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Hand

Radiographic Evaluation after Arthroscopic Partial Trapeziectomy with Suture-button Suspensionplasty for Thumb Carpometacarpal Arthritis

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Background: Arthroscopic partial trapeziectomy with suture-button suspensionplasty was developed for the surgical treatment of thumb carpometacarpal arthritis. However, the relationship between clinical results and radiographic evidence is unclear.

Methods: The authors retrospectively reviewed 33 consecutive patients who underwent arthroscopic partial trapeziectomy with suture-button suspensionplasty for thumb carpometacarpal arthritis between 2016 and 2021. Clinical and radiographic outcomes were recorded, and the correlations between them were evaluated.

Results: The average patient age at surgery was 69 years. Patient radiologic evidence was Eaton stage II in three thumbs, III in 25 thumbs, and IV in five thumbs. The average trapezial space ratio (TSR) was 0.36 immediately after the operation but declined to 0.32 after 6 months. In contrast, the average joint subluxation was reduced to 0.005 immediately after the operation compared with 0.28 before, and was maintained at 0.04 at final follow-up. A statically significant correlation was detected between grip strength and TSR ($P = 0.03$), and between pinch strength and TSR ($P = 0.02$). A significant correlation was detected between TSR and trapezium height ($P = 0.0215$), which remained after partial trapeziectomy. No correlation was detected between rope position and other clinical or radiographic scores.

Conclusions: Suture-button can have an effect on the medialization of the first metacarpal base. Excessive trapeziectomy can result in functional deficiency of the thumb through metacarpal subsidence, which potentially causes loss of grip and pinch strength. *(Plast Reconstr Surg Glob Open 2023; 11:e4983; doi: 10.1097/GOX.0000000000004983; Published online 10 May 2023.)*

INTRODUCTION

Thumb carpometacarpal (CMC) joint osteoarthritis is a common condition characterized by joint space narrowing, subluxation, sclerosis, and cystic changes with osteophytes or loose bodies, resulting in decreased function of the thumb and hand, and pain with use.[1,2] Eaton classification describes four stages of CMC joint osteoarthritis based on a true lateral radiograph of the trapeziometacarpal joint of the thumb. In earlier stage conditions, nonsurgical treatment, including activity modification, use of an orthosis, nonsteroidal anti-inflammatory drugs, and intraarticular steroid injections, are employed.[3] Surgery is indicated if nonsurgical treatment does not alleviate the patient's symptoms. The goal of surgical treatment is to eliminate pain while maintaining mobility and stability of the joint to restore function of the hand. There is a wide variety of surgical interventions, such as metacarpal extension osteotomy; CMC joint arthrodesis; total joint arthroplasty; and trapeziectomy with its many variations, including ligament reconstruction and tendon interposition, abductor pollicis longus suspensionplasty, hematoma distraction arthroplasty, and suture-button suspensionplasty.[4–9] Interestingly, there is no evidence suggesting that one procedure is superior to another.[10,11] Among many options above, a combination of partial trapeziectomy with suture-button suspensionplasty has gained popularity, and encouraging early to mid-term results have been reported.[9,12–17] However, there have been no reports on the postoperative radiographic follow-up evaluation of the suspension effect with suture-button. The purpose of this study is to

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investigate the preoperative and postoperative follow-up radiographic evaluation after partial trapeziectomy with suture-button suspensionplasty and its correlation with clinical outcomes, aiming to identify the optimum surgical procedure.

PATIENTS AND METHODS

This study was approved by the institutional review board, the ethics committee of Kyoto University Graduate School, and the faculty of medicine. All patients signed written informed consent.

We reviewed 33 patients who underwent suture-button suspensionplasty with arthroscopic partial trapeziectomy for symptomatic thumb CMC osteoarthritis between 2016 and 2021, with a minimum follow-up period of 6 months. Indications for surgery were persistent symptoms despite a minimum of 6 months of nonsurgical treatment and radiographic signs of Eaton stage II, III, or IV osteoarthritis. Contraindications included patients with systematic inflammatory arthritis or hyperlaxity syndromes.

