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Outcomes of Tension-Free Epineural Repair in Digital Nerve Injuries

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Abstract

Purpose: Digital nerve injuries can lead to sensory loss, pain, cold intolerance, and reduced quality of life. This study evaluates the outcomes of primary tension-free end-to-end repair under a microscope and the factors affecting these results.

Methods: A retrospective review of 27 fingers from 23 patients treated between January 2022 and May 2024 was evaluated. Epineural repair was performed using 8:0 or 9:0 polypropylene sutures. Sensory recovery was assessed with two-point discrimination (2-PDT) and the Semmes-Weinstein Monofilament Test (SWMT). Cold intolerance and patient satisfaction were recorded.

Results: Of the patients, 43.5% (n=10) were female, with a mean age of 39.3 years (range: 15-56), and the mean follow-up duration was 21.1 months (range: 6-31). The mean 2-PDT was 8.89 ± 3.9 mm (range: 4-20), with excellent and good sensory recovery observed in 92.6% of cases. The mean SWMT was 3.49 ± 0.6 (range: 2.44-5.07), and only 3.7% of patients exhibited loss of protective sensation. Cold intolerance was present in 48.1% of cases. Patient satisfaction scores averaged 7.8 ± 1.3 (range: 5-10) on a 10-point scale. The presence of flexor tendon or digital artery injuries and cold intolerance was significantly associated with lower satisfaction scores ($p < 0.05$)

Conclusion: Primary epineural repair under a microscope is effective in restoring sensory function following digital nerve injuries and contributes to high patient satisfaction. However, coexisting injuries and cold intolerance negatively impact outcomes. Further studies with larger cohorts are needed.

Keywords: Digital nerve injury, digital nerve repair, sensory recovery, cold intolerance, patient satisfaction.

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Dijital Sinir Yaralanmalarında Gerilimsiz Epinöral Tamir Sonuçları

Öz

Amaç: Dijital sinir yaralanmaları duyu kaybı, ağrı, soğuk intoleransı ve yaşam kalitesinde azalmaya neden olabilir. Bu çalışma, mikroskop eşliğinde gerçekleştirilen primer gerilimsiz uç-uca onarımın sonuçlarını ve bu sonuçları etkileyen faktörleri değerlendirmeyi amaçlamaktadır.

Yöntemler: Ocak 2022 ile Mayıs 2024 tarihleri arasında dijital sinir yaralanması bulunan 23 hastanın 27 parmağı retrospektif olarak incelendi. Epinöral onarım, 8:0 veya 9:0 polipropilen sütürler kullanılarak gerçekleştirildi. Duyusal iyileşme, iki nokta diskriminasyon testi (2-PDT) ve Semmes-Weinstein Monofilament Testi (SWMT) ile değerlendirildi. Soğuk intoleransı ve hasta memnuniyeti kaydedildi.

Bulgular: Hastaların %43,5'i (n=10) kadın olup, ortalama yaş 39,3 yıl (aralık: 15-56) ve ortalama takip süresi 21,1 ay (aralık: 6-31) idi. Ortalama 2-PDT 8,89 ± 3,9 mm (aralık: 4-20) olarak bulundu ve vakaların %92,6'sında mükemmel ve iyi duyusal iyileşme gözlendi. Ortalama SWMT değeri 3,49 ± 0,6 (aralık: 2,44-5,07) olup, yalnızca %3,7 hastada koruyucu duyunun kaybı saptandı. Soğuk intoleransı vakaların %48,1'inde mevcut idi. Hasta memnuniyet skorları 10 üzerinden ortalama 7,8 ±1,3 (aralık: 5-10) olarak belirlendi. Fleksör tendon veya dijital arter yaralanmalarının varlığı ve soğuk intoleransı, anlamlı şekilde daha düşük memnuniyet skorları ile ilişkilendirildi ($p < 0,05$).

