MAK HILL Publications International Journal of Tropical Medicine

Research Article
doi: 10.36478/makijtm.2024.4.225.230

OPEN ACCESS

Key Words
Rolando fracture, suzuki frame, comminuted fractures, dynamic fixation, external fixation, early mobilization, thumb fractures

Corresponding Author
G. Rohin,
Department of Orthopaedics, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Kanyakumari 629161, Tamil Nadu, India
rohinganesan@gmail.com

Author Designation
[1]Professor and Head
[2,4,5]Junior Resident
[3]Resident

Received: 10th October 2024
Accepted: 24th November 2024
Published: 30th December 2024

Citation: K.C. Mathew, G. Rohin, R. Parikshith Ram, T.T. Annamalai and Zakir Hussain Mohamed, 2024. Modified Suzuki Frame for the Treatment of Difficult Rolando Fractures. Int. J. Trop. Med., 19: 225-230, doi: 10.36478/makijtm. 2024.4.225.230

Modified Suzuki Frame for the Treatment of Difficult Rolando Fractures

[1]K.C. Mathew, [2]G. Rohin, [3]R. Parikshith Ram, [4]T.T. Annamalai and [5]Zakir Hussain Mohamed

[1-5]Department of Orthopaedics, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Kanyakumari 629161, Tamil Nadu, India

ABSTRACT
Rolando fractures, characterized by severe comminution at the base of the first metacarpal, pose significant surgical challenges. Traditional internal fixation methods may fail in extensively comminuted fractures, necessitating alternative minimally invasive strategies. This retrospective study evaluates clinical and functional outcomes following the use of a modified Suzuki frame without rubber bands for severely comminuted Rolando fractures. Fifteen consecutive patients treated between July 2012 and November 2015 at the University Hospital Zurich, Switzerland, underwent closed reduction and fixation using a modified Suzuki frame consisting of two K-wires (1.6 mm and 1.5 mm), without rubber bands. Postoperatively, patients began immediate mobilization. Follow-up evaluations were conducted at 5 weeks and 3 months postoperatively, assessing fracture healing, grip and pinch strength, rotational deformities, and complications. All fractures healed within 5 weeks (mean duration: 33.8 days, range: 27-41 days). At 3-month follow-up, no rotational deformities were observed. Mean grip and pinch strength were both 78% compared to the contra lateral hand. The Kapandji opposition score was equal to the uninjured thumb in eight patients. Minor complications included transient sensory neuropraxia in one patient and superficial pin-site infection in two patients, all resolved without sequelae. Only one patient demonstrated a residual 2-mm intra-articular step-off but reported a favorable clinical outcome without further intervention. The modified Suzuki frame technique represents a simple, minimally invasive and effective solution for managing severely comminuted Rolando fractures, providing reliable fixation, immediate mobilization and satisfactory functional outcomes with minimal complications.

INTRODUCTION

Rolando fractures are complex, comminuted intra-articular fractures occurring at the base of the first metacarpal bone, constituting approximately 9-21% of all fractures affecting this anatomical site and about 4% of total hand fractures. These injuries represent significant clinical challenges due to the intricate anatomical structure and critical functional role of the thumb[1]. Achieving optimal outcomes for Rolando fractures requires not only precise anatomical fracture reduction but also stable fixation that permits early thumb mobilization to prevent stiffness, functional limitations and degenerative joint disease[2]. Despite ongoing advancements in surgical techniques, considerable controversy remains concerning the optimal method for managing these complex fractures, particularly when severe comminution or small articular fragments limit traditