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Clinical Significance of Arthroscopic Debridement, Trapeziectomy, and Joint Replacement for Basilar Thumb Joint Arthritis: A Meta-analysis of Pain Score Improvements

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Introduction: A meta-analysis was conducted comparing the impact of Arthroscopic debridement (AD), trapeziectomy (TRAP), and joint replacement (JR) on the change in pain scores on patients with Basilar thumb joint arthritis (BTJA).
Methods: Four databases were searched for studies presenting pain outcomes following surgical intervention for BTJA. Pain scores were reported using the Visual Analog Scale (VAS) and compared against the pre-established threshold for Minimal Clinically Important Difference (MCID) of 1.65.
Results: Eighteen studies with 763 patients treated with AD(n=102, 13%), TRAP(n=428, 56%), and JR(n=233, 31%) between 2010 and 2023 with a mean follow-up period of 38 ± 28 months were included. There were 25 groups including 4 AD, 14 TRAP, and 7 JR. The mean difference between pre- and post-operative VAS pain was 4.9 ± 2 for all groups. Meta-analysis demonstrated a mean delta VAS of 3.6 (95%CI 1.79-5.38, for AD, 5.1(95%CI, 4.20-6.02) for TRAP and 6.8(95%CI, 5.93-7.97) for JR. ANOVA showed a significant difference between groups (P=0.016). Post-Hoc testing showed a significant difference between AD and JR (P=0.014).
A significant improvement in pain scores, surpassing the MCID threshold, was obtained in all surgical interventions. Change in pain score was 2.6 times MCID for AD, 2.9 times for TRAP, and 3.6 times for JR.
Conclusions: All interventions showed significant improvement in pain. Variability in treatment options and improvement depends on patient selection and surgeon's preference. This data can be used to counsel patients regarding the expected pain relief. However, longevity, and long-term outcomes warrant further study.

Keywords: Basilar thumb joint arthritis, surgical interventions, systematic review, meta-analysis, minimal clinically important difference.

INTRODUCTION

The prevalence of Basilar thumb joint arthritis is 7% for men and 15% for women[1] although the most common sufferers are elderly women[2]. For patients who fail conservative management, surgery is offered. Surgical techniques range from arthroscopic debridement (AD) to trapeziectomy (TRAP) procedures and joint replacement[3] (JR). Although some meta analyses have found evidence that JR may provide superior functional outcomes to those offered by TRAP,[4,5] due to higher rate of complications and reoperation,[6] the majority of reviews[4,7-10]on the topic cite a lack of high-quality evidence sufficient to confirm any single technique as superior to the others. A recent survey[11] asked hand surgeons how they selected a surgical treatment for "end stage" BTJA. Only 15% of respondents endorsed "current evidence" as the answer; 55% cited "personal clinical experience" and 22% cited "The procedure is what I primarily did during my training" This has left hand surgeons without clear guidance on how best to treat this condition highlighting the need for more clear evidence on the merits of various treatments for BTJA.

This study aimed to compare the efficacy in pain relief obtained after AD, TRAP, and JR in patients with BTJA. The primary outcome measure is the change from preoperative to postoperative pain as measured

by visual analog scale (VAS). This information can be used when patients are counseled during shared decision-making.

MATERIALS AND METHODS

Article selection algorithm can be found in "Appendix A". PubMed, Cochrane, Embase, and Medline databases were systematically searched for eligible studies. All articles were searched and selected on the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) criteria[12]. Articles found through database searches underwent title and abstract screening, followed by full manuscript assessment against eligibility criteria.

Eligible Studies

All original research studies that reported mean pre and post-operative VAS for AD, TRAP, and JR published after 2009 with greater than 6 months of follow up were eligible for inclusion. Studies involving nonoperative management or revision surgery along with case reports, metanalyses and review papers were excluded.

