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# Comparative Analysis of Ultrasound-Assisted Precise Localization vs. Traditional Open Incision in Situ Decompression for the Treatment of Cubital Tunnel Syndrome

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## ABSTRACT

**AIM:** To retrospectively analyze and compare ultrasound-assisted localization in situ with the traditional, open incision method for treating cubital tunnel syndrome (CuTS).

**MATERIAL and METHODS:** We retrospectively analyzed 51 patients treated between 2018 and 2022 and categorized them according to treatment method: ultrasound-assisted precise localization in situ decompression (n=21; Cohort 1) and traditional open incision in situ decompression (n=30; Cohort 2). We additionally collected Visual Analogue Scale (VAS) scores, Vancouver Scar Scale (VSS) scores, modified Bishop scores, aesthetic appearance, preoperative Dellon's stage, and analgesics requirements. Additional dependent variables of interest included operation time, hospital stay duration, complications, and reoperation rate.

**RESULTS:** Neither cohort demonstrated significant changes in Dellon's stage, modified Bishop score, or VAS scores between baseline and 6 weeks postoperative. Cohort 1 showed better aesthetics and postoperative VSS and VAS scores than Cohort 1. In addition, Cohort 1 enjoyed a significantly shorter mean operation time and hospital stay. Cohort 1 had 5 (23.80%) complications, including superficial infection (n=1), hematoma (n=1), and incomplete decompression (n=3). Cohort 2 had 9 complications (30.00%), including superficial infection (n=2), hematoma (n=2), and severe scarring (n=5). The partial, incomplete decompression cases in Cohort 1 and the severe scar case in Cohort 2 were treated with reoperation.

**CONCLUSION:** Both procedures effectively treated most cases of CuTS and were associated with good postoperative outcomes. Patients who underwent ultrasound-assisted localization in situ decompression had shorter surgeries and hospital stays, better postoperative aesthetics, better VSS and VAS scores, and required less pain medication during the postoperative period. Traditional open incision in situ produced a more thorough decompression.

**KEYWORDS:** Cubital tunnel syndrome, Ultrasound, Ulnar nerve, Decompression

## INTRODUCTION

Cubital tunnel syndrome (CuTS) is the second most common upper extremity, peripheral nerve entrapment site, with the most common site being the elbow (7). The typical clinical manifestations of CuTS include paresthesias in the ring/small finger and the dorsum of the hand, including numbness, tingling, and hypesthesia. In severe cases, the hypothenar and other intrinsic hand muscles can atrophy or develop claw finger deformities (10,20). Patients with milder symptoms can be effectively treated using conservative methods; surgery is preferred for patients with more severe symptoms.

Surgical treatment methods for CuTS include traditional open *in situ* decompression, endoscopic *in situ* decompression, ul-

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trasound-assisted precise localization *in situ* decompression, etc. With the development of ultrasound technology and minimally invasive surgery, ultrasound-assisted precise localization *in situ* decompression has been widely applied (9,17). Although many studies have reported that ultrasound-assisted precise localization *in situ* decompression is an effective treatment for CuTS, no study has compared that with traditional incision *in situ* decompression.

Therefore, we retrospectively compared the two surgical procedures' clinical efficacy, advantages, and disadvantages and described our experience treating patients with CuTS.

