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Original Research Paper

Ultrasound guided Brachial Plexus Catheter for Upper Limb Digit Reimplantation Surgeries: A Retrospective Analysis of One Year in a Tertiary Trauma Center.

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ABSTRACT:
Introduction: Most traumatic digital amputations occur at a young age and the treatment options are revascularization, replantation of the amputated segment, or stump closure. Anesthesia management in these patients plays a major role, including the insertion of a brachial plexus catheter for adequate pain control and vasodilation. Use of ultrasound not only reduces incidence of complications but also enhances success rate. **Methods**: After approval from the Clinical Audit & Control Department, a retrospective analysis was performed in all patients who underwent digit reimplantation surgeries in 2022. Brachial plexus catheters were inserted intraoperatively under general anesthesia or after extubation in the Post Anesthesia Care Unit (PACU). All brachial plexus catheterization was performed under dual guidance (ultrasound + peripheral nerve stimulator). **Results**: A total of 46 patients underwent digit reimplantation surgery in the year 2022, and the supraclavicular catheter was the most preferred site of catheter insertion in 37 patients (80%). Five patients (11%) developed catheter related complications, which were detected early and managed accordingly. In our case series, a success rate of 70% was found, while a failure rate of 22%, where the end point was amputations. **Conclusion**: Insertion of a brachial plexus catheter in digit reimplantation surgery resulted in better outcomes. It helps counter pain induced vasoconstriction and leads to vasodilation, improving the peripheral circulation.

Keywords: Traumatic amputation, reimplantation, continuous brachial plexus catheter, ultrasound guided, survival of digits.

INTRODUCTION:

Traumatic digit amputations are a common surgery in Rashid hospital, Dubai, United Arab Emirates, being tertiary trauma center with experienced hand surgery team, success of reimplanted digit depends on working as team. Anesthesia management plays a major role in these patients. Although digit amputation is usually not life threatening, it decreases the patient's ability to perform the same pre-injury tasks and causes psychological stress[1,2]. In addition, most patients with traumatic digital amputation are young and of a working age. Treatment options includes revascularization, replantation of the amputated segment, or stump closure.

Most of these patients receive general anesthesia during reimplantation surgery because these surgeries are of longer duration and require absolute immobility as a surgical team working under a microscope. After reimplantation, they receive a brachial plexus catheter[2,3] for vasodilation and increased vascular perfusion in the reimplanted digit to improve survival. Pain management also plays a key role in the prevention of pain induced vasoconstriction. The Brachial plexus can be inserted in

various location[3-5] depending on the patient's condition and anesthetist's experience.

Based on above evidences our hypothesis is that use of brachial plexus catheter for digit amputation provide vasodilation and provide adequate analgesia thus, avoiding pain induced vasoconstriction.

Use of currently available high-resolution ultrasound for brachial plexus catheter allows prompt depiction of brachial plexus and surrounding anatomy including vasculature. Identification of pleura is very important in avoiding potential serious complications. Thus, we decided to use ultrasound guided brachial catheter insertion to avoid completion and to increase success rate.

In the postoperative period, close monitoring of vascular patency is key to the survival of the replanted digit[6-8]. Perfusion will be monitored by the surgical team and staff nurse by examining the color, pulp turgor, capillary refill, and temperature of the replanted digit[9,10].

METHOD:

After approval from the Clinical Audit & Control Department, Dubai Health authorities, HRS/RH/023/2023 retrospective analysis was performed for all patients who underwent digit reimplantation surgeries in 2022. Reimplantation of the digit was defined as a partial or total amputation of the digit in which vascular restoration was performed. There were no exclusion criteria. All patients were evaluated and graded according to the American Society of Anesthesiology criteria (ASA). Since these were emergency limb saving surgeries, aspiration prophylaxis was administered if the patients were in the full stomach. All patients received general anesthesia, as these surgeries required absolute immobility and were operated under a microscope. Patients were monitored according to international standards in monitoring.

The brachial plexus catheters were inserted intraoperatively under general anesthesia after the patient was completely out of muscle relaxation or after extubation in the PACU, depending on the last dose of heparin used during the surgery. All brachial plexus catheterization was performed under dual guidance (ultrasound + peripheral nerve stimulator) according to institutional policies for insertion of peripheral nerve catheters. A B. Braun peripheral nerve catheter was used. All patients were put on an infusion protocol for local anesthesia with a basal rate, patient bolus, lockout interval and maximum 4 hours dose limit.