All surgical procedures were performed as described by Maeda et al.[14] Partial trapeziectomy was performed arthroscopically through the 1-U portal and the 1-R portal. The resection volume of the trapezium is approximately 3 mm from the CMC joint surface. After making CMC space, a Mini-TightRope fixation system (Arthrex, Naples, Fla.) is used to suspend and medialize the thumb metacarpal. Tightening the fiber wire with correct tension is performed under fluoroscopy control to check the radial abduction and volar abduction of the thumb metacarpal. Preoperative and postoperative plain radiograph is shown in Figure 1.

Takeaways

Question: What is the relationship between clinical results and radiographic evidence after partial trapeziectomy with suture-button suspensionplasty for thumb carpometacarpal arthritis?

Findings: The role of suture-button involves medialization of the proximal base of the first metacarpus rather than suspension to maintain the trapezial space.

Meaning: Excessive trapeziectomy can result in functional deficiency of the thumb through metacarpal subsidence, which potentially causes loss of grip and pinch strength.

We recorded demographic data, preoperative Eaton stage, duration of nonsurgical treatment, and visual analogue scale (VAS) score, as well as pinch strength (PS), grip strength (GS), range of motion (ROM), rope position, joint subluxation, and metacarpal subsidence. Data concerning each of these items were recorded at preoperation, immediately after operation, 1 month after operation, and 6 months after operation. Rope position was represented by the distance between the rope insert point in the second metacarpal and the second metacarpal base, as a percentage of second metacarpal length, measured in the thumb lateral view (Fig. 2). Joint subluxation was represented by the subluxated portion of the proximal metacarpal articular surface, as a percentage of the proximal metacarpal articular surface, measured in the thumb AP view of a plain radiograph. Metacarpal subsidence was represented by trapezial space height (TSH) and trapezial space ratio (TSR), indicated by TSH as a percentage of thumb proximal phalanx length. TSH was measured as the gap distance between the metacarpal base and the