Outcome Measures

The primary outcome was pain rating via the VAS. The VAS score is a single-item continuous scale that serves to subjectively measure intensity of pain[13]. Patients are given a line 10 cm long[14] with the words "No pain" on the zero end and the words "Pain as bad as it could be" on the other and asked to mark the

Table I. — Extracted Data from 18 Included Studies.

Study Number	Authors	Published Year	Journal Index	Study Design	Treatment Modality	Patients (n)	Follow-up (mo)	Mean pre-op VAS	Pre-op SD	Mean post-op VAS	Post-op SD
1	Furia et al.	2010	Q1	Case-control	AD	44	12	7.7	1.4	2.7	1.1
2	Nordback et al.	2012	Q1	Prospective	TRAP	55	12	6.5	3.2	1.07	1.52
3	Taleb et al.	2014	Q2	Case series	JR	7	30	8	1.14	2	4.33
4	Lee et al.	2015	Q1	Retrospective	TRAP	19	36	7.2	1.75	1.7	0.75
5	Pereira et al.	2015	Q2	Case series	JR & TRAP	26	20	6.6	1.75	6.03	2.25
6	Chuang et al.	2015	Q2	Prospective	AD	23	24	5.7	0.5	1	0.7
7	Robles-Molina et al.	2017	Q2	Prospective	JR & TRAP	65	56	9.24	0.85	1.35	1.84
8	Cebrian-Gomez et al.	2019	Q1	Prospective	JR & TRAP	146	46.6	7.55	1.13	1.06	1.24
9	Oh et al.	2019	Q2	Prospective	JR & TRAP	39	38	6.19	1.76	0.75	1
10	Dreant et al.	2019	Q2	Retrospective	JR	25	27.5	8	2.06	1	1.3
11	Lucet et al.	2019	Q2	Prospective	AD	20	12	2.4	2.9	0.1	0.5
12	Dréant et al.	2021	Q2	Case series	TRAP	21	30	3.5	0.75	2	0.75
13	Rodriguez-Buitrago et al.	2021	Q2	Retrospective	TRAP	105	8.4	6.95	2.17	1.02	2.01
14	Muramatsu et al.	2022	Q2	Retrospective	TRAP	24	20	7.5	0.6	1.8	1.4
15	Zheng et al.	2022	Q2	Case series	AD	10	81.6	6.4	1.3	1.1	1.6
16	Yamaura et al.	2022	Q2	Retrospective	TRAP	13	45.4	8.1	1.2	2.9	2.5
17	Morais et al.	2022	Q2	Randomized controlled trial	TRAP	76	38.9	4.55	2.71	1.44	1.3
18	Fauqette et al.	2023	Q1	Retrospective	JR	66	107.5	7.9	1.3	1	1.5

AD, arthroscopic debridement; TRAP, trapeziectomy; JR, joint replacement

point on that line that corresponds to their pain level.

Statistical Analysis

The interventions were compared via quantitative meta-analysis using a random effects model to calculate the 95% confidence interval (95% CI). The null hypothesis, that the true effect size is 0, was rejected if the P value was less than .05. The mean post-operative VAS values were subtracted from the corresponding mean pre-operative values to calculate delta (Δ)VAS. ΔVAS levels were compared to the MCID (1.6) for hand surgery ΔVAS which was calculated by Randall[13] et al. using the distribution model. An ANOVA test followed by a post-hoc test was performed in statistical package for the social sciences to assess the difference between the groups. R studio was used to perform the meta-analysis.

Assessment of Publication of Bias

A funnel plot (Figure 1) was created to assess for publication bias. Funnel plots plot the effect size on the horizontal axis vs standard error on the vertical axis. Studies that inside the plot lines are considered low risk for publication bias.

Quality Control

An Ottawa-Newcastle scoring was performed separately by two researchers and conflicts were adjudicated by a third researcher.