Postoperatively, all patients were followed up daily and as required until removal of peripheral nerve catheter. The pain score, integrity of nerve catheter, amount of local anesthesia consumed, and any signs of catheter migration and complications were noted. Digit perfusion was assessed using the capillary refilling technique. If the patient complained of pain, it was managed with a physician bolus; if no relief catheter function was assessed with ultrasound and reinsertion was planned. All complications related to the brachial plexus catheter were explained to the patients and nursing staff for early monitoring and recognition. The peripheral nerve catheter was removed after a discussion with the surgical team.

Success of reimplantation was defined as establishment of vascularity and perfusion in the digit was achieved and failure as when patient digits were amputated. Data is analyzed using SPSS Version 20.0 for Windows (IBM Corporation ARMONK, NY, USA). Categorical variables were presented as numbers and percentages.

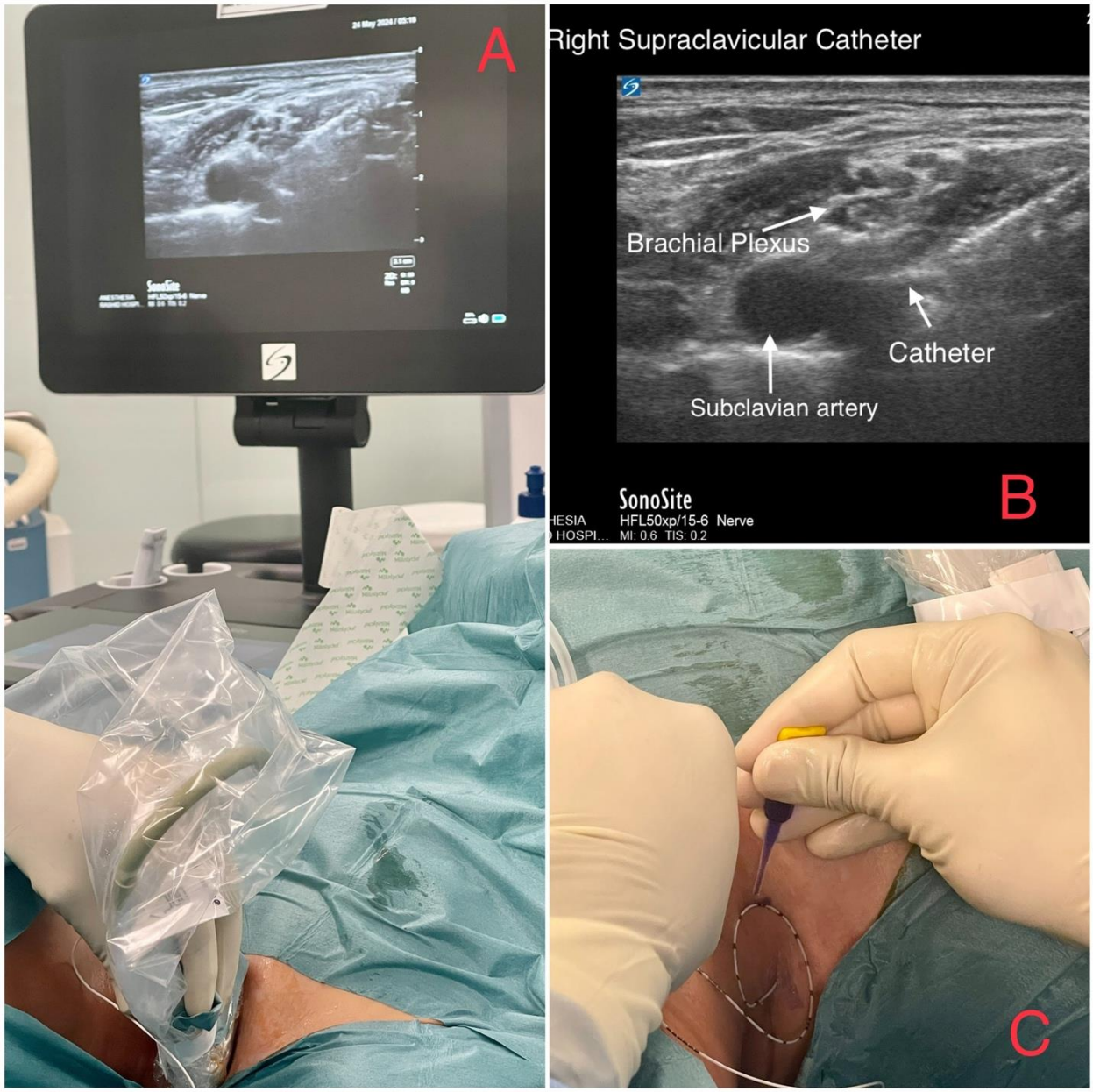

Figure: A. Ergonomics, sterility and position for performing catheter insertion.
B. Ultrasound image showing brachial plexus, catheter tip and subclavian artery on first rib.
C. Fixation of catheter with surgical glue.

RESULTS:

A total of 46 patients underwent digit reimplantation surgery in 2022. Off these all were male, with a mean age of 34.2 years, and only one pediatric patient (<18 year). Six patients had co morbidity such as diabetes, hypertension and asthma. Eight patients were smokers.

Table 1 – Number of digits for reimplantation.

Digits reimplanted	Number of patients
1	31
2	7
3	3
4	1
5	4

Thirty-one patients had one finger reimplantation (Table 1), eleven patients had 2-4 fingers reimplantation, and four patients had all the finger amputated needing reimplantation surgery.

Table 2 – Brachial plexus catheter location.

Location	Number of patients
Supraclavicular	37 (80%)
Infraclavicular	9 (20%)

The most preferred site for brachial plexus catheter insertion (Table 2) by anesthetist in patients who underwent digit reimplantation surgery was the supraclavicular (80%) brachial plexus catheter. Followed by infraclavicular (20%) brachial plexus catheters.

Table 3 – Catheter placement.

Location	Number of patients
Pre operatively (before reimplantation surgery)	2 (4%)
Intra operatively (under anesthesia)	25 (55%)
In PACU	13 (28%)
Post operatively (Scheduled next day)	6 (13%)