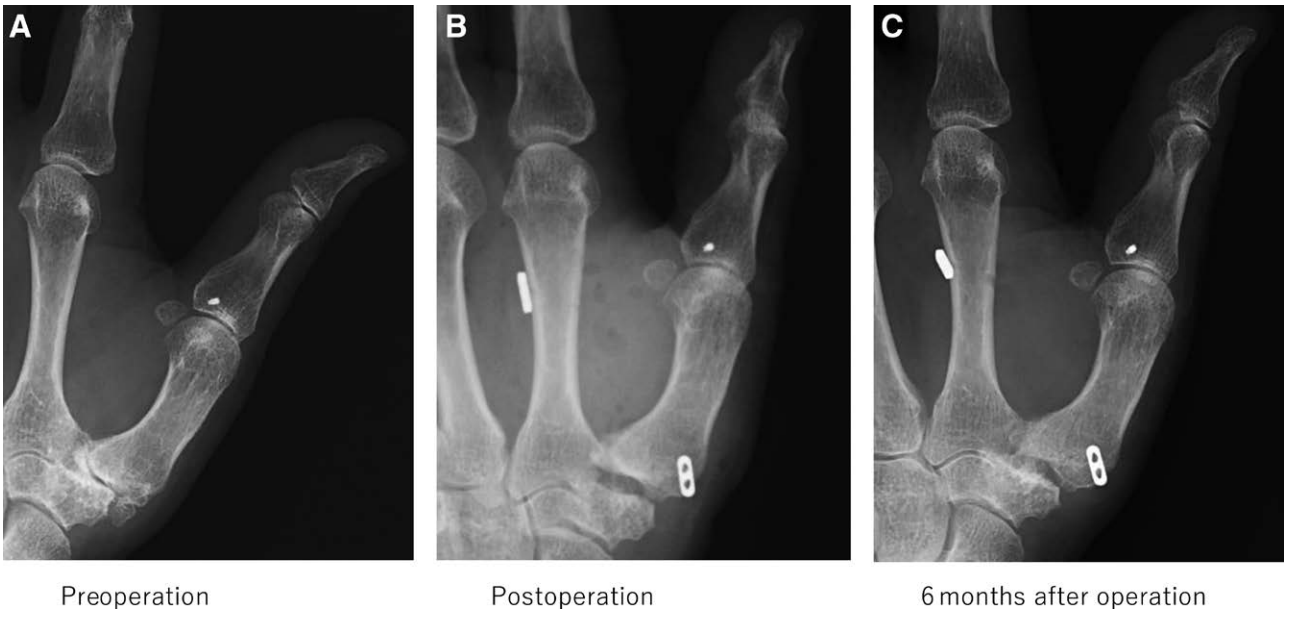

Fig. 1. Plain X-ray films preoperation (A), postoperation (B), and 6 months after operation (C). Preoperation shows Eaton stage III with metacarpal subluxation. In postoperative radiograph, TSH increased and metacarpal subluxation improved. Six months after operation, the metacarpal subsidence progressed.

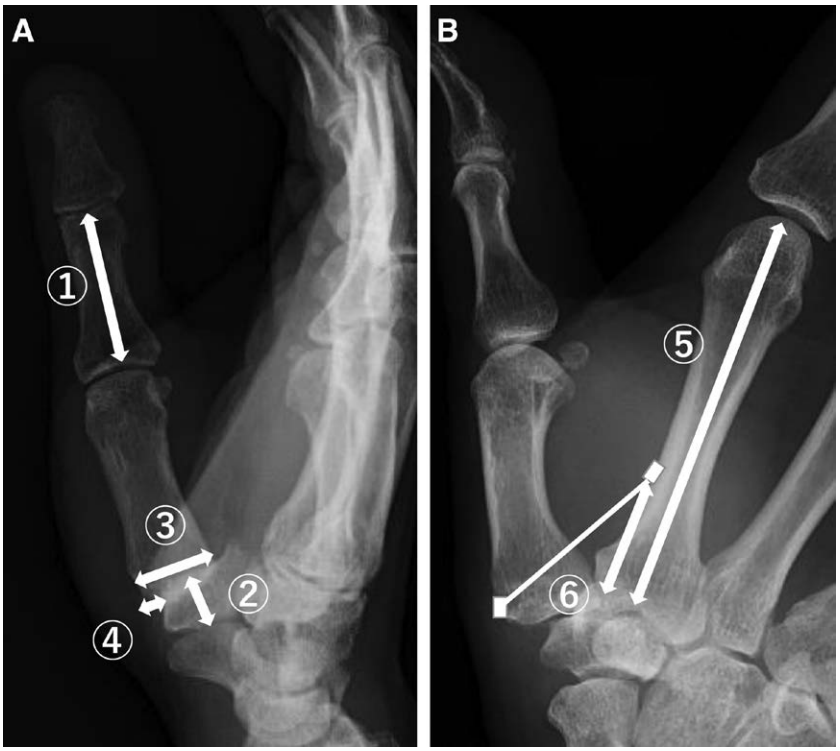

Fig. 2. Measurement procedure of plain radiographs. A, ① thumb proximal phalanx length; ② TSH; ③ proximal metacarpal articular surface; ④ subluxated portion of the proximal metacarpal articular surface. B, ⑤ second metacarpal length; ⑥ length between rope insert point and second metacarpal base. TSR, joint subluxation, and rope position are indicated by ②/①, ④/③, and ⑤/⑥, respectively.

edge of the distal scaphoid the thumb AP views of plain radiographs, as shown in Figure 2.

Statistical analysis was carried out by the Mann-Whitney U test between each preoperative and postoperative score, and by Spearman's rank correlation among each evaluation criteria, with a threshold of significance at $P = 0.05$.

RESULTS

The average age of patients at the time of surgery was 69 years (range, 47–80 years). There were 15 men and 18 women. There was radiologic evidence of Eaton stage II in three thumbs, III in 25 thumbs, and IV in five thumbs. Mean duration of nonsurgical treatment was 37.8 months (range, 6–120 months) (Table 1).