Sonuç: Mikroskop altında gerçekleştirilen primer epinöral onarım, dijital sinir yaralanmalarında duyusal fonksiyonun geri kazanılmasında etkili olup, yüksek hasta memnuniyeti sağlamaktadır. Bununla birlikte, eşlik eden yaralanmalar ve soğuk intoleransı sonuçları olumsuz etkilemektedir. Daha büyük hasta gruplarıyla ve daha uzun takip süreleriyle yapılacak ileri çalışmalara ihtiyaç vardır.

Anahtar kelimeler: Dijital sinir yaralanması, dijital sinir onarımı, duyusal iyileşme, soğuk intoleransı, hasta memnuniyeti.

INTRODUCTION

Digital nerve injuries of the fingers are among the most common hand traumas[1]. In Europe, the incidence of digital nerve injuries is 6.2 per 100,000 people[2]. They often occur following cuts from sharp objects such as knives or glass but can also result from severe hand trauma[3,4]. Digital nerve injuries are often associated with concomitant tendon lacerations, arterial injuries, and fractures[5].

Digital nerve injuries can cause sensory loss, pain, numbness, cold sensitivity, and reduced quality of life in the fingers[6]. With advancements in microsurgical techniques, primary tension-free end-to-end repair has become the standard treatment for digital nerve injuries [7-9]. In delayed cases, primary repair may not be possible due to gap formation after debridement, requiring nerve grafting[5,10]. Therefore, timely and appropriate treatment can optimize patient outcomes.

Various factors such as age, type of injury, time from injury to repair, repair type, and follow-up duration can influence nerve recovery[4,11]. However, there is limited evidence on functional recovery and the benefits of nerve repair as reported by patients, and clinical uncertainty remains regarding the effectiveness of repair following digital nerve injuries.

This study aimed to objectively and subjectively evaluate the outcomes of patients who underwent primary end-to-end epineural repair under a microscope for digital nerve injuries and to analyze the factors influencing these outcomes.

METHODS

Patients who underwent primary end-to-end repair for digital nerve injuries between January 2022 and May 2024 were retrospectively reviewed. Patient data collection was conducted after obtaining approval from institutional clinical research

ethics committee (Decision no:2025/134). All patients were informed about the study's purpose in accordance with the Helsinki Declaration, and consent was obtained.

Patients who declined to participate, did not attend regular follow-ups, had less than 6 months of follow-up, underwent graft repair, or had communication difficulties (pediatric patients or adults with mental disabilities) were excluded.

Surgical Technique

Following admission to the emergency department, all patients underwent appropriate preoperative preparation and were subsequently taken to the operating room. Surgical procedures were performed under either general anesthesia or regional nerve block, with the use of a pneumatic tourniquet to ensure a bloodless field. Prophylactic intravenous cephalosporin was routinely administered prior to the skin incision. The digital nerve was exposed using a Bruner incision to allow optimal visualization and access. Under an operating microscope, the severed ends of the digital nerve were meticulously prepared. Microsurgical repair was then performed using an epineural end-to-end technique with 3 to 4 interrupted sutures of 8-0 or 9-0 polypropylene, ensuring a tension-free approximation (Figures 1 and 2). Associated injuries, including fractures of the phalanges, digital artery lacerations, and flexor tendon injuries, were simultaneously addressed and repaired as indicated. The tourniquet was released prior to skin closure to facilitate hemostasis. Postoperatively, all patients were immobilized with a dorsal protective splint for a duration of four weeks.