Brachial plexus catheter placement was done in various location (Table 3), twenty-five patients it was performed intraoperatively under general anesthesia. In thirteen patients it was performed in PACU. Two patients received brachial plexus catheter before start of reimplantation procedure in the induction room. Six (13%) patients who received a brachial plexus catheter the next day, were those who had developed complication requiring reinsertion and some patients had partial amputation, received a single short brachial plexus block, and the surgical team requested a brachial plexus catheter after performing vascular repair in partially reimplanted digits.

Table 4 – Duration of catheter in situ.

Number of days	Number of patients
3	5 (11%)
4	7 (15%)
5	11 (25%)
6	16 (35%)
7	6 (13%)
8	1 (2%)

Most patients (60%) brachial plexus catheter was kept for 5-6 days (Table 4), five patient's catheter was kept for three days, minimum duration in our study. Six patients had their catheter removed after seven days, only one patient catheter was kept for eight days, maximum duration in our study.

Table 5: Complications.

Complications (5 patients – 11%)	Number of patients
LAST	1
Catheter tip migration	2
Catheter tip broken	1

The complication rate in our case series was 11% (Table 5). A patient who had local anesthesia toxicity was a 22-year, 56 kg male who complained of perioral numbness and light headedness after discharge from the PACU. He had received supraclavicular catheter, after insertion of catheter a bolus of 15 ml of 0.75% ropivacaine was given, then he was put on 0.2% ropivacaine, basal 5 ml/hour, patient bolus of 5 ml, lockout interval of 30 min and dose limit of 40 ml/4hours. The infusion was immediately stopped and intravascular catheter placement was ruled out under ultrasound guidance. Local anesthesia toxicity in this patient might be due to excessive dose of local anesthetic agent. One patient had ptosis and miosis and Horner's syndrome was diagnosed. This could be due to excessive migration of local anesthesia to the interscalene brachial plexus. Local anesthesia infusion was temporarily stopped and the basal infusion was reduced. One patient had a catheter tip outside of the supraclavicular brachial plexus sheath. This was recognized as the patient had excessive pain that was not relieved by a physician bolus, under ultrasound scanning the catheter tip crossing subclavian artery to the opposite side was noted. While removing catheter one patient had its tip broken, which was confirmed with chest X ray.