RESULTS

A total of 1068 studies were identified through database searching. After removal of duplicates and abstract screening, 581 articles were assessed for eligibility by the inclusion criteria. From these 581 studies, 550 were excluded after screening and review, resulting in 31 eligible studies. Narrowing our search to journals with high impact factor resulted in 18 studies, published between 2010 and 2023[15-32]. In accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a flow chart of the results of the study selection process is prepared (Figure 2).

Study Characteristics

Studies investigating arthroscopic debridement, trapeziectomy, or joint replacement were assessed in this systematic review (SR). Only one study[25] in this SR was a randomized controlled trial; One was a case-control[27]; four were cross-sectional[15,18,29,30]; six were prospective cohort studies[16,17,20,27,28,31,32]; and six were retrospective cohort studies[19,21-24,26].All studies were published after the year 2010. This resulted in a total of 763 patients, of which 76 (10%) had arthroscopic debridement, 442 (58%) had a trapeziectomy procedure. 245 (32%) had a joint replacement. The mean follow-up period for the studies was 38 ± 28 months (Table I).

Outcomes

The meta-analysis demonstrated a mean delta pain score of 3.6 (95%CI 1.79-5.38, P<0.01) for AD, 5.1 (95%CI, 4.20-6.02, P<0.01) for TRAP and 6.8 (95%CI, 5.93-7.97, P<0.01) for JR (Figure 3).

The ANOVA test showed a significant difference between groups (P<0.016). The Post-hoc test showed a significant difference between AD and JR (P<0.014). There was no significant difference between AD and TRAP or TRAP and JR.

A significant improvement in pain scores, surpassing the MCID threshold, was obtained in all surgical interventions. Specifically, the average change in pain score was 2.1 times the MCID for AD, 3.1 times

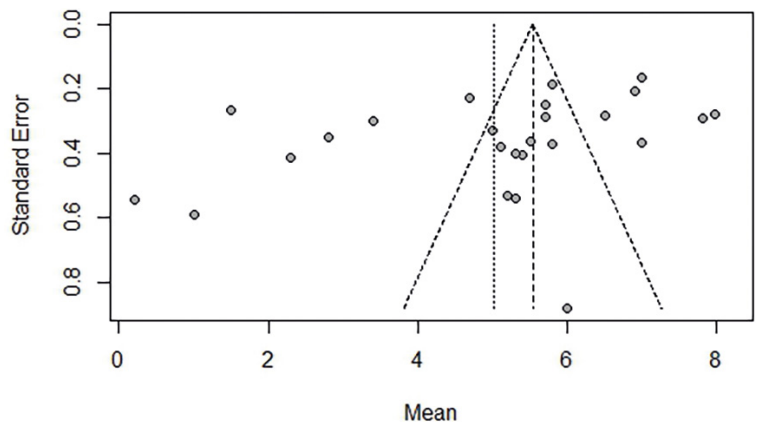

Fig. 1 — Funnel Plot.

