et al., 2018).

RESULTS

Literature Search, Study Selection and Study Characteristics

The electronic research resulted in 576 records from various databases. After the process of duplication elimination, screening, and exclusion, the remaining 3 studies were included in qualitative synthesis. The remaining articles were excluded due to lack of mean and standard deviation data, non-English article, unavailable full-text and did not meet the inclusion and exclusion criteria. This meta-analysis included a total number of 469 patients consisting of 235 patients undergoing all arthroscopic and 234 patients undergoing mini-open rotator cuff repair. The follow-up period was observed at 24 months postoperatively. The patient's ages ranged from 37 to 73 years old, with average age of 55.23 years old. Gender-wise, male is more dominant with 271 males and 198 females.

Table 2.
Characteristic of the studies

No.	Studies	Journal	Study Design	Level of Evidence
1	Zwaal et al. (2013)	Arthroscopy: The Journal of Arthroscopy & Related Surgery	Randomized Controlled Trial	II
2	Liu et al. (2017)	Medicine	Randomized Controlled Trial	II
3	MacDermid et al. (2021)	The American Journal of Sports Medicine	Randomized Controlled Trial	I

Table 3.
Characteristic of the study populations

No.	Studies	Number of Subjects	Age (year)	Male	Female	Follow Up
1	Zwaal et al. (2013)	AA: 47 MO: 48	AA: 57.2±8 MO: 57.8±7.9	AA: 29 MO: 28	AA: 18 MO: 20	AA: 26w MO: 26w
2	Liu et al. (2017)	AA: 50 MO: 50	AA: 53.5±4.3 MO: 52.5±5	AA: 25 MO: 24	AA: 25 MO: 25	AA: 24m MO: 24m
3	MacDermid et al. (2021)	AA: 138 MO: 136	AA: 55.8±8.5 MO:54.6±10.1	AA: 85 MO: 80	AA: 53 MO: 56	AA: 24m MO:24m

Table 4.
Characteristic of Outcome of studies

No	Reference	Outcome Measure				
		VAS	ROM Flexion	ROM Rotation	DASH score	Constant score
1	Zwaal et al. (2013)	AA: 3.4±0.3 MO: 3.9±0.3	AA: 153±3.7 MO: 141±5.5	AA: 53±2.3 MO: 51±2.7	AA: 56±2.8 MO: 62±3.6	AA: 76±2 MO: 72±3.3
3	Liu et al. (2017)	AA: 0.9±0.7 MO: 0.9±0.7	AA: 160.7±5.6 MO: 159.1±4.9	AA: 68.2±5.3 MO: 69.2±5.7	AA: 32.7±4.4 MO: 30.6±7.6	AA: 74.1±8.4 MO: 74.7±6.8
4	MacDermid et al. (2021)	AA: - MO: -	AA: 164.5±1 MO: 164.7±0.9	AA: 58.2±1.5 MO: 58.5±1.4	AA: - MO: -	AA: - MO: -

VAS Score

In 2 studies, including a total of 97 patients in the arthroscopic group and 307 patients in the mini-open group, VAS scores were analyzed. Figure 4 demonstrates there were no significant differences between the arthroscopic and mini-open repair on VAS score (SMD = -0.82 95%CI -2.44, 0.80 P = 0.32). A heterogeneity ($p<0.05$) was found in VAS analysis. Low heterogeneity was evident among these studies (I^2 = 96%; P = <0.00001).