Table 6: Outcome of reimplantation surgery.

Outcome	Number of patients
Successful	32 (69%)
Unsuccessful	10 (22%)
Partial	4 (9%)

Thirty-two patients had successful reimplantation (Table 6), where the adequate vascularity was achieved. In four patients it was partial success, where multiple fingers were reimplanted and some off which were successful. In ten patients reimplantation was failure, resulting in amputation of digit.

DISCUSSION:

This case series provided us valuable information regarding a critical surgery, anesthesia department practice, and outcome of peripheral nerve catheter for reimplantation surgery. All patients who underwent digit reimplantation underwent brachial plexus catheter insertion. All patients were young male, which could be due to the type of injury, as most of this was related to the occupation of the patients. Most patients had one finger requiring reimplantation (Table 1). One patient was an 11-year-old boy whose finger was stuck in the door and it was successful reimplantated and he received a supraclavicular brachial plexus catheter under anesthesia. Regarding comorbidities and smoking, there were no statistical differences in reimplanted digit survivability, even though all patients were advised not to smoke and avoid caffeinated drinks after reimplantation to prevent vasoconstriction.

The most preferred site (Table 2) was the supraclavicular (80%) brachial plexus catheter. This could be due to the ease of insertion under ultrasound and the superficial nature of the plexus compared with the infraclavicular region. Then majority (55%) of the patients' brachial plexus catheter insertion was performed intraoperatively (Table 3); all these patients were out of muscle relaxation and dual guidance was used (ultrasound + PNS)[11-13]. Patients who received a brachial plexus catheter in the PACU was mostly administered intravenous heparin intraoperatively, which was administered less than 1 h before skin closure. Even though there are no studies that mention avoiding catheter insertion in a patient who received prophylactic heparin, our intuition decided to avoid, as there is always a risk of arterial injury with placement of the brachial plexus catheter. Most patients (60%) were kept for 5-6 days (Table 4), which is related to the establishment of vascularity. We discussed with the surgical team and confirmed the same. In a case report by Clifford et al., an infraclavicular catheter was maintained for 33 days after surgery for mid-humeral amputation. Whenever a

catheter is kept for more than 7 days, close monitoring including an eye on the patient general condition, and justification of its prolonged use. Regarding inadequate pain management, three patients (7%) had this problem. All patients received a physician bolus, and the local anesthesia infusion protocol was modified.

The complication rate (Table 5) in our case series was 11%; all complications were recognized early and appropriate intervention was performed. It is worth noting that all complications were related to supraclavicular catheters, which are prone to dislodgment and migration, which also proves the advantages of infraclavicular catheter in which muscular support from the pectoral muscle prevents dislodgment and migration. Therefore 3-4 cm of catheter should be inserted into brachial plexus sheath[14]. A review of published evidence by B.M. Ilfeld[2], concluded that use of ultrasound may decrease the incidence of many/most of the complication related to peripheral nerve catheters. One patient's catheter tip was broken while its removal at sixth day. Despond O et al[15] suggested that in the absence of obvious signs of catheter-related complications the best treatment of retained supraclavicular catheter is to avoid surgical removal. Our patient was very anxious and requested broken tip to be removed, which was successfully performed under local anesthesia.

The outcome of surgery (Table 6) depends on many factors such as time of surgery from the time of injury, partial or total amputation, clearcut or crush injury, distal or proximal interphalangeal joint, preservation of amputated digits before reaching the hospital, and surgical technique. In our case series, a success rate of 69% (32 patients) was found, with a failure rate of 22% (10 patients) where the end point was amputation. In 9% (4 patients) partial success was considered as there were multiple fingers amputated, and few survived reimplantation. HE Cho[1] et.al also concluded that multiple factors are involved in the outcome and return of functionality. Another study by M. Eskin[5], where perfusion index was compared between interscalene, supraclavicular, and infraclavicular blocks, concluded that all of these blocks will increase the perfusion index, which provides solid evidence for the use of brachial plexus catheters in reimplantation patients.

Our case series has a drawback, as we did not access vascularity ourselves and depended on surgical team assessment; functionality of the reimplanted digits was also not taken into consideration. H.H Su[4] et al performed a RCT in which, they used an axillary brachial plexus catheter, monitored skin temperature, and concluded that it increased skin temperature, an index of tissue perfusion of reconstructive digits; however, graft survival was good in both groups. We could not monitor the temperature in our case series, as all our patient's hand were kept elevated and under forced air warming blankets to aid vasodilation. We believe that, an RCT with uniform patient grouping and a standard brachial plexus insertion technique will provide better data for comparison and analysis.