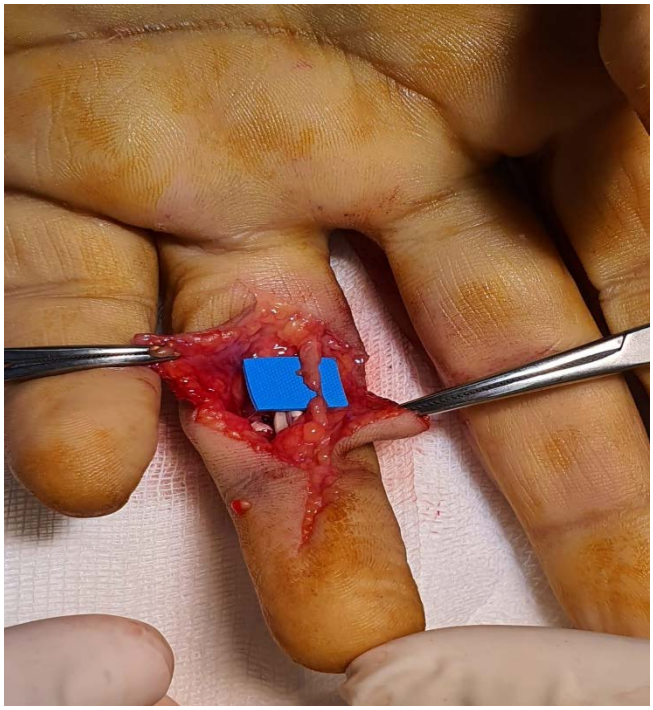

Figure 1: Digital nerve injury

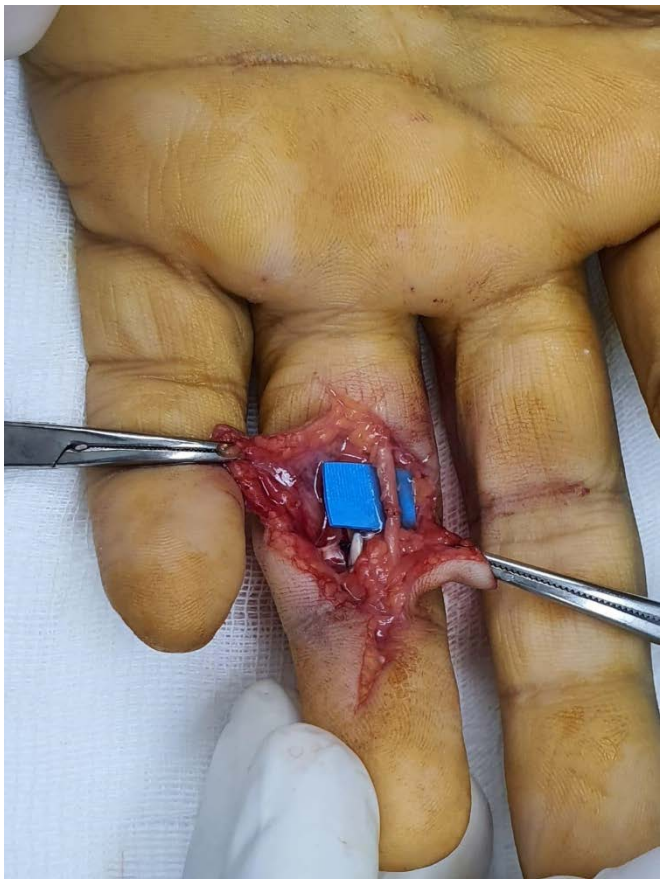

Figure 2: Digital nerve after epineural repair

Patient age, gender, follow-up duration, injured side, finger and digital nerve involvement, and accompanying bone fractures, digital artery, and flexor tendon injuries were recorded.

Sensory recovery was assessed using two-point discrimination (2-PDT) and Semmes-Weinstein Monofilament Test (SWMT). The 2-PDT was performed using a Dellon 2-Point Disk-Criminator, and the narrowest distance at which two points were felt was recorded in millimeters. Results were classified as excellent (≤ 6 mm), good (7-15 mm), and poor (15-30 mm) according to the Mackinnon classification[11]. SWMT was performed using a 20-piece monofilament set (Touch-Test, North Coast Medical Inc., Gilroy, CA, USA). Monofilaments were applied vertically to the skin with the patient's eyes closed, pressed until slight bending occurred for two seconds, and results were recorded based on monofilament markings. A modified classification system derived from Imai et al. was used to group SWMT results, with scores ≤ 2.83 considered "normal," 2.83-4.31 as "reduced light touch," 4.31-4.56 as "reduced protective sensation," 4.56-6.10 as "loss of protective sensation," and > 6.10 as "anesthetic"[11].