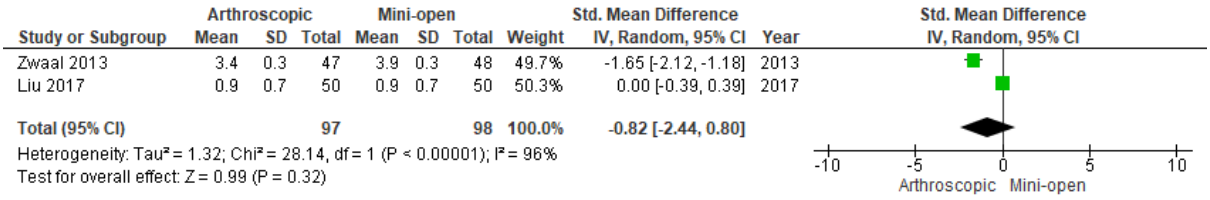

Figure 4. Forest plot analysis VAS

Range of Motion

In 3 studies, including a total of 235 patients in the arthroscopic group and 234 patients in the mini-open group, range of motion were analyzed. Figure 5 demonstrates there were no significant differences between the arthroscopic and mini-open repair on flexion ROM (SMD = 0.86 95%CI -0.53, 2.25 P = 0.23). A heterogeneity ($p<0.05$) was found in flexion ROM analysis. Low heterogeneity was evident among these studies (I^2 = 98%; P = <0.00001). Figure 6 demonstrates there were no significant differences between the arthroscopic and mini-open repair on external rotation ROM (SMD = 0.12 95%CI -0.47, 0.71 P = 0.69). A heterogeneity ($p<0.05$) was found in external rotation ROM analysis. Low heterogeneity was evident among these studies (I^2 = 89%; P = 0.0002).

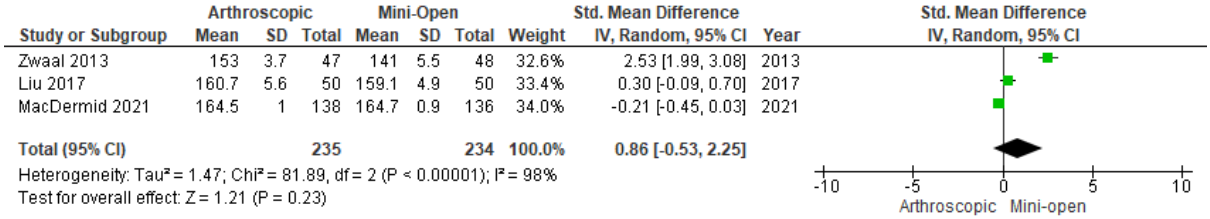

Figure 5. Forest plot analysis ROM Flexion

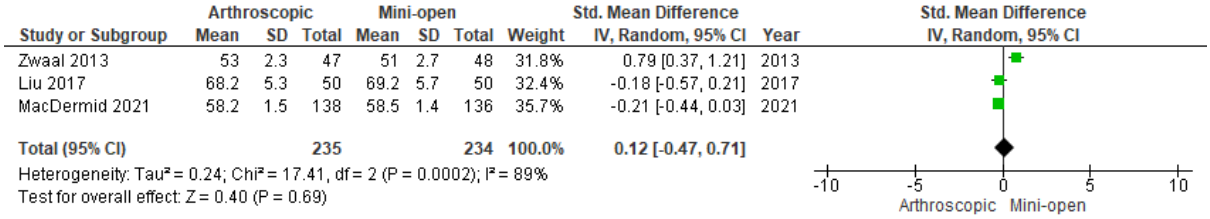

Figure 6. Forest plot analysis ROM External Rotation

DASH Score

In 2 studies, including a total of 97 patients in the arthroscopic group and 98 patients in the mini-open group, range of motion were analyzed. Figure 7 demonstrates there were no significant differences between the arthroscopic and mini-open repair on DASH score (SMD = -0.75 95%CI -2.88, 1.39 P = 0.49). A heterogeneity ($p<0.05$) was found in the DASH score analysis. Low heterogeneity was evident among these studies (I^2 = 98%; P = <0.00001).

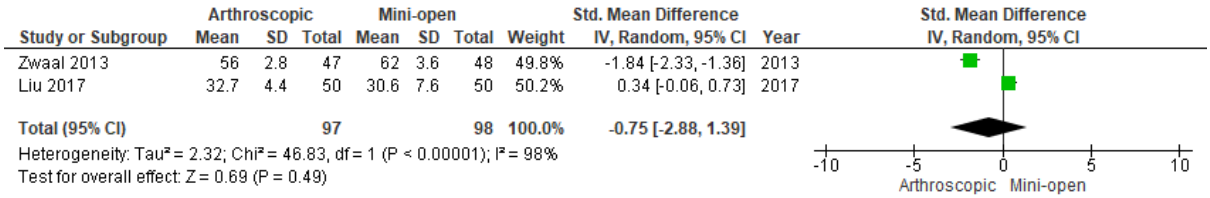

Figure 7. Forest plot analysis DASH Score

Constants Score

In 2 studies, including a total of 97 patients in the arthroscopic group and 98 patients in the mini-open group, range of motion were analyzed. Figure 8 demonstrates there were no significant differences between the arthroscopic and mini-open repair on Constant score (SMD = 0.68 95%CI -0.82, 2.18 P = 0.37). A heterogeneity ($p<0.05$) was found in Constant score analysis. Low heterogeneity was evident among these studies (I^2 = 96%; P = <0.00001).