CONCLUSION:

Our case series concludes that the insertion of a brachial plexus catheter in digit reimplantation surgery results in satisfactory outcomes. It helps counter pain induced vasoconstriction and leads to vasodilation, improving the peripheral circulation. Optimizing pain control while decreasing post-operative dependence on opioids and reducing the risk of chronic pain and its subsequent physiological and psychological sequelae with this injury, which usually occurs in young working males. We noticed that all these patients need close monitoring for adequate pain control, recognition of early signs of complications and adequate intervention. With these data, we could create a clinical practice guideline (CPG) for these groups of surgeries for better patient outcomes, and we recommend a place involved in reimplantation surgeries.

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REFERENCES:

1. Outcomes Following Replantation/Revascularization in the Hand. H.E Cho, Sandra V, Kevin C, Hand Clin. 2019 May; 35(2): 207–219.

2. Continuous Peripheral Nerve Blocks - A Review of the Published Evidence, B M. Ilfeld, Anesthesia & Analgesia 113(4): p 904-925, October 2011.

3. Prolonged continuous infraclavicular brachial plexus perineural infusion following replantation of a mid-humeral amputation Sean P Clifford, Brittany M, Kelly H, SAGE Open Med Case Rep. 2019; 7.

4. The effects of continuous axillary brachial plexus block with ropivacaine infusion on skin temperature

and survival of crushed fingers after microsurgical replantation. HH Su, Ping L, Chi Yu, Chin Liew, Chang Gung Med J, 2005 Aug;28(8):567-74.

5. Comparison of the effects of interscalene, supraclavicular and infraclavicular peripheral nerve blockades on perfusion index, M Eskin, Ayşegul C, Ortadogu Medical Journal, Turkey, 2020; 12(1): 96-102.

6. Replantation: current Concepts and outcomes. Bueno RA Jr., Battiston B, Ciclamini D, Titolo P, Panero B, Tos P. Clin Plast Surg 2014;41(3):385–395, Plastic Surgery 7th edition ed: Wolters Kluwer; 2013

7. Results After Distal Digital Replantation - Is It Worth The Effort? David Braig, J.R Thiele, V. Penna, G. Stark, S. Eisenhardt, Handchir Mikrochir Plast Chir 2017 Feb;49(1):29-36.

8. Continuous brachial plexus blockade for digital replantations, Kurt E, Ozturk S, Isik S, et al and toe-to-hand transfers. Ann Plast Surg 2005; 54(1): 24–27.

9. The use of prolonged peripheral neural blockade after lower extremity amputation: the effect on symptoms associated with phantom limb syndrome. Borghi B, D'Addabbo M, White PF, et al. Anesth Analg 2010; 111(5): 1308–1315.

10. A randomized comparison of infraclavicular and supraclavicular continuous peripheral nerve blocks for postoperative analgesia. Mariano E, Sandhu N, Loland V, et al. Reg Anesth Pain Med 2011; 36(1): 26–3.

11. Supraclavicular vs. Infraclavicular Brachial Plexus Nerve Blocks: Clinical, Pharmacological, and Anatomical Considerations A Kaye, V Allampalli, P Fisher, R Urman, Anesth Pain Med. 2021 Oct; 11(5).

12. Ultrasound-guided brachial plexus blocks. P Raju, D Coventry, Continuing Education in Anaesthesia Critical Care & Pain, Volume 14, Issue 4, August 2014, 185–191.

13. Ultrasound-guided infraclavicular brachial plexus block. N.S. Sandhu, L.M. Capan, British Journal of Anaesthesia Volume 89, Issue 2, August 2002, Pages 254-259.

14. An unusual complication of interscalene brachial plexus catheterization: delayed catheter migration, C.R. Jenkins, M.K. Karmakar, British Journal of Anaesthesia, volume 95, issue 4, 535-537, October 2005.

15. Broken Interscalene Brachial Plexus Catheter: Surgical Removal or Not? Despond O, Kohut G, Anesthesia & Analgesia 110(2):p 643-644, February 2010.