Cold intolerance was categorized as none:1, mild:2, moderate:3, and severe:4, and patients were asked to self-report their condition.

Postoperative satisfaction was assessed using a 10-point scale, with 1 being "not satisfied at all" and 10 being "very satisfied."

Statistical Analysis: Data were analyzed using SPSS software (ver. 30.0; IBM Corp., Armonk, NY, USA). Normality was assessed using the Kolmogorov-Smirnov test, skewness, and kurtosis. Categorical variables were compared using Pearson's chi-squared test and Fisher's exact test. Parametric variables were compared using an independent sample t-test. Quantitative variables are expressed as mean ± standard deviation, and qualitative variables as numbers (n), frequencies, or percentages. P-values < 0.05 were considered statistically significant.

RESULTS

Primary epineural repair was performed on 27 fingers of 23 patients with digital nerve injuries. Of the patients, 43.5% (n=10) were female, and 56.5% (n=13) were male. The mean age at surgery was 39.3 years (range: 15-56), and the mean follow-up duration was 21.11 months (range: 6-31). The right side was involved in 40.7% (n=11) of cases, and the left side in 59.3% (n=16). All patients were right-hand dominant. The second finger was injured in 40.7% (n=11), the first finger in 18.5% (n=5), the third finger in 14.8% (n=4), the fourth finger in 14.8% (n=4), and the fifth finger in 11.2% (n=3). The radial digital nerve was injured in 70.4% (n=19), and the ulnar digital nerve in 29.6% (n=8). Two partial injuries were observed in both radial and ulnar digital nerves.

Digital artery injuries were present in 37% (n=10), flexor tendon injuries in 37% (n=10), and bone fractures in 7.4% (n=2).

The mean 2-PDT was 8.89 ± 3.9 mm (range: 4-20). According to the Mackinnon classification, 40.7% (n=11) had excellent, 51.9% (n=14) had good, and 7.4% (n=2) had poor outcomes. The mean SWMT was 3.49 ± 0.6 (range: 2.44-5.07). Based on the Imai classification, 22.2% (n=6) had normal sensation, 66.7% (n=18) had reduced light touch, 7.4% (n=2) had reduced protective sensation, and 3.7% (n=1) had loss of protective sensation.

Cold intolerance was present in 48.1% of cases (33.3% mild, 11.1% moderate, and 3.7% severe). Cold intolerance was significantly more common in patients with digital artery injuries ($p < 0.05$).

The mean patient satisfaction score was 7.85 ± 1.3 (range: 5-10). No significant association was found between gender, side of injury, or

presence of bone fractures and overall satisfaction scores ($p > 0.05$). Patients with flexor tendon or digital artery injuries and cold intolerance had significantly lower satisfaction scores ($p < 0.05$). Patients with partial digital nerve injuries had significantly higher satisfaction scores compared to those with complete injuries ($p < 0.05$).

DISCUSSION

Digital nerve injuries are among the most common peripheral nerve injuries and often result from cuts by sharp objects. If left untreated, they can lead to sensory loss, impaired hand function, and reduced quality of life[11,13,14]. In this study, we evaluated the objective and subjective outcomes of patients who underwent primary end-to-end epineural repair under a microscope for digital nerve injuries. Our results showed that sensory function improved after digital nerve repair, with high patient satisfaction. However, satisfaction was lower in patients with flexor tendon or digital artery injuries and those with cold intolerance.

Digital nerve injuries frequently occur in young males and in the non-dominant hand[4,13,15]. The demographic data in our study are similar to other published studies; the mean age of patients with digital nerve injuries was 39.3 years and 56.5% of the patients were male. This is likely due to the working population predominantly consisting of males[2]. Additionally, 59.3% of injuries occurred in the non-dominant hand. Since most cutting and mechanical tools are held with the dominant hand, the non-dominant hand is more exposed to trauma and injury. Consistent with the literature, the index finger was the most commonly injured (40.7%) in our study[13,15].