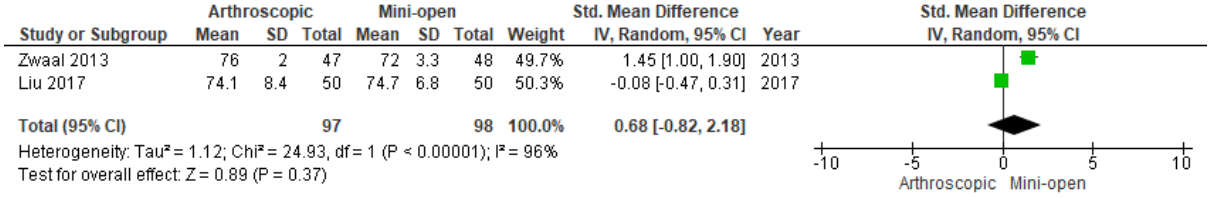

Figure 8. Forest plot analysis Constant Score

DISCUSSION

Rotator cuff complex includes four distinctive collaborative muscles dedicated for glenohumeral motion and stability (Martin I. Boyer et al., 2014). According to Yamamoto et al. (2010), there is 20.7% prevalence of full-thickness rotator cuff tears in general population, with associated predisposing risk factors among those with history of trauma, dominant arm and elderly age (Yamamoto et al., 2010). In 1962, Mc Laughlin proposed conservative treatment over surgical treatment avoiding early rotator cuff repair on the average rotator cuff rupture since certain full-thickness rotator cuff tears remains compatible with normal function. Some underlying conditions supporting delayed rotator cuff repair includes: (1) rotator cuff tear or degenerated cuff is estimated over 25% on cadaver shoulders with or without symptoms, (2) over 50% patients showed spontaneous recovery without surgical treatment, (3) no advantages are expected on diseased tendon/tendinopathies, (4) early and late rotator cuff repair show similar outcomes, and (5) early diagnosis occupy certain challenges. Aggressive treatment including surgical management is not recommended due to high recovery rate ranges from 33% to 90% with conservative treatment alone. It is specifically important in managing rotator cuff tear among elderly and patients with low activity demands (Azar et al., 2020).

Nevertheless, unsuccessful conservative treatment requires switching to other treatment modalities preferably operative treatment. A recent meta-analysis by Brindisino et al. (2021) comparing rotator cuff repair and nonoperative treatment showed operative rotator cuff repair results in better pain relief and functional improvement up to 24 months follow-up (Brindisino et al., 2021). A less than 50% cuff thickness lesion would be sufficiently treated with acromioplasty and debridement. On the contrary, a more than 50% thickness with longer and thicker lesion requires further cuff excision and repair. Younger patients less than 60 years old yield in better outcomes. Poor outcomes are associated with older patients of more than 65 years old, lesion morphology of large and massive tears (>3 cm), moderate to severe muscle atrophy, more than 2.5 mm tear retraction, and comorbid disease diabetes (Green et al., 2023; Shah et al., 2022).

Procedure wise, rotator cuff repair may be performed arthroscopically, mini-open (arthroscopically assisted), or if necessary, convert to the traditional open procedure. An arthroscopically assisted open rotator cuff treatment, also known as a mini-open procedure, offers advantages over open procedures by performing some diagnostic and decompression phases through the arthroscope while leaving some steps open (McCluskey & Gaunt, 2006). A more recent procedure, all-arthroscopic rotator cuff repair gains popularity with advantages of clear visualization on glenohumeral intra-articular, little or no deltoid detachment, less soft-tissue dissection and smaller incision hence better scarring cosmetically. Rotator cuff tear size, tendon quality, tendon mobility, and suture anchor location can all be accurately determined using arthroscopic procedures (Norberg et al., 2000).

In between the two procedures, there are mixed results on which type is more superior. In accordance to the high prevalence of rotator cuff tear, hence, many researchers are exploring this topic intensely. Patient and surgeon's wise, all-arthroscopic procedure is more convenient compared to other mini-open repair. Unfortunately, many studies showed otherwise. Previous studies over the years showed satisfactory outcomes with both all-arthroscopic and mini-open procedure in both clinical and functional outcomes. In 2005, Buess ket al. (2005) mentioned arthroscopic cuff repair produced equivalent or better outcomes to open repair. Patients who underwent an arthroscopic repair experienced a significantly greater reduction in pain and an improved functional outcome regarding mobility. The only concern with arthroscopic

procedure is it might not be appropriate for large rotator cuff tears (Buess et al., 2005). Ten years apart, Ji et al. (2015) performed similar study and showed indistinguishable surgery time, functional outcome, pain score and range of motion between both procedures (Ji et al., 2015). Nevertheless, a more recent larger review by Migliorini et al. (2021) comparing 1644 rotator cuff repairs between arthroscopic and mini-open surgery reported similar outcomes between the two procedures, similar to our results (Migliorini et al., 2023).