Mean preoperative VAS score was 69.6 (range, 50–100), and postoperative VAS score at final follow-up was 7.1 (range, 0–50). Mean preoperative PS was 3.4 kg (range, 0.4–10 kg), and postoperative PS at final follow-up was 5.2 kg (range, 1.5–10 kg). Mean preoperative GS was 23.0 kg (range, 5–40 kg), and postoperative GS at final follow-up was 33.4 kg (range, 10–52 kg). Mean preoperative palmar abduction ROM (PA-ROM) was 45.8 degrees (range, 20–65 degrees), and postoperative ROM at final follow-up was 55.0 degrees (range, 30–70 degrees). Mean preoperative radial abduction ROM (RA-ROM) was 45.2 degrees (range, 5–60 degrees), and postoperative ROM at final follow-up was 53.9 degrees (range, 0–80 degrees) (Fig. 3). Mean rope position was 33.3% (range, 14.9–53.2%). Mean preoperative joint subluxation was 28.1% (range, 0.0–57.4%), and postoperative subluxation at final follow-up was 0.52% (range, 0.0–16.5%) (Fig. 4). Mean preoperative TSH was 10.2 mm (range, 3.2–13.6 mm), and postoperative TSH at final follow-up was 10.5 mm (range, 6.7–13.9 mm). Mean preoperative TSR was 35.8% (range, 11.5–48.7%), and postoperative TSR was 36.4% (range, 24.6–52.7%) immediately after surgery

Table 1. Patient Demographics

	No.	%
Age		
≤ 60	5	15.2
61–70	12	36.4
71–80	12	36.4
81–90	4	12.1
Gender		
Men	15	45.5
Women	18	54.4
Side		
Right	14	42.4
Left	19	57.6
Eaton classification		
II	3	9.1
III	25	75.8
IV	5	15.2

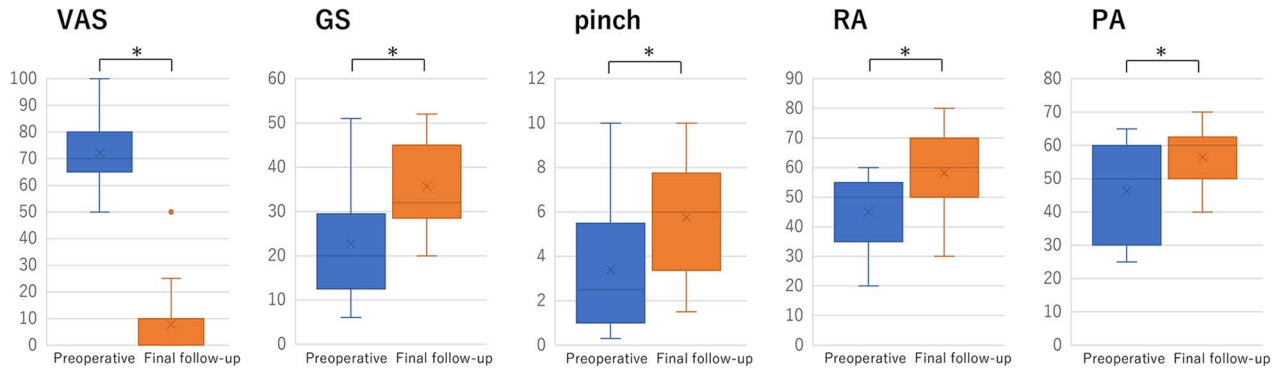

Fig. 3. Comparison of clinical parameters preoperatively and at final follow-up. VAS, GS, pinch (PS), RA (radial abduction), and PA (palmar abduction) measurements of preoperative and postoperative conditions are shown with statistical differences. Significant improvement was detected in all clinical parameters.