## MATERIAL and METHODS

### Study Population

A follow-up analysis was conducted on patients with CuTS from 2018 to 2022. The inclusion criteria were confirmed diagnosis of CuTS, physical examination results (including instances of paresthesias in the ring/small finger and the dorsum of the hand and/or atrophy of the hypothenar muscles and other intrinsic muscles of hands), ultrasound [including maximum cross-sectional area (CSA) of the ulnar nerve around the cubital tunnel ≥0.10 $cm^2$], and electromyography (EMG; motor conduction velocity across the elbow <50 m/s). We excluded patients with osseous anomalies around the elbow, peripheral neuropathies, subluxation of the ulnar nerve in the cubital tunnel, and tumors. The patients were divided into two cohorts according to treatment: Cohort 1 received ultrasound-assisted precise localization *in situ* decompression, and Cohort 2 underwent traditional open incision *in situ* decompression. Before the operation, the advantages and disadvantages of the two surgical methods were discussed with the patients and their close relatives in a nonpersuasive fashion, and the treatments were selected by the patients themselves. This study was performed following the 1975 Declaration of Helsinki. The institutional review board approved this study, and each patient provided informed consent to use his or her data at the final follow-up (Ethics Committee of Clinical Medicine, Yangzhou University; Date: July 30, 2022; N0.:YZUNSFC2022-LCYXY-51).

### Surgical Procedure

#### *Ultrasound-assisted precise localization in situ decompression*

For ultrasound-assisted precise localization, the compression site with the maximum CSA of the ulnar nerve around the cubital tunnel ≥0.10 $cm^2$ was marked on the skin's surface with a marker. Then, the skin and subcutaneous tissue of the compression site were incised. The ulnar nerve around this site was exposed and decompressed *in situ* (Figure 1).

#### *Traditional open incision in situ decompression*

After brachial plexus anesthesia, the skin and subcutaneous tissue were cut sequentially. The ulnar nerve was identified and decompressed *in situ* from about 5 cm above to about 5cm below the medial epicondyle of the humerus. While protecting the posterior branches of the medial antebrachial cutaneous nerve, the surgeon released the distal aspect of the medial intermuscular septum, the arcuate ligament of Osborne, and the two heads of the flexor carpi ulnaris. Care was taken to protect the ulnar nerve's stability within the cubital tunnel to prevent ulnar nerve subluxation. If subluxation occurred, anterior ulnar nerve surgery was considered (Figure 2).

### Postoperative Management

Both cohorts were hospitalized postoperatively, and painkillers were initiated and adjusted according to the patient's postoperative VAS and individual pain tolerance. Hospital discharge was determined based on the patient's wound condition and willingness.

### The Evaluation Indexes

The VAS (15,21) was used to assess pain immediately and 6 weeks postoperatively. The VAS consisted of an 10 cm line ranging from 0 (no pain) to 10 (the worst pain). All scars were assessed using the VSS, which examines pigmentation, vascularity, pliability, height, pruritus, and pain. The maximum total score was 18 points, with higher scores corresponding to more severe scarring and vice versa (5,12). The effect of in situ decompression CuTS symptoms was evaluated using the modified Bishop scoring system (9), graded as excellent (8–9), good (6–7), fair (4–5), or poor (0–3) based on the nine-point rating system, 12 months postoperative. Aesthetics/appearance was assessed by asking patients to rate their satisfaction (3 = satisfied; 2 = satisfied with reservations; 1 = dissatisfied). According to the sensory and motor injury innervated by the ulnar nerve and the related physical examination, Dellon's stages include mild, moderate, and severe (8). The need for pain medication was assessed as no need (score of 1), need for oral nonsteroidal drugs (score of 2), and need for intravenous nonsteroidal drugs (score of 3), with lower scores indicating less of a need for pain killers and vice versa. Operation time, hospital stay, complications, and whether or not reoperation occurred were also recorded.

### Statistical Analysis

Quantitative data from both cohorts are analyzed using the Mann–Whitney or Student's t-test. Between-cohort comparisons were made using the chi-square or Fisher's exact test, with statistical significance defined as $p<0.05$. All the statistical analyses were performed using SPSS (version 26.0) for Windows.