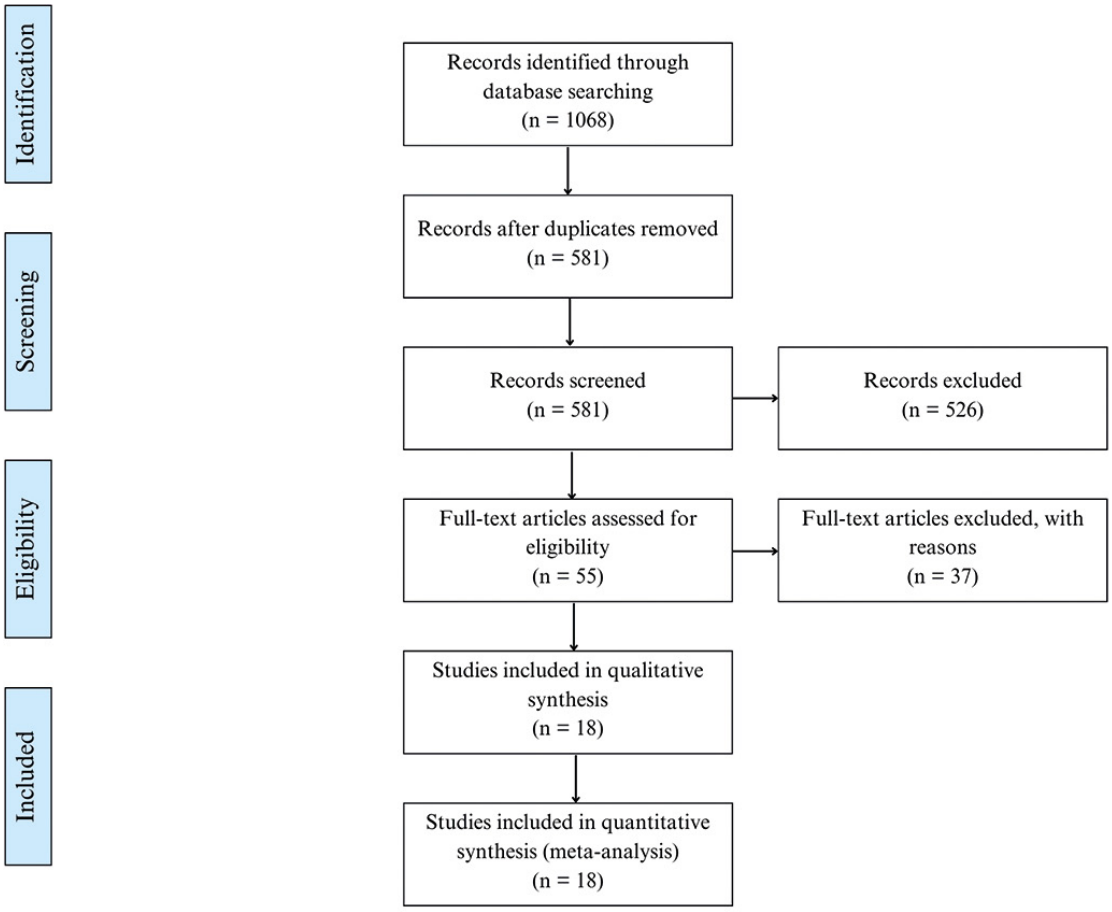

Fig. 2 — PRISMA Flow Chart.

for TRAP, and 4 times for JR. This difference was statistically significant (P=0.016).

Publication bias

The observed funnel plot shows no substantial publication bias (Figure 1).

Quality Assessment

An Ottawa Newcastle assessment of the included studies (Tables II and III) found an average score of 7.1.

DISCUSSION

The most important finding of our study is that JR is superior to AD with respect to delta pain scores. There was not a significant difference between AD and TRAP or between TRAP and JR. Specifically, AD was associated with a mean delta pain score of 3.6 (95%CI 1.79-5.38, P<0.01), 5.1 for TRAP (95%CI, 4.20-6.02, P<0.01) and 6.8 for JR (95%CI, 5.93-7.97, P<0.01). The second finding is that all of the delta pain scores were greater than the MCID.

Our results were consistent with existing literature. Previous studies[4,8] comparing TRAP with JR found no superiority in terms of pain except for a recent randomized controlled trial by De Jong et al.[33] which demonstrated a greater pain reduction associated with JR than with TRAP. This significant difference could be explained by the fact that pain was assessed as part of the Michigan Hand Outcome Questionnaire and not using the VAS scale. Few meta analyses have included AD techniques, however, a 2022 paper by McGinley[3] et al. found that trapeziectomy was superior to AD in terms of pain. In contrast to his search strategy, our meta-analysis included articles published only in high impact journals which could explain the discrepancy of our findings. This paper adds to current literature by being the first to utilize the MCID for VAS pain scores in BTJA finding that all interventions were associated with a clinically meaningful alleviation of patients' pain.

