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Outcomes of post burn flexion contracture release under tourniquet versus tumescent technique in children

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ABSTRACT

Objective: To compare the clinical outcomes of release of flexion contractures after burn of the hand in children using tourniquet or tumescent technique in terms of operative time, postoperative pain score, and percentage of graft take.

Methods: Patients aged 3 to 12 years who required release of post-burn flexion contractures involving volar aspect of palm and fingers were enrolled from outpatient clinic. Patients were randomized in 1:1 ratio to the use of either tumescent technique or tourniquet during contracture release. Duration of procedure, postoperative pain score, percentage of graft take, and any complications were assessed and analyzed in both groups by a blinded observer.

Results: Of the 160 patients randomized in the study (80 in each group), 84 (52.5%) were males. The mean±SD age of participants was 7.84±3.49 years, with no statistically significant difference in gender and age distribution between the groups. Similarly, there was no statistically significant difference in duration of surgery in both groups. However, there was a statistically significant difference in percentage of graft take at the 14th postoperative day; significantly more graft take was noted in the tumescent group (8.97±3.7 cm vs. 7.26±2.6 cm; P=0.001). Mean analgesia consumed in the tumescent group was significantly less than that of the tourniquet group (6.26±1.9 mg vs. 9.41±2.2 mg; P≤0.001). Similarly, statistically significant difference in the mean FLACC pain score was noted, with remarkably low pain score in the tumescent group.

Conclusion: We found that the use of the tumescent technique for the release of flexion contracture resulted in better graft take, lower pain scores, and lesser consumption of analgesic than the use of tourniquet.

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1. Introduction

Flexion contractures after burn are common in the pediatric population. Contracture release and covering the defect with full thickness skin graft is a commonly used procedure to correct this deformity [1]. The procedure is traditionally performed under tourniquet control because a bloodless operative field is needed to visualize important neurovascular structures in the hand [2]. However, several infrequent but devastating adverse events, especially in children, are associated with the use of tourniquet [3,4].

The use of tumescent technique without a tourniquet is gaining acceptance because it avoids complications associated with tourniquet use, establishes a blood less surgical site, and decreases operative time by limiting long general anesthetic protocols [5]. A high dose of epinephrine (1:1000) does not cause necrosis of fingers, and the use of tumescent anesthesia often results in better surgical outcomes with prolonged postoperative analgesia [6].

The benefits of the tumescent technique as bundled with wide awake local anesthesia no tourniquet have been established [7]. Epinephrine has been used for hand contracture release at a concentration of 1:1,000,000 as a substitution for pneumatic tourniquet. Thus, epinephrine diluted in a local anesthetic solution can be a potential replacement for a tourniquet in hand surgeries performed under general anesthesia [8,9]. McKee et al. [10] and Bashir et al. [11] have established a clinically meaningful outcome, operative field visibility, and confirmed that the best operative field visibility is attained at around 25 min after the infiltration of the tumescent fluid [10,11].

To our knowledge, no study has compared the tumescent technique with tourniquet and examined outcomes during and after release of post burn flexion contractures under general anesthesia. Therefore, our objective was to compare the clinical outcomes of release of post burn flexion contractures of the hand using the tumescent technique or tourniquet in children under general anesthesia, in terms of operative time, postoperative pain score, and percentage of graft take.

2. Materials and methods

Patients aged 3 to 12 years with post burn flexion contractures involving volar aspect of the palm and fingers requiring skin graft for resurfacing were enrolled from our outpatient clinic. Patients were excluded if they had recurrent post-burn contractures, bleeding disorders, vascular insufficiency, Raynaud's disease, and allergic hypersensitivity to epinephrine or lidocaine. Patients requiring $\leq 2\,cm^2$ skin graft after release of contracture were also excluded. After informed consent, we collected demographic, clinical, and laboratory information. Patients were randomized to tourniquet or tumescent group by using computer generated randomization table. The study protocol was approved by the Institutional Review Board.

Standard general anesthesia with endotracheal intubation was given keeping the same induction agent, muscle relaxant, inhalational gases, and perioperative analgesic in all the patients. Tourniquet technique used in our study involved limb exsanguinations by elevating the arm at 90° for 5 min, and then pneumatic tourniquet was applied after placing the cotton padding underneath the cuff and inflated at a fixed pressure of 100 mmHg above systolic blood pressure to obtain arterial occlusion pressure. The maximum duration for continuously inflated tourniquet was kept at 1.5 h followed by deflation for 15 min every hour [3,12,13]. Tumescent solution was injected after general anesthesia. The tumescent solution used in our study was prepared by adding 1 ml of 1:1000 epinephrine and 10 ml of 2% lidocaine (200 mg) to 100 ml of normal saline, making a final solution concentration of 0.18% lidocaine with 1:111000 epinephrine. The end point of tumescence was firm and pale skin [11]. Total amount of the tumescent solution injected in each case was noted. Patients were blinded to group allocation as inflation of tourniquet, and infiltration of the tumescent solution was performed after giving general anesthesia to the patients. In the tourniquet group, surgery was started immediately after tourniquet inflation. In the tumescent group, surgery was started 25 min after infiltration of the tumescent solution. Contractures were released followed by coverage with partial thickness skin graft harvested from non weight bearing area of foot. Operative time to secure graft was measured by calculating the time utilized to secure per square centimeter of graft: time (T) in minutes to secure per cm^2 of graft=Total operative time/Size of graft secured in cm^2 as measured on a transparent graph paper. In the tourniquet group, total operative time was from start of exsanguination and tourniquet application to the completion of dressing. In the tumescent group, total operative time was from the start of the tumescent solution infiltration to the completion of dressing. Percentage of graft take was measured on 14th postoperative day: graft take in cm^2 at 14th postoperative day measured by utilizing a transparent graph paper/Graft secured in cm^2 at the time of operation measured by utilizing a transparent graph paper $\times 100$. The same dressing protocol was used in both groups to secure the graft. Postoperative pain score was calculated by utilizing Face Leg Activity Cry Consolability (FLACC) pain scale by the doctor on duty at 6, 12, and 24 h postoperatively, taking time of arrival in the ward as zero hour. The doctor measuring the pain score was blinded to group allocation. Nalbuphine was given as diluted slow intravenous injection, as needed, in standard dose of 0.1 mg/kg body weight/dose. Maximum 4 doses were given in first 24 h after surgery. Total dose of postoperative analgesia given to each patient in first 24 h after surgery was calculated. Patients were discharged after 48 h. Dressings were changed on day 7 and then on day 14.

Sample size of 160 patients (80 patients for each group) was estimated using 10% level of significance, 90% power of test with the expected mean value of operative time in the tumescent group as 69.2 min and in the tourniquet technique as 75 min. A pilot study was conducted in our department with similar inclusion and exclusion criteria, which helped us in calculating sample size as it replicated the original study. Continuous data were summarized with mean (standard deviation) or median (interquartile range) as appropriate, and categorical data were summarized using frequencies. To compare quantitative data, normality was tested using one-sample Kolmogorov–Smirnov test. For continuous variables

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