## RESULTS

### Cohorts' Characteristics

Fifty-one patients, including 21 in Cohort 1 and 30 in Cohort 2, met all inclusion/exclusion criteria and were included in the final analysis. Table I presents the Cohorts' demographic and clinical characteristics. No significant between-group differences existed for age, sex, follow-up time, disease period, preoperative CSA, or preoperative Dellon's stage composition ($p>0.05$). The mean follow-up times of Cohorts 1 and 2 were both 8 months (range: 1–36 months; $p>0.05$). Table II lists the Cohorts' clinical outcomes. The mean postopera-

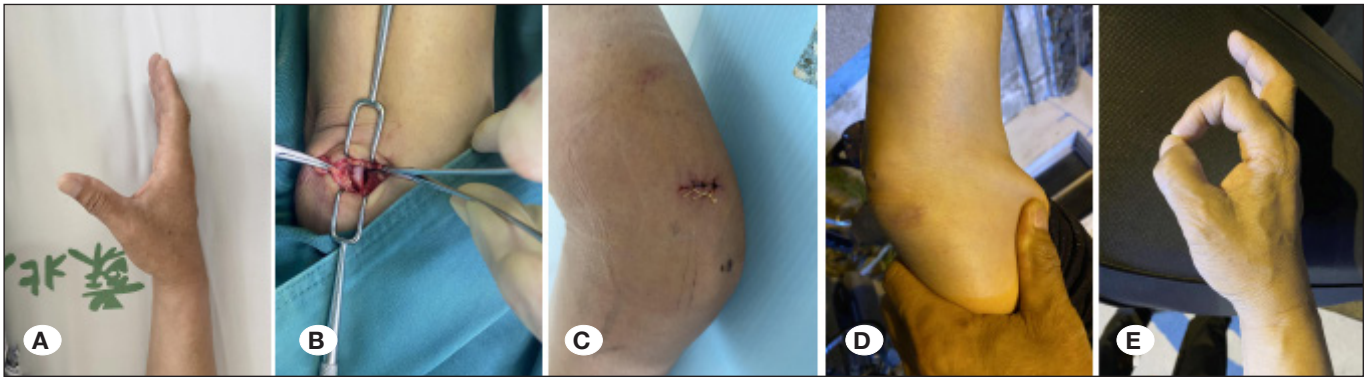


**Figure 1:** Ultrasound-assisted precise localization in situ decompression. **A)** Preoperative hand function. **B)** Small incision in surgery. **C)** Incisions one day after surgery. **D)** incisions 3 months after surgery. **E)** Hand function 3 months after surgery.

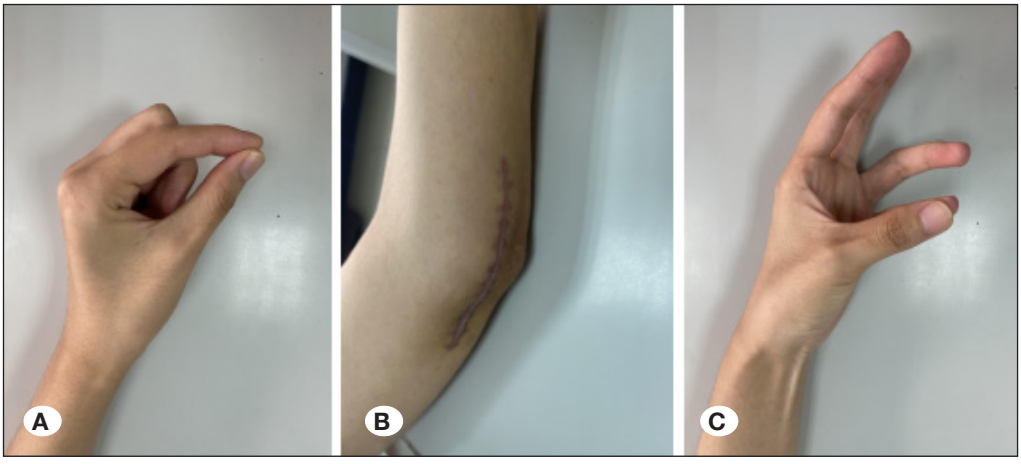


**Figure 2:** Traditional open incision in situ decompression. **A)** Hand function at three months after surgery 1. **B)** Incisions 3 months after surgery. **C)** Hand function at three months after surgery 2.

