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Original Article

Orthopaedics Section

A Comparative Assessment of Functional Outcomes of Conservative Treatment versus Dynamic External Fixator for Proximal Interphalangeal Joint Fracture-dislocation: Cross-sectional Study

PRIYANK BHARATBHAI OZA[1], DILIP KUMAR NAIDU[2], GOWTHAMAN NAMBIRAJ[3], KEVIN J DHAS[4], MILAP MAHENDRABHAI BHALODIYA[5], PARTH DEEPAK MEHTA[6], VIJAY ANAND BALASUBRAMANIAN[7]

ABSTRACT

Introduction: Finger joint dislocations, particularly involving the Proximal Interphalangeal (PIP) joint, pose common challenges in hand injuries. Despite various treatment modalities available including extension block splinting, extension block pinning, Open Reduction and Internal Fixation (ORIF), hemi-hamate arthroplasty, volar plate arthroplasty, and Dynamic External Fixator (DFS), comparative studies assessing functional outcomes are scarce. Definitive treatments for a particular type of PIP fracture-dislocation are not defined. Dynamic external fixation is a minimally invasive and cost-effective surgical treatment that allows early joint mobilisation with soft-tissue preservation.

Aim: To compare the functional outcomes of conservative treatment versus DFS for PIP joint fracture-dislocation.

Materials and Methods: A comparative prospective interventional study was conducted at SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India from August 2022 to August 2024. Patients aged 18-50 years with PIP fracture-dislocations less than three-week-old were included. Patients were randomised to receive conservative management using buddy strapping (Group A) or DFS (Group B). Functional assessments, radiographic monitoring, and pain evaluations were conducted preoperatively and at follow-up appointments for a duration of three months. The association between categorical variables was examined using Chi-square tests, with a p-value <0.05 indicating statistical significance.

Results: Group B exhibited significant improvements in Range Of Motion (ROM) (88.3±7.7) (p-value=0.001), extensor lag (1.9±1.7°) (p-value=0.013), intra-articular step-off (1.1±1.1) (p-value=0.002), grip strength (81.4±5.9) (p-value=0.001), and pain scores (0.5±0.7) (p-value=0.001) compared to Group A's ROM (76.3±7.4), extensor lag (3±2°), intra-articular step-off (2±1.3), grip strength (70±6.2), and pain scores (2.2±1.1) at three months follow-up. Disability scores (Quick Dash) were also significantly lower in Group B (10.9±4.4) (p-value <0.001) compared to Group A (31.6±13.5) at three months.

Conclusion: DFS-Suzuki frame treatment showed superior outcomes compared to conservative treatment for PIP fracture-dislocations. It resulted in improved motion, strength, and pain scores, along with reduced disability.

Keywords: Buddy strapping, Grip strength, Range of motion, Suzuki frame

INTRODUCTION

Finger joint dislocations, especially of the PIP joint, are common in hand injuries. The PIP joint, located between the proximal and middle phalanges, is a pivotal hinge essential for hand function. A PIP fracture involves a break in these bones, intra-articular or extra-articular, while a PIP joint dislocation refers to their misalignment due to significant trauma [1-3]. The incidence of PIP joint fracture-dislocations is around 67.9 per 100,000 people annually [4]. Hand fractures constitute 10% of adult fractures, with phalangeal fractures more common in men and the small finger most frequently affected. Sports injuries predominate in those under 30 years, work-related causes in the 30-70 years age group, and falls in those over 70 years [4-7]. The PIP joint, susceptible to dorsal, volar, and lateral dislocation patterns, presents unique treatment challenges. These injuries, prevalent but often overlooked, can lead to overtreatment and stiffness. Athletes commonly suffer PIP joint injuries, which may be mismanaged, leading to permanent stiffness or deformity. Immediate evaluation and treatment are crucial, as delayed or non healing fractures often result in chronic stiffness [8]. Non displaced or mildly displaced fractures are usually treated with closed reduction and conservative methods, while surgical interventions may be necessary for more complex or intra-articular fractures [1].