The superiority of JR in terms of pain relief should be considered against higher complication rates including reoperation for subluxation and dislocation[6]. Pain relief, however, should not be the only factor

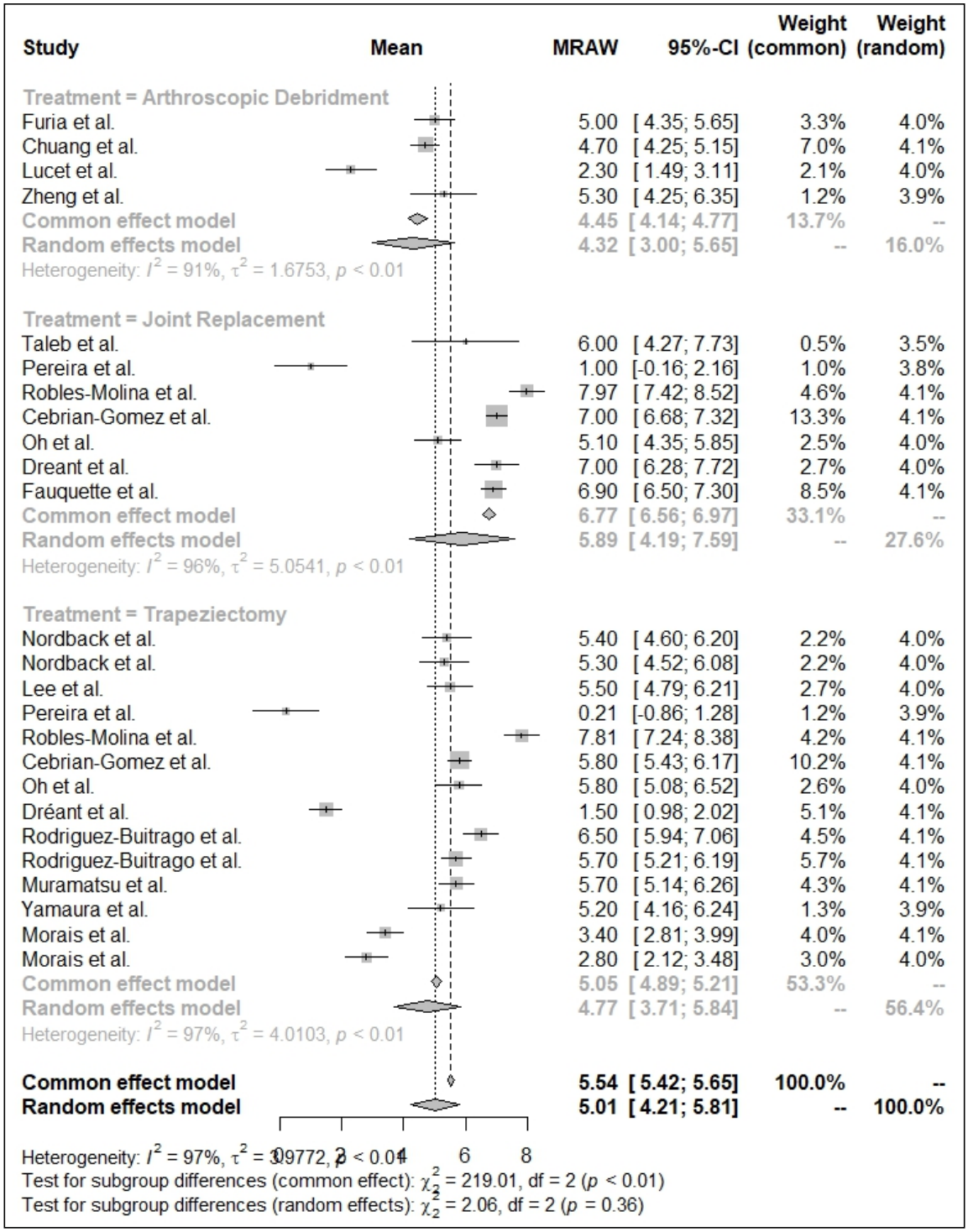

Fig. 3 — Forest Plot.