**Table I:** Demographic and Clinical Characteristics of Two Cohorts*

| Mesure | Cohort 1 | Cohort 2 | p-value |
|---|---|---|---|
| Age, (years) | 50.14 ± 16.20 (17,72) | 54.13 ± 15.00 (21,73) | p>0.05 |
| Gender | | | p>0.05 |
| Male | 12 | 15 | |
| Female | 9 | 15 | |
| Disease period | 8.38 ± 9.62 (1,36) | 8.20 ± 9.10 (1,36) | p>0.05 |
| Follow-up time | 9.24 ± 2.21 (6,14) | 8.93 ± 3.04 (6,18) | p>0.05 |
| Preoperative CSA | 0.14 ± 0.33 (0.1,0.22) | 0.15 ± 0.31 (0.1,0.19) | p>0.05 |
| Dellon's stage | | | p>0.05 |
| Mild | 2 | 2 | |
| Moderate | 4 | 5 | |
| Severe | 15 | 23 | |

**Data are shown as n (%) and were determined using chi-square or Fisher exact test.*

**Table II:** Clinical Outcomes of Two Cohorts*

| Mesure | Cohort 1 | Cohort 2 | p-value |
|---|---|---|---|
| Post operation VAS | 2.95 ± 0.59 (2,4) | 5.03 ± 1.00 (4,7) | **p<0.05** |
| 6 weeks postoperation VAS | 2.14 ± 0.36 (2,3) | 2.30 ± 0.54 (2,4) | p>0.05 |
| VSS | 2.95 ± 0.74 (2,4) | 8.50 ± 3.58 (4,16) | p>0.05 |
| Bishop score | 7.24 ± 2.34 (2,9) | 6.73 ± 2.56 (2,9) | p>0.05 |
| Aesthetic Appearance | 1.19 ± 0.40 (1,2) | 1.87 ± 0.68 (2,3) | **p<0.05** |
| Painkillers requirement | 1.90 ± 0.31 (0,2) | 2.67 ± 0.48 (2,3) | **p<0.05** |
| Operation time | 37.62 ± 7.35 (25,50) | 39.30 ± 2.78 (35,45) | **p<0.05** |
| Hospital stay | 2.14 ± 0.85 (1,3) | 5.70 ± 1.29 (4,8) | **p<0.05** |

**Data are shown as mean ± SD and were determined using Mann-Whitney test or Student's t test*
*†Statistically significant difference.* ***VAS:*** *Visual analogue scale,* ***VSS:*** *Vancouver scar scale.*

**Table III:** Complications of the Two Cohorts*

| Complications | Cohort 1 | Cohort 2 | p-value |
|---|---|---|---|
| Superficial infection | 1 (4.77%) | 2 (6.67%) | p>0.05 |
| Hematoma | 1 (4.77%) | 2 (6.67%) | p>0.05 |
| Incomplete decompression | 3 (14.29%) | 0 (0%) | **p<0.05** |
| Severe scar | 0 (0%) | 5 (16.67%) | **p<0.05** |
| Total | 5 (23.80%) | 9 (30%) | p>0.05 |