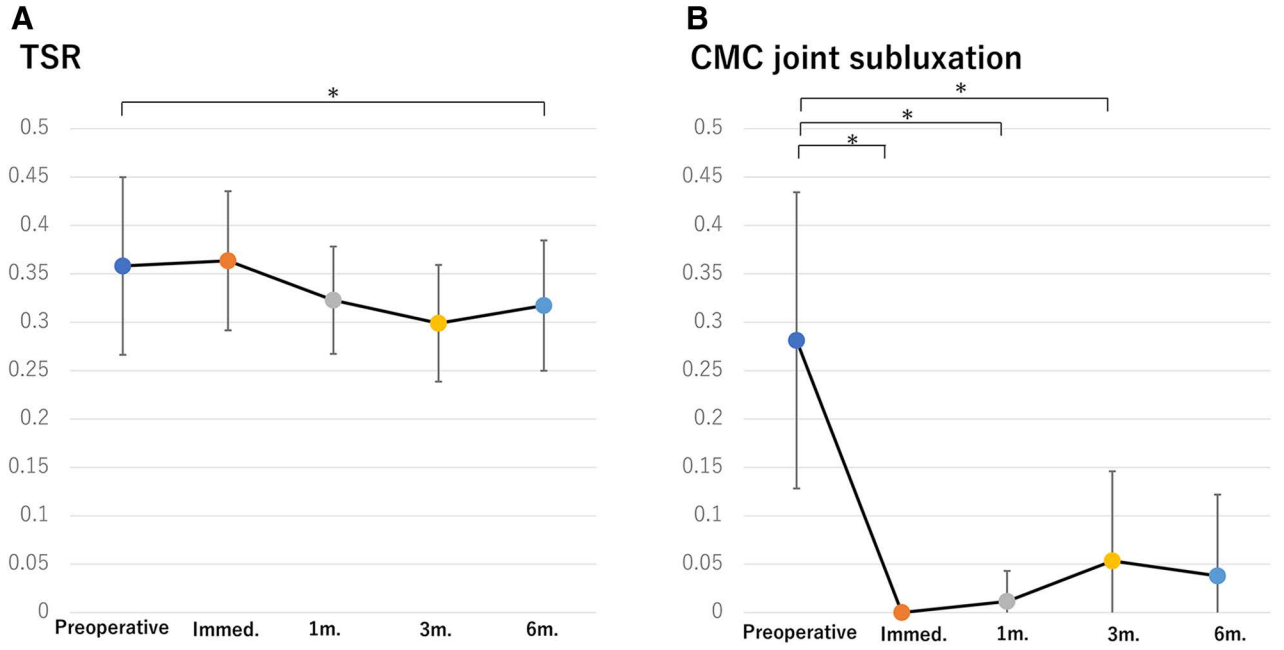

Fig. 4. A, TSR of the preoperative and postoperative (immediately after, 1 month after, 3 months after, 6 months after) conditions. Although maintained for a short period, TSR gradually decreased over time. B, CMC joint subluxation of the preoperative and postoperative (immediately after, 1 month after, 3 months after, 6 months after) conditions. Reduced immediately after surgery, improvement of CMC joint subluxation was maintained over the observation period.

and 31.7% (range, 21.3–44.7%) 6 months after surgery (Fig. 4). Statistical analysis showed significant improvement in all postoperative clinical parameters, including VAS ($P \leq 0.01$), GS ($P = 0.027$), PS ($P = 0.049$), RA-ROM ($P = 0.0207$), and PA-ROM ($P = 0.0237$; Fig. 3). Compared with preoperative score, TSR was maintained for a short postoperative period but declined over time. In contrast, joint subluxation was immediately reduced after surgery and maintained until final follow-up (Fig. 4).

Among postoperative scores, a statically significant correlation was detected between GS and TSR ($P = 0.0311$), and between PS and TSR ($P = 0.0214$) (Fig. 5). Among preoperative and postoperative score variation, the amount of score change, significant correlation was detected between trapezium height and TSH ($P = 0.0319$), and trapezium height and TSR ($P = 0.0215$). No correlation was detected between rope position and other clinical or radiographic scores.

No complications, including bacterial infection, neuropraxia, or fracture of the second metacarpal, were observed in this series of patients. No revision surgery was required.