Digital nerve injuries are rarely isolated. Fakin et al. reported that 56% of patients had digital artery injuries, 44% had tendon injuries, and 7% had bone fractures[16]. In a systematic review by Kim et al., 13% of patients had digital artery injuries, 31% had tendon injuries, and 6% had bone fractures[17]. Similarly, in our study, 37% of fingers had digital artery injuries, 37% had flexor tendon injuries, and 7.4% had bone fractures. Because of the nature of the trauma that caused the injury and the close anatomical proximity of the digital artery, nerve, and bone, it is not surprising that digital nerve injuries are accompanied by artery, tendon, and bone injuries.

While no sensory test comprehensively evaluates all sensory and hand function parameters, 2-PDT and SWMT are commonly used to objectively assess sensory recovery[6]. Bulut et al. reported excellent and good outcomes in 91% of patients following digital nerve repair, with 10% experiencing loss of protective sensation[11]. Similarly, Herman et al. found that 92% of patients had excellent or good outcomes, while 16% had loss of protective sensation[20]. Our results also demonstrated significant sensory recovery, with 92.6% of patients achieving excellent or good outcomes based on 2-PDT. According to SWMT, only 3.7% of patients experienced loss of protective sensation. These results likely contributed to high patient satisfaction. The lower rate of protective sensation loss in our study compared to the literature may be due to the relatively small sample size, and this rate may increase with larger patient groups. These findings align with previous research highlighting the effectiveness of microsurgical techniques in restoring sensory function following digital nerve injuries[9,15,18,19]. However, the possibility of protective sensation loss should always be discussed with patients preoperatively.

Cold intolerance is a common complication following nerve injuries, and its pathophysiology is not fully understood[6,21,22]. While the nerve injury itself is likely the primary factor, accompanying vascular injuries have

also been associated with cold intolerance[21]. Repairing digital artery injuries has been reported to positively influence outcomes, possibly due to improved blood flow in the surrounding tissues, which may enhance nerve recovery[23]. In a systematic review by Dunlop et al., cold intolerance was reported in 2-53% of patients following digital nerve repair[24]. In our study, cold intolerance was observed in 48.1% of cases, consistent with the literature. However, cold intolerance was significantly more common in patients with digital artery injuries, which we attribute to incomplete restoration of perfusion following artery repair. Cold intolerance is widely recognized as a complication that disrupts daily activities and reduces patient satisfaction[21,22]. *In our study*, lower satisfaction scores were observed in patients with cold intolerance and accompanying flexor tendon or digital artery injuries. Digital artery injuries likely increased cold intolerance, while flexor tendon injuries may have contributed to joint stiffness and limited motion, both of which negatively impacted satisfaction[15,21,22]. Higher satisfaction scores in patients with partial nerve injuries compared to those with complete injuries highlight the importance of injury severity on patient-reported outcomes. This finding aligns with previous studies emphasizing the role of low trauma in nerve recovery[4,11].

Our study has several limitations. The small sample size limits the generalizability of the results. The retrospective design introduces the risk of bias in data obtained from medical records. Surgeries were performed by different surgeons, which may have introduced variability. More homogeneous results could be achieved if all repairs were performed by a single surgeon. Although our results are promising, the mean follow-up duration was relatively short. We recommend further studies with larger patient groups, prospective designs, and longer follow-up periods to confirm these findings.

In conclusion, this study demonstrates that primary epineural repair under a microscope following digital nerve injuries promotes sensory recovery and enhances overall patient satisfaction. However, satisfaction was lower in cases with accompanying flexor tendon or digital artery injuries and cold intolerance. These findings underscore the importance of early and appropriate surgical intervention, as well as meticulous repair of accompanying injuries.

Ethics Committee Approval: Patient data collection was conducted after obtaining approval from the institutional clinical research ethics committee (Decision no:2025/134). All patients were informed about the study's purpose in accordance with the Helsinki Declaration, and consent was obtained.

Conflict of Interest: The authors declared no conflicts of interest.

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