**Data are shown as n and were determined using chi-square.*

tion VAS scores of Cohorts 1 [2.95 ± 0.59 (range 2–4)] and 2 [0.03 ± 1.00 (range 4–7)] were significantly different (p<0.05). However, there was no significant between-group difference in the mean VAS scores, obtained 6 weeks postoperatively from Cohorts 1 [2.14 ± 0.36 (range 2–3)] and 2 [2.30 ± 0.54 (range 2–4)] (p>0.05). The mean VSS scores of Cohorts 1 and 2 are 2.95 ± 0.74 (range 2–4 ) and 8.50 ± 3.58 (range 4–16), respectively, and there is a statistical difference (p<0.05). The aesthetic appearance mean scores of Cohorts 1 and 2 are 1.19 ± 0.40 (range 1–2) and 1.87 ± 0.68 (range 2–3), respectively, indicating a statistically significant advantage of the ultrasound-assisted precise localization *in situ* decompression cohort over the traditional open incision *in situ* decompression cohort (p<0.05). The mean Bishop scores of Cohorts 1 and 2 are 1.87 ± 0.68 (range 2–9) and 6.73 ± 2.56 (range 2–9), respectively, and there is a statistical difference (p<0.05). Comparing Cohorts 1 and 2, the mean operation time (37.62 ± 7.35 min (range 25–50 min) versus 39.30 ± 2.78 min (range 35–45 min), p<0.05), and hospital stay 2.14 days ± 0.85 days versus 5.70 days ± 1.29 days, p<0.05) all showed statistically significant differences, ultrasound-assisted precise localization *in situ* decompression has a great advantage over the traditional open situ decompression.

### Complications and Reoperation

Postoperative complications include superficial infection, deep infection, hematoma, incomplete decompression, and severe scarring. Of the 51 patients, 14 developed complications (Table III). Among them, five cases are in Cohort 1, and nine cases are in Cohort 2, with incidences of 23.80% and 30%, respectively, showing no statistical difference between the two cohorts. In Cohort 1, one patient acquired a superficial infection, one acquired hematoma, and three acquired incomplete decompression, which means that patients have limited recovery of symptoms after surgery. Postoperative ultrasound showed that the ulnar nerve is still decompressed in the cubital tunnel but not in its original location, and two need reoperation. In Cohort 2, two patients acquired a superficial infection, two acquired hematoma, and five had severe scars. In addition, the two patients with severe scars developed symptoms of ulnar nerve compression that required a second operation to resolve. The complications of superficial infection, deep infection, and hematoma in both cohorts are cured with dressing and drainage.

## DISCUSSION

CuTS is the second most common peripheral nerve entrapment, with an incidence of 0.36 per 1,000 (3,11). In addition to pain and discomfort, its major symptoms include sensory and motor impairments. Treatment aims to cure the condition and/or prevent symptom exacerbation.

Current CuTS treatments include splinting, and operations include *in situ* decompression, transposition, and epicondylectomy (13,18,19). Situ decompression can be divided into traditional open, endoscopic, and ultrasound-assisted techniques. These three methods have satisfactory efficacy (1). Traditional open *in situ* decompression is a relatively simple and effective treatment. Endoscopic *in situ* decompression is minimally invasive and produces only small scars. However, specialized endoscopic equipment and techniques are needed, increasing physician demands. Many comparative studies have reported the advantages and disadvantages of these two surgical methods (2,14). Ultrasound-assisted localization therapy is an accurate and comprehensive disease evaluation method that is minimally invasive and leaves only a small scar (9,16). However, there are few reports on the efficacy of ultrasound-assisted precise localization *in situ* decompression compared with traditional open *in situ* decompression for CuTS.

We use two surgical methods to treat CuTS: ultrasound-assisted precise localization *in situ* decompression and traditional open *in situ* decompression. Both methods produce satisfactory results, with no significant differences in postoperative Bishop scores. In addition, almost all patients achieved symptom relief without progression and varying sensory and functional recovery.

Ultrasound-assisted precise localization *in situ* decompression produced superior results for nearly all indexes reviewed and recorded. This method is precise, minimally invasive, and leaves only a small scar. In our experience, only a 3-cm incision is necessary for *in situ* release, much smaller than a traditional incision (typically around 10 cm). Patients who undergo ultrasound-assisted precise localization *in situ* decompression experience less pain the day after surgery than patients who undergo traditional release. This observation is consistent with cohort-specific differences in postoperative pain medication requirements. Traditional open *in situ* decompression methods typically require intravenous analgesics. However, most patients with ultrasound-assisted can achieve satisfactory pain relief using only oral analgesics. In fact, no patients required intravenous drugs, with few requiring analgesics. Cohort 1 enjoyed a shorter operation time and hospital stay duration, potentially mitigating the inconvenience of hospitalization. Compared with Cohort 2, Cohort 1 demonstrated superior postoperative scar appearance, scar length, color, softness, thickness, and pain. Disadvantages to ultrasound-assisted precise localization *in situ* decompression include the risk of incomplete release. Two patients in this study required reoperation for this reason. The location of incomplete release is not at the location marked by ultrasound before the first surgery, which is confirmed intraoperatively in patients undergoing secondary surgery. In one case, the incomplete release was caused by a small cyst in the cubital canal. The other patient experienced ulnar compression from thickened ligament tissue. These entrapment points were not detected during the patients' first ultrasound examinations. This oversight could be related to equipment- or operator-specific factors. Our study used a maximum CSA of the ulnar nerve around the cubital tunnel of ≥0.10 $cm^2$ to determine the compression point. This method features high diagnostic accuracy, with a sensitivity of 0.85 and a specificity of 0.91 (4,6). However, some small deep cysts and entrapment with insignificant CSA area enlargement may still escape detection.

No patients in Cohort 2 experienced incomplete release. This is the biggest advantage of the traditional open situ decompression methods, which treat the entrance of the cubital tunnel to the exit; consequently, the release is nearly always complete. However, the large-scale release can also damage surrounding tissue and cause scarring. Two patients required a second surgery because the nerve was trapped again due to severe scarring. Reoperation rates were 9.52% for Cohort 1 and 6.45% for Cohort 2, indicating no significant statistical difference.

Cohorts 1 and 2 had similar complication rates. Except for the second operation case mentioned above, no other patients required reoperation. Instances of infection and hematoma were resolved by dressing changes or immobilization.

This study had some limitations. First, because of the relatively short time after the second operation, our follow-up data from patients who underwent reoperation were incomplete; thus, our comparison remains incomplete until sufficient data is collected. Furthermore, the small sample size, short follow-up time, and retrospective design limited the strength of our findings. In addition, potential biases in personal practice and experience may exist.

## CONCLUSION

Ultrasound-assisted precise localization *in situ* decompression and traditional open *in situ* decompression effectively alleviated CuTS symptoms. Besides a higher risk of incomplete release, ultrasound-assisted precise localization *in situ* decompression had many advantages over traditional, more invasive methods. These advantages included less pain, less scarring, better postoperative appearance, and shorter hospital stays. However, the complete reliance on ultrasound for accurate positioning may increase the risk of incomplete release.

**AUTHORSHIP CONTRIBUTION**

Study conception and design: TW

Data collection: YW

Analysis and interpretation of results: WW

Draft manuscript preparation: CY

Critical revision of the article: WW

All authors (TW, YW, CY, WW) reviewed the results and approved the final version of the manuscript.

## REFERENCES

1. Bolster MA, Zophel OT, van den Heuvel ER, Ruettermann M: Cubital tunnel syndrome: A comparison of an endoscopic technique with a minimal invasive open technique. J Hand Surg Eur Vol 39:621-625, 2014