DISCUSSION

In the current study, we report favorable clinical results for the surgical procedure of arthroscopic partial

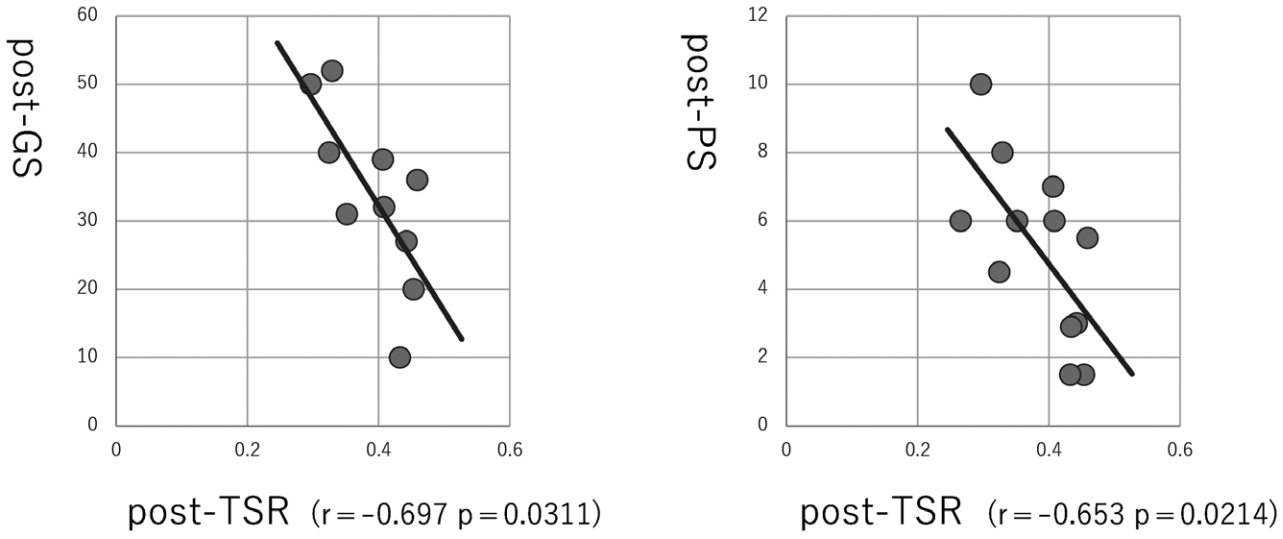

Fig. 5. Statically significant correlation between postoperative GS and TSR, and pinch and TSR.

trapeziectomy with suture-button suspensionplasty, with indication that the amount of trapeziectomy can play an important role in thumb function through metacarpal subsidence.

Surgical management of moderate to severe CMC osteoarthritis consists of hematoma distraction arthroplasty, ligament reconstruction and tendon interposition, and trapeziectomy with tendon interposition, among which no significant functional difference has been observed postoperatively.[7,8,11] Arthroscopic partial trapeziectomy is a minimally invasive technique with favorable functional outcomes compared with open surgical methods, preserving the joint capsules and ligaments.[14] Moreover, combined with suture-button suspensionplasty, this technique results in even better function, suspending the metacarpal and allowing a cushion of scar tissue to form within the trapeziectomy space.[12] In 2010, Cox et al first described suture-button suspensionplasty in 16 patients undergoing arthroscopic partial trapeziectomy, with encouraging results.[18] Two years later, Yao and Song reported the results of 21 patients who underwent suture-button suspensionplasty after partial (arthroscopic) or complete (open) trapeziectomy, with good functional outcomes.[9]

In the current study, we found that postoperative VAS score, PS, GS, PA-ROM, and RA-ROM were all significantly improved compared with their preoperative status. TSR declined approximately 12% over the 6-month follow-up period. Although our follow-up period is limited, this is considered relatively small compared with a previous study (26% in 2 years, 29% in 5 years).[19] Even utilizing suture-button for suspension, TSR declined during the follow-up period. In contrast, CMC joint subluxation was maintained until final follow-up with suture-button. The role of suture-button involves medialization of the proximal base of the first metacarpus rather than suspension to maintain the trapezial space.