Conservative measures like buddy taping immobilise an injured finger by taping it to an adjacent uninjured finger, providing support and stability. Benefits include simplicity, minimal equipment, cost-effectiveness, and effectiveness in promoting joint alignment and healing. However, disadvantages include the risk of slight digit foreshortening, restricted ROM, and variability in patient compliance and comfort [9]. The DFS combines movement and traction to prevent foreshortening and maintain mobility in PIP joint fracture dislocations. Advantages include active or passive motion options and potential realignment of articular fragments. However, it requires a trained hand therapist, involves a bulky splint, may incur higher costs, and can be challenging for patients to understand [9]. Long-term follow-up for PIP joint injuries is challenging, especially in the young, active population, with each digit presenting unique problems. No single treatment method is superior, and patient occupation, motivation, and access to skilled hand therapists are crucial [1].

Comparative prospective interventional studies on functional outcomes, particularly between buddy taping and dynamic traction methods, are lacking. This research gap necessitates a study comparing conservative treatment and DFS for PIP joint fracture-dislocations. The study aimed to compare the functional outcomes of conservative treatment versus DFS for proximal-interphalangeal joint fracture-dislocation. Objectives included studying the role of both treatments in maintaining motion and preventing stiffness, and comparing functional outcomes and complications.

MATERIALS AND METHODS

This comparative prospective interventional study was conducted at the tertiary care setting in the Department of Orthopaedics at SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India the study spans from August 2022 to August 2024 with Ethical clearance number - SRMIEC-ST1122-445. All participants provided informed written consent, patients were selected consecutively based on predefined inclusion and exclusion criteria.

Inclusion criteria: Patients aged 18 to 50 years of both sexes, PIP fracture dislocations less than three weeks old were included in the study.

Exclusion criteria: Age below 18 or above 50 years, Metacarpophalangeal (MCP) or Distal Interphalangeal (DIP) fracture-dislocations, associated phalanx fracture of the same finger, rheumatoid arthritis, osteoarthritis, psoriatic arthritis, or gout, associated tendon injury such as mallet finger, neglected fracture-dislocations exceeding three weeks were excluded form the study.

Sample size: The sample size of 60 (30 in each group) was calculated based on a similar study by Mukherjee P et al., [10]. The expected mean difference in the PIP ROM between the groups as 5.2 with the standard deviation of 6. The level of significance and power were taken as 5% and 90%, respectively.

The formula used for calculation was:

$n \geq 2(S^2)\ (Z \propto n \geq 2 + Z1-\beta)^2/\ (\delta)^2$

Where S is the standard deviation δ is the expected mean difference

$n \geq 2(62)(1.96 + 1.28)^2\ (5.2)^2$

$n \geq 72 * 10.5\ 27$

$\approx$ n=28$\approx$ 30.

Patients were randomly assigned to Group A (Conservative management using buddy strapping) and Group B (DFS -suzuki frame) using computer generated numbers, ensuring unbiased allocation independent of age, sex, or side (right or left). Both the groups included 30 patients each.

Allocation of Study Groups

Group A (Conservative Management Using Buddy Strapping): Patients received standard conservative treatment involving buddy strapping. This method aims to immobilise and stabilise the injured PIP joint by aligning it with an adjacent finger [Table/Fig-1].

Group B (DFS): Patients undergo surgical intervention using a DFS (Suzuki Frame). This approach involves surgical stabilisation of the PIP joint, allowing controlled movement to support healing [Table/Fig-2].

Preoperative evaluation: Before treatment commenced, each patient underwent a comprehensive preoperative assessment. This included a detailed history, a thorough physical examination of the affected hand and injured finger for deformity, swelling, bruising, neurovascular status, and ROM of adjacent joints. Radiographic imaging provides crucial insights into the extent of the fracture-dislocation and joint alignment, with Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) scans used for further evaluation if needed.