2. Buchanan PJ, Chieng LO, Hubbard ZS, Law TY, Chim H: Endoscopic versus open in situ cubital tunnel release: A systematic review of the literature and meta-analysis of 655 patients. Plast Reconstr Surg 141:679-684, 2018
3. Caliandro P, La Torre G, Padua R, Giannini F, Padua L: Treatment for ulnar neuropathy at the elbow. Cochrane Database Syst Rev 11:CD006839, 2016
4. Chang KV, Wu WT, Han DS, Ozcakar L: Ulnar nerve cross-sectional area for the diagnosis of cubital tunnel syndrome: A meta-analysis of ultrasonographic measurements. Arch Phys Med Rehabil 99:743-757, 2018
5. Chen HH, Huang TC, Hsu YC, Chen HC: Prospective clinical trial comparing barbed dermal suture and interrupted suture closure of the anterolateral thigh flap donor site in a Taiwanese population based on the Vancouver scar scale and the patient and observer scar assessment scale. J Plast Reconstr Aesthet Surg 74:3196-3211, 2021
6. Chen IJ, Chang KV, Wu WT, Ozcakar L: Ultrasound parameters other than the direct measurement of ulnar nerve size for diagnosing cubital tunnel syndrome: A systemic review and meta-analysis. Arch Phys Med Rehabil 100:1114-1130, 2019
7. Chiou HJ, Chou YH, Cheng SP, Hsu CC, Chan RC, Tiu CM, Teng MM, Chang CY: Cubital tunnel syndrome: Diagnosis by high-resolution ultrasonography. J Ultrasound Med 17:643-648, 1998
8. Dellon AL: Review of treatment results for ulnar nerve entrapment at the elbow. J Hand Surg Am 14:688-700, 1989
9. Gao JM, Yuan Y, Gong KT, Ma XL, Chen X: Ultrasound-assisted precise in situ decompression for cubital tunnel syndrome. Orthop Surg 13:840-846, 2021
10. Harding IJ, Morris IM: The aetiology and outcome of 170 ulnar nerve lesions confirmed with electrophysiological testing. Acta Orthop Belg 69:405-411, 2003
11. Hulkkonen S, Lampainen K, Auvinen J, Miettunen J, Karppinen J, Ryhanen J: Incidence and operations of median, ulnar and radial entrapment neuropathies in Finland: A nationwide register study. J Hand Surg Eur Vol 45:226-230, 2020
12. Kim JS, Hong JP, Choi JW, Seo DK, Lee ES, Lee HS: The efficacy of a silicone sheet in postoperative scar management. Adv Skin Wound Care 29:414-420, 2016
13. Kim KW, Lee HJ, Rhee SH, Baek GH: Minimal epicondylectomy improves neurologic deficits in moderate to severe cubital tunnel syndrome. Clin Orthop Relat Res 470:1405-1413, 2012
14. Krejci T, Vecera Z, Krejci O, Salounova D, Houdek M, Lipina R: Comparing endoscopic and open decompression of the ulnar nerve in cubital tunnel syndrome: A prospective randomized study. Acta Neurochir (Wien) 160:2011-2017, 2018
15. Lee JH, Alrashdan MS, Kim SG, Rim JS, Jabaiti S, Kim MJ, Kim SM: Functional and esthetic assessment of radial forearm flap donor site repaired with split thickness skin graft. Eur Arch Otorhinolaryngol 268:109-115, 2011
16. Limbekar NS, Soong MC, Vytopil MM, Blanchet DT, Paci GM, Ho DT: High-resolution ultrasound in the diagnosis and surgical management of ulnar neuropathy at the elbow. Orthopedics 44:285-288, 2021
17. Lucchina S, Fusetti C, Guidi M: Sonographic follow-up of patients with cubital tunnel syndrome undergoing in situ open neurolysis or endoscopic release: The SPECTRE study. Hand (NY) 16:385-390, 2021
18. Mahan MA, Gasco J, Mokhtee DB, Brown JM: Anatomical considerations of fascial release in ulnar nerve transposition: A concept revisited. J Neurosurg 123:1216-1222, 2015
19. Shah CM, Calfee RP, Gelberman RH, Goldfarb CA: Outcomes of rigid night splinting and activity modification in the treatment of cubital tunnel syndrome. J Hand Surg Am 38:1125-1130.e1, 2013
20. Staples JR, Calfee R: Cubital tunnel syndrome: Current concepts. J Am Acad Orthop Surg 25:e215-e224, 2017
21. Yuan C, Liu H, Zhang H, Wang T, Gu J: Reconstruction of thumb pulp defects using free lateral great toe flaps. J Hand Surg Am 46:421.e1-421.e7, 2021