Our data show a significant correlation between preoperative and postoperative score variation for trapezium height and both TSH and TSR, and excessive trapeziectomy was considered a possible contributory factor for postoperative metacarpal subsidence. Also, our finding that metacarpal subsidence can result in thumb function loss via declination of GS and PS indicates that excessive trapeziectomy can potentially cause functional deficiency of the thumb. On the other hand, some researchers reported that metacarpal subsidence after total trapeziectomy with ligament reconstruction and tendon interposition does not correlate with functional outcome.[20] Regarding trapeziectomy amount, Yao reported that the average postoperative trapezial height was 74% of the preoperative value.[12] Another previous study recommends reducing a minimum of 3–4 mm of the distal surface of the trapezium.[21] Yet another recommends avoiding excessive reduction and limiting the reduction amount to 3 mm radio-dorsally and 2 mm ulno-palmarly, which is considered favorable to preserve 50% of carpometacarpal ligament enthesis.[22] This previous research also reported that total trapeziectomy can result in residual pain through inducing scaphometacarpal impingement, and poor thumb function through MP hyperextension.[22] When comparing total and partial trapeziectomy, metacarpal subsidence was significantly less in partial trapeziectomy. Also, an inverse correlation between thumb length and Disabilities of the Arm, Shoulder, and Hand score has been reported.[23] The acceptable and optimal amount of trapeziectomy or degree of metacarpal subsidence remains unknown, and further study is needed.

Regarding the rope position, Yao recommended that the rope pass from the thumb metacarpal base slightly distally to the second metacarpal metaphyseal–diaphyseal junction.[12] The manufacturer recommends that the rope pass through the proximal one-third of the second metacarpal.[24] In previous research, a low angle rope trended toward resisting subsidence more than a high angle rope.[25] No correlation between rope position and metacarpal subsidence was detected in this study. It is possible

that metacarpal subsidence is caused by the amount of trapeziectomy, and that suture-button plays an important role not in metacarpal subsidence but in medialization of the first metacarpal base.

This study had some limitations. First, being a retrospective study, it only included patients who were able to return for follow-up. Second, the relatively short follow-up period of 6 months is also a limitation to this study. Third, we did not measure the function scores such as the Disabilities of the Arm, Shoulder, and Hand score, Hand20, or Michigan Hand Questionnaire score, but measured only the VAS score as a patient-related outcome. Fourth, we do not have control data of patients who underwent other surgical procedures such as partial trapeziectomy alone, nor are we aware of the impact of joint capsule or ligament removal. In addition, we do not have data regarding cost analysis, such as time of anesthesia and operation, equipment needed, and comparison with traditional procedures.

In conclusion, among various surgical treatments for thumb CMC osteoarthritis, partial trapeziectomy with suture-button suspensionplasty exhibits good clinical outcomes in both subjective and objective scores. Although the appropriate amount of trapeziectomy and acceptable degree of postoperative metacarpal subsidence are not yet clearly understood, our data highlighted the possibility that excessive trapeziectomy can result in functional deficiency of the thumb through metacarpal subsidence, which potentially causes loss of GS and PS. Therefore, in future study, search for optimal amount of trapeziectomy is strongly desired to avoid subsidence after surgery, therefore leading to even better outcomes.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

REFERENCES

1. Sodha S, Ring D, Zurakowski D, et al. Prevalence of osteoarthrosis of the trapeziometacarpal joint. *J Bone Joint Surg Am.* 2005;87:2614–2618.
2. Haara MM, Heliövaara M, Kröger H, et al. Osteoarthritis in the carpometacarpal joint of the thumb. Prevalence and associations with disability and mortality. *J Bone Joint Surg Am.* 2004;86:1452–1457.
3. Berger AJ, Meals RA. Management of osteoarthrosis of the thumb joints. *J Hand Surg Am.* 2015;40:843–850.
4. Parker WL, Linscheid RL, Amadio PC. Long-term outcomes of first metacarpal extension osteotomy in the treatment of carpal-metacarpal osteoarthritis. *J Hand Surg Am.* 2008;33:1737–1743.
5. Vermeulen GM, Brink SM, Slijper H, et al. Trapeziometacarpal arthrodesis or trapeziectomy with ligament reconstruction in primary trapeziometacarpal osteoarthritis: a randomized controlled trial. *J Bone Joint Surg Am.* 2014;96:726–733.
6. Huang K, Hollevoet N, Giddins G. Thumb carpometacarpal joint total arthroplasty: a systematic review. *J Hand Surg Eur Vol.* 2015;40:338–350.
7. Vinycomb T, Crock J. Trapeziectomy with ligament reconstruction and tendon interposition: a minimum 10-year follow-up. *Hand Surg.* 2013;18:365–368.
8. Gray KV, Meals RA. Hematoma and distraction arthroplasty for thumb basal joint osteoarthritis: minimum 6.5-year follow-up evaluation. *J Hand Surg Am.* 2007;32:23–29.
9. Yao J, Song Y. Suture-button suspensionplasty for thumb carpometacarpal arthritis: a minimum 2-year follow-up. *J Hand Surg Am.* 2013;38:1161–1165.
10. Wajon A, Vinycomb T, Carr E, et al. Surgery for thumb (trapeziometacarpal joint) osteoarthritis. *Cochrane Database Syst Rev.* 2015;2:Cd004631.
11. Baker RHJ, Al-Shukri J, Davis TRC. Evidence-based medicine: thumb basal joint arthritis. *Plast Reconstr Surg.* 2017;139:256e–266e.
12. Yao J, Cheah AE. Mean 5-year follow-up for suture button suspensionplasty in the treatment of thumb carpometacarpal joint osteoarthritis. *J Hand Surg Am.* 2017;42:569.e1–569.e11.
13. Özçelik IB, Uğurlar M, Sarı A. Arthroscopic hemitrapeziectomy and suture button suspensionplasty in the treatment of first carpometacarpal joint Eaton-Littler stage 2-3 arthrosis. *J Wrist Surg.* 2019;8:132–138.
14. Maeda A, Ikeguchi R, Noguchi T, et al. Clinical results of arthroscopic partial trapeziectomy with suture-button suspensionplasty for thumb carpometacarpal arthritis. *Hand (N Y).* 2022; 15589447221075663.
15. Lucet A, Ligeard M, Salle de Chou E, et al. Arthroscopic treatment of basal joint arthritis by partial trapeziectomy with ligament reconstruction: short-term results from a prospective study of 20 patients. *Hand Surg Rehabil.* 2019;38:102–107.
16. Chuang MY, Huang CH, Lu YC, et al. Arthroscopic partial trapeziectomy and tendon interposition for thumb carpometacarpal arthritis. *J Orthop Surg Res.* 2015;10:184.
17. Aliu O, Davis MM, DeMonner S, et al. The influence of evidence in the surgical treatment of thumb basilar joint arthritis. *Plast Reconstr Surg.* 2013;131:816–828.
18. Cox CA, Zlotolow DA, Yao J. Suture button suspensionplasty after arthroscopic hemitrapeziectomy for treatment of thumb carpometacarpal arthritis. *Arthroscopy.* 2010;26:1395–1403.
19. Yoshimura Y, Ichihara S, Hara A, et al. Examination of the effect of thumb string shortening and insertion position after suture-button suspensionplasty for thumb carpometacarpal arthritis. *J Jpn Soc Surg Hand.* 2021;38:237–241.
20. Yang SS, Weiland AJ. First metacarpal subsidence during pinch after ligament reconstruction and tendon interposition basal joint arthroplasty of the thumb. *J Hand Surg Am.* 1998;23:879–883.
21. Corella F, Ocampos M, Laredo R, et al. Arthroscopic trapeziectomy and suture button suspensionplasty: a review of the literature and description of the "three-step arthroscopic trapeziectomy technique." *J Wrist Surg.* 2022;9:366–381.
22. Higashi Y, Hayami N, Fujitani R, et al. Functional and radiological outcomes of arthroscopic hemi-trapeziectomy and suspensionplasty for trapeziometacarpal osteoarthritis. *J Jpn Soc Surg Hand.* 2021;38:228–232.
23. Salas C, Mercer DM, O'Mahony G, et al. Thumb metacarpal subsidence after partial trapeziectomy with capsular interposition arthroplasty: A biomechanical study. *Hand (N Y).* 2016;11:444–449.
24. Mini TightRope CMC Surgical Technique. Available at https://arthrex.g.kuroco-img.app/v=1647399694/files/topics/47254_ext_04_0.pdf. Accessed May 4, 2022.
25. Hozack BA, Fram B, Ilyas AM, et al. Optimal position of the suture button suspensionplasty (TightRope) for thumb basal joint arthritis. *Hand (N Y).* 2022;17:79–84.