Intervention: In Group A, which involved conservative management using buddy strapping, the initial step was evaluating the injured finger to ensure proper hygiene and preparation for strapping. Buddy strapping was then applied, where the injured finger was

[Table/Fig-1]: Buddy strapping.

[Table/Fig-2]: Suzuki frame.

aligned with an adjacent uninjured finger, and a protective pad was placed over the dorsal aspect of the fracture site. The injured finger was then secured to the adjacent finger using adhesive tape or a buddy strap, ensuring immobilisation in a functional position, typically with slight flexion to support healing.

In Group B, the injured finger underwent assessment to confirm the necessity for surgical intervention, followed by obtaining appropriate consent. The surgical procedure entails making an incision at the fracture site, reducing the fracture-dislocation, and then applying a DFS to stabilise the joint. This fixator aids in maintaining proper alignment and supporting the healing process through controlled movement and traction.

Postoperative care: Following intervention, patients underwent structured postoperative care designed to facilitate recovery and optimise outcomes. Early mobilisation was initiated shortly after surgery, focusing on gentle ROM exercises to prevent joint stiffness and enhance flexibility. One week postoperatively, formal hand therapy was initiated, incorporating both active and passive ROM exercises. This therapeutic regimen continues for three months to promote healing and restore functional capabilities. Medication management included a prescribed course of antibiotics and analgesics for five days postoperatively to prevent infection and manage pain effectively. Patient education plays a crucial role in postoperative care, with comprehensive instructions provided on wound care, activity restrictions, and medication adherence. Emphasis was placed on following rehabilitation protocols and attending scheduled follow-up appointments to monitor progress closely.

Follow-up: Regular follow-up visits were scheduled at specified intervals- one week, two weeks, four weeks, and three months, postoperatively. These appointments served to monitor healing progress, assess radiological and functional outcomes.

Functional outcomes were assessed through ROM, extensor lag, grip strength, pain levels measured on the Visual Analog Scale (VAS) [11], and disability scores using the Quick Disabilities of the Arm, Shoulder, and Hand (Quick DASH) questionnaire [12].

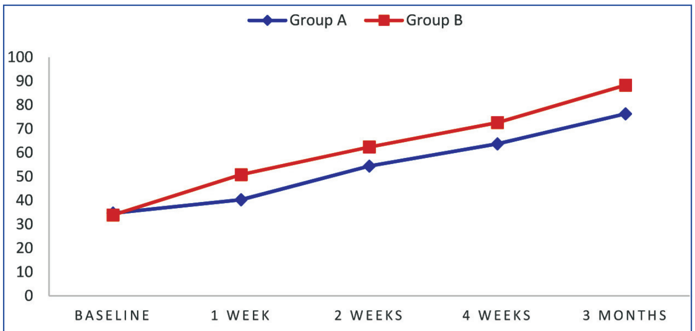
STATISTICAL ANALYSIS

The data were entered into Microsoft Excel 2013 and analysed using SPSS version 21.0 Continuous variables were displayed as mean and standard deviation, while categorical variables were expressed as frequency distribution and percentage. Associations were tested using Chi-square tests with a significance level of 0.05. Table and bar charts represented categorical data distributions to facilitate comparison and interpretation of result.

RESULTS

The average age of participants in Group A was 35.4±9.7 years, and in Group B, the average age was 36.4±8.9 years, In Group A, 18 (60%) were males and 12 (40%) were females. In Group B, 20 (66.7%) were males and 10 (33.3%) were females.