in selecting an intervention for this condition. For example, JR is associated with greater functional outcomes in two commonly reported outcome measures: Quick Disabilities of the Arm, Shoulder, and Hand (QDASH) and pinch strength than TRAP[4]. However, it is also associated with more complications and revisions than TRAP[34]. Although AD has the advantage of reduced disruption of soft tissues[3], many patients who undergo AD for BTJA require escalation to more invasive surgeries later on. For example, of the 26 patients included in Pereira's study, 10 went on to TRAP, one denervation, and one CPRS plus TRAP. It is likely that AD also leads to fewer complications and quicker recovery than TRAP or JR, but further research is required to confirm this. In light of current evidence, procedure selection should be based on the

Table II. — Quality Assessment of the Studies Using Newcastle-Ottawa Scale for Cohort Studies.

Study Number	Authors	Published Year	Representativeness of the Exposed Cohort	Selection of the Non-Exposed Cohort	Ascertainment of Exposure	Outcome not Present at Start of Study	Comparability*	Assessment of Outcome	Follow-Up Length	Follow-Up Adequacy	Total
2	Nordback et al.	2012	*	*	*	*	*	*	*	*	8
4	Lee et al.	2015	*		*	*		*	*	*	6
6	Chuang et al.	2015	*		*	*		*	*	*	6
7	Robles-Molina et al.	2017	*	*	*	*	**	*	*	*	9
8	Cebrian-Gomez et al.	2019	*	*	*	*	**	*	*	*	9
9	Oh et al.	2019	*	*	*	*	**	*	*	*	9
10	Dreant et al.	2019	*		*	*		*	*	*	6
11	Lucet et al.	2019	*		*	*		*	*	*	6
13	Rodriguez-Buitrago et al.	2021	*	*	*	*	**	*	*	*	9
14	Muramatsu et al.	2022	*		*	*		*	*	*	6
16	Yamaura et al.	2022	*		*	*		*	*	*	6
18	Fauqette et al.	2023	*		*	*		*	*		5

*A maximum of 2 stars can be allotted. One for the age and one for the other controlled factors.

Table III. — Quality Assessment of the Studies Using Newcastle-Ottawa Scale for Case-Control Studies.

Study Number	Authors	Published Year	Case Definition Adequate	Representativeness of Cases	Selection of Controls	Definition of Controls	Comparability*	Ascertainment of Exposure	Same Ascertainment Method	Non-response Rate	Total
1	Furia et al.	2010	*	*	*	*	**	*	*	*	9

*A maximum of 2 stars can be allotted. One for the age and one for the other controlled factors.

needs of individual patients. Prioritizing longevity favors AD or TRAP while maximizing function and pain reduction favors JR.

A strength of our study is that our data was drawn exclusively from high impact publications. The studies included were found to have an average score of 7.1 on Ottawa Newcastle testing. One limitation of our study is that it assessed only pain without looking at any of the other factors that should be considered when selecting a treatment for BTJA nor did it take into account the Eaton-Littler pre-operative arthritic severity. Further research is needed to compare functional outcomes between AD, TRAP, and JR. Additionally, we were only able to include one randomized controlled trial in our study which indicates a dearth of existing literature.

CONCLUSION

Our meta-analysis underscores the clinically significant effectiveness of AD, TRAP, and JR in managing pain among patients with BTJA and highlights the superiority of JR compared to AD. Despite the significant improvements in delta pain scores across all interventions, further research is needed including more randomized controlled trials

that directly compare AD, TRAP, and JR in order to establish a causal link between type of intervention and outcome of surgery. Given the current evidence available, the choice of procedure should be individualized based on factors such as function and reoperation rates rather than pain relief.

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