Among the 3 included randomized controlled trial studies (Liu et al., 2017; MacDermid et al., 2021; van der Zwaal et al., 2013)in the recent 10 years, our study concluded between the two procedures either arthroscopic repair or mini-open rotator cuff repair have comparable results and can be thought of as alternate therapy choices. At a mean 24.57 weeks follow-up, both methods of rotator cuff repairs show promising results in clinical and functional outcomes. Clinical outcomes are measured using VAS pain score, and range of motion. Flexion and external rotation range of motion is evaluated. Functional outcomes are measured using DASH score and Constant score.

Visual analog scale (VAS) analysis shows reduced pain levels up to below 4 points. A study by Zwaal et al. (2013) reported a reduced VAS pain score level to a mean value of 3,65 out of 10. A study by Liu et al. (2017) mentioned an even better pain relief of VAS pain score to 0.9±0.7 between the arthroscopic and mini-open rotator cuff repairs. In terms of shoulder movement, clinical analysis is performed on the forward flexion and external rotation ROM as the primary movement in the shoulder joint. There is an insignificant difference between flexion and external rotation ROM in 3 studies with 0.86 and 0.12 standard mean differences, respectively ($p=0.23$, and $p=0.69$). Arthroscopic and mini-open rotator cuff repairs gain flexion and rotation ROM improvement equally. The small incision with minimal scarring correlates positively with functional pain score postoperatively. Hence, noticeable faster recovery motivates patient for early rehabilitation intensely. The goal of rotator cuff repair is achieved, which are: pain relief, functional improvement, and increase shoulder strength as well as range of motion. Optimal stability is perceived throughout rehabilitation process improving rotator cuff muscle strengths and glenohumeral motion. In our study, the overall outcome is seen with improved glenohumeral range of motion, at flexion and external rotation (Ghodadra et al., 2009; Lähteenmäki et al., 2007).

Comprehensive functional outcomes are assessed with DASH and Constant scores included in 2 studies by Zwaal et al. (2013) and Liu et al. (2017). Both studies reported that either type of rotator cuff repair allows significant improvement with a low DASH score and high Constant score indicating excellent functional improvement at 24 months follow-up (van der Zwaal et al., 2013, Liu et al., 2017). On the long-term follow-up, all patients are able to perform daily tasks and activities satisfactorily. On a staged follow-up, Liu et al. reported relatively better DASH and Constant score within early postoperative period, continued with similar outcomes at 24 weeks follow-up. DASH score measurement at 3- and 6-months follow-up postoperatively shows significant difference with lower DASH score (43.8 vs. 47.8, and 38.6 vs. 42.7, respectively) in arthroscopic group, indicating better functional outcomes of the affected upper limb. While Constant score measurement at 1 month follow-up postopertively shows significant difference with higher Constant score (52.8 vs. 50.9) in arthroscopic group, indicating better limb functions. Hence, it is acceptable to conclude despite similar long-term functional outcomes at minimum 24 months postoperatively, arthroscopic rotator cuff repairs shows significant desirable functional outcomes up to 6 months postoperatively period (Greiwe, 2015). Arthroscopic repair gains benefits over mini-open and open repairs being less invasive, less recovery time, and less risk of complications. In comparison to mini-open

rotator cuff repair, it is safe to choose between the two procedures for rotator cuff repairs, with similar long-term outcome at 24 months follow-up (MacDermid et al., 2021). Furthermorre, complication rate are low between the two procedures, limited to re-tear, stiffness, and local infection (Randelli et al., 2012). Proper indication considering patient's demand according their activity level; and surgeon's preference as well as trained skills made up the clinical judgment.

CONCLUSION

Arthroscopic and mini-open surgeries serve equally balanced excellent options for rotator cuff repairs. At 24 months follow-up, both arthroscopic and mini-open repairs provide pain relief, restoration of ROM, and improved functional outcomes for daily activities. Thus, proper indication according to each patient's need and surgeon's preference remains essential for choosing the surgical procedures.

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