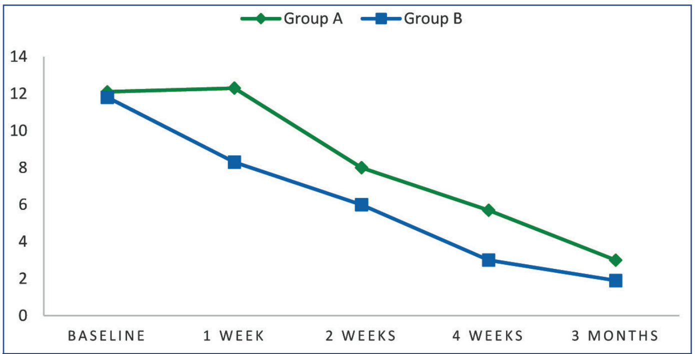
[Table/Fig-3] presents the comparison of the ROM between the two groups. In Group A, the average ROM increased from 34.7±8.5 preoperatively to 76.3±7.4 at three months follow-up. In contrast, in Group B, the average ROM score increased from 33.9±8.4 preoperatively to 88.3±7.7 at three months follow-up. The ROM showed statistically significant differences between the groups at one week (p-value=0.001), two weeks (p-value=0.001), four weeks (p-value=0.001), and the 3rd month follow-up (p-value=0.001). Thus, significant improvement in ROM was observed in Group B.



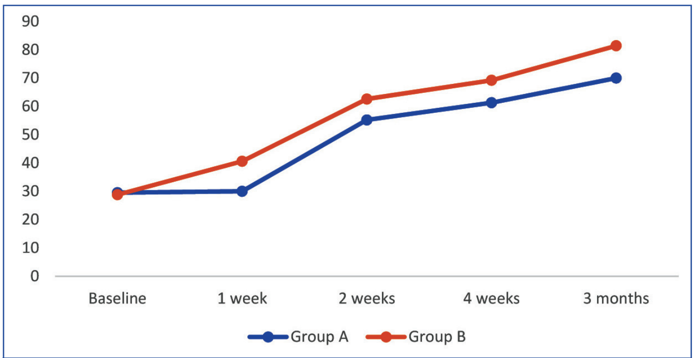
[Table/Fig-3]: Comparison of Range Of Motion (ROM) between groups.

The [Table/Fig-4] illustrates the comparison of extensor lag between the two groups. In Group A, the mean baseline extensor lag decreased from 12.1±3.3° to 3±2° at the 3rd month follow-up. Similarly, in Group B, the mean baseline extensor lag decreased from 11.8±4.7° to 1.9±1.7° at the 3rd month follow-up. Statistically significant differences in extensor lag were observed between the groups at one week (p-value=0.001), two weeks (p-value=0.001), four weeks (p-value=0.001), and the 3rd month follow-up (p-value=0.013). Group B exhibited significant improvement in extensor lag at each follow-up compared to the other group. In Group A, the average intra-articular step-off decreased from 3.4±1.3 at baseline to 2±1.3 at the 3rd month follow-up. Similarly, in Group B, the average intra-articular step-off decreased from 3.1±1.4 at baseline to 1.1±1.1 at the 3rd month follow-up. Statistically significant differences in intra-articular step-off were observed between the groups at the 3rd month follow-up (p-value=0.002). Patients in Group B exhibited significant improvement in intra-articular step-off compared to those in Group A.

The comparison of grip strength between groups is presented in the [Table/Fig-5]. In Group A, the baseline average grip strength of 29.5±6.4% increased to 70±6.% at the 3rd month follow-up. In contrast, in Group B, the baseline average grip strength of 28.8±5.8% increased to 81.4±5.9% at the 3rd month follow-up. Grip strength demonstrated statistically significant differences between the groups at one week (p-value=0.001), two weeks (p-value=0.001), four weeks (p-value=0.001), and the 3rd month follow-up (p-value=0.001). Therefore, Group B exhibited significant improvement in grip strength at each follow-up compared to the other group.

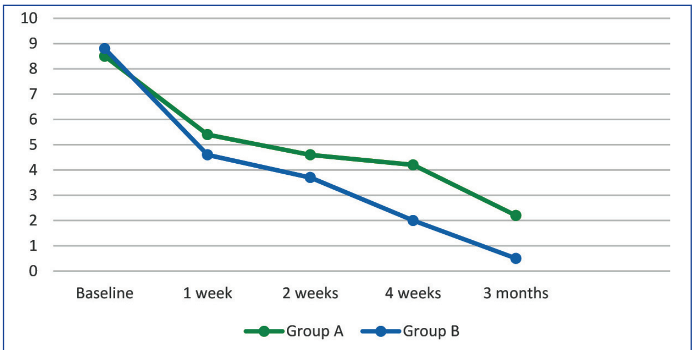


[Table/Fig-4]: Comparison of extensor lag (degree°) between groups.



[Table/Fig-5]: Comparison of grip strength (%) between groups.

The comparison of VAS score between groups is presented in [Table/Fig-6]. In Group A, the average VAS score decreased from 8.5±1.1 at baseline to 2.2±1.1 at the 3rd month follow-up. Conversely, in Group B, the average VAS score decreased from 8.8±1.2 at baseline to 0.5±0.7 at the 3rd month follow-up. Statistically significant differences in VAS score were observed between the groups at one week (p-value=0.005), two weeks (p-value=0.007), four weeks (p-value=0.001), and the 3rd month follow-up (p-value=0.001). The majority of patients in Group B experienced a reduction in pain compared to Group A.



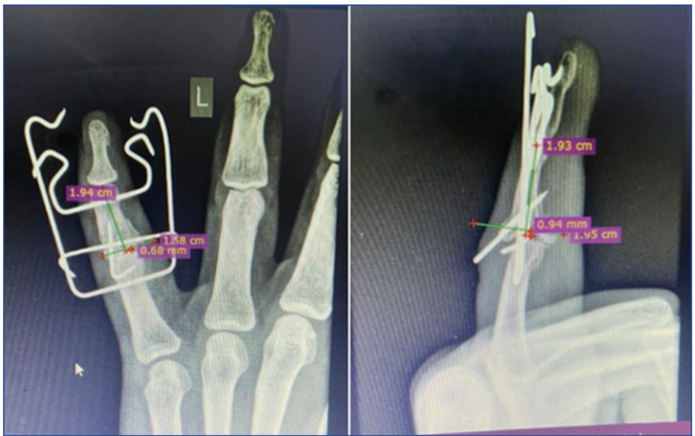
[Table/Fig-6]: Comparison of VAS pain score between group.

A statistically significant difference was found between groups in terms of disability scores. Hence, the patients in Group A had higher disability scores compared to those in Group B [Table/Fig-7]. Radiological outcomes were evaluated through standardised radiographic assessments, focusing on parameters such as intra-articular stepoffs, joint alignment, and bone healing progression [Table/Fig-8,9].

Quick dash	Group	Mean±SD	T value	p-value
3 months	A	31.6±13.5	-7.966	<0.001*
	B	10.9±4.4		

[Table/Fig-7]: Comparison of Quick DASH scores between groups at 3 months.

[Table/Fig-8]: Follow-up X-ray of PIP fracture-dislocation of index finger treated with buddy strapping.



[Table/Fig-9]: Follow-up X-ray of PIP fracture little finger treated with Suzuki frame.

DISCUSSION

Group B treated with dynamic external fixation had shown better and superior functional and radiological outcome with reduced disability scores after three months follow-up as compared to Group A treated with conservative treatment. The study highlighted significant improvements in ROM over three months for both treatment groups. Group B, treated with a DFS, showed superior gains compared to Group A (conservative treatment), suggesting that the DFS facilitated better-controlled mobilisation and enhanced ROM outcomes. Abou M et al., reported higher ROM outcomes with DFS treatment compared to pilon fixation [12]. Similarly, Kodama A et al., observed specific ROM improvements in PIP and DIP joints post-treatment [13]. Turgut MC and Toy S, also demonstrated ROM improvement across various degrees for PIP and DIP joints [14].

The study demonstrated a reduction in extensor lag over time for both treatment groups, with Group B (DFS) showing a more pronounced improvement compared to Group A (conservative treatment). This suggests that the DFS facilitated better early mobilisation and prevented joint contracture. Kodama A et al., reported specific measurements of extension and flexion at the PIP and DIP joints, indicating varying degrees of hyperextension or flexion contracture [13]. Ellis SJ et al., observed concentric reduction in all joints post-treatment but noted residual issues like small step-off deformities or arthritis in some patients, highlighting challenges in achieving complete anatomical alignment [15].

A reduction in intra-articular step-offs for both treatment groups was seen, with Group B (DFS) showing more significant improvement compared to Group A (conservative treatment). The DFS likely contributed to better anatomical reduction and alignment, thereby reducing step-offs compared to conservative management alone. Abou M et al., reported radiographic findings indicating varying degrees of intra-articular involvement depending on the fracture type [12]. Variations in fracture patterns, severity, and treatment modalities across studies contribute to differences in intra-articular step-off outcomes.

In the present study, both treatment groups showed significant increases in grip strength over time, with Group B (DFS) demonstrating greater improvement compared to Group A (conservative treatment). The DFS likely facilitated early mobilisation and muscle strengthening, contributing to enhanced grip strength outcomes. Ellis SH et al., reported varying grip strength outcomes, with values ranging from 71% to 110% of the unaffected hand post-treatment [15]. Won SH et al., observed skin injuries associated with buddy taping potentially limiting grip strength improvement in their study [16]. Differences in grip strength outcomes between studies may be attributed to factors such as initial injury severity and treatment modalities.

Both treatment groups in the present study experienced significant reductions in VAS scores, indicating decreased pain levels post-treatment. Group B, treated with a DFS, showed a more pronounced reduction in VAS scores compared to Group A, likely due to better joint stabilisation and early mobilisation facilitated by the DFS. Previous studies like Ellis SH et al., and Paschos NK et al., have also demonstrated decreased pain levels with various interventions, though the present study suggests additional benefits with dynamic external fixation [15,17].

Significant differences in Quick DASH scores were observed between Group B (DFS) and Group A (conservative treatment) in the present study, indicating superior functional outcomes associated with dynamic external fixation. The dynamic nature of the external fixator likely contributed to improved functional recovery and reduced disability scores by providing stable joint stabilisation and facilitating controlled mobilisation. Ellis SH et al., did not specifically assess Quick DASH scores but noted variability in grip strength and pain levels post-treatment, highlighting their impact on overall functional outcomes [15].

Limitation(s)

The limitation of this study included single-centre study design, relatively small sample size and potential attrition during follow-up could affect the robustness of results. Despite randomisation, inherent biases in patient selection and treatment allocation might influence outcomes. Future research should prioritise multicentre studies to enhance external validity across diverse patient populations. Extending follow-up durations, standardising treatment protocols, and incorporating comprehensive outcome measures such as patient-reported outcomes and cost-effectiveness analyses would provide a more holistic evaluation of treatment effectiveness and inform clinical decision-making.

Based on the findings of this study DFS can be incorporated as the treatment for these fractures with the better functional outcome compared to conservative treatment.

CONCLUSION(S)

The DFS treatment resulted in superior functional outcome compared to conservative treatment for PIP fracture-dislocations less than three-week-old. Significant improvements in ROM, extensor lag, grip strength, pain scores and intra-articular step-off along with lower disability scores were seen with dynamic external fixation. Therefore, DFS-Suzuki frame treatment may be considered as an effective intervention for managing such fractures.

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PARTICULARS OF CONTRIBUTORS:

1. Student, Department of Orthopaedics, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.
2. Professor, Department of Orthopaedics, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.
3. Professor, Department of Orthopaedics, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.
4. Professor, Department of Orthopaedics, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.
5. Student, Department of Orthopaedics, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.
6. Student, Department of Orthopaedics, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.
7. Professor, Department of Orthopaedics, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Priyank Bharatbhai Oza,
86, Yash Vihar, Ambaji Road, Chansma Highway, Patan-384265, Gujarat, India.
Email: priyankoza1201@gmail.com

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- iThenticate Software: Aug 30, 2025 (2%)

ETYMOLOGY: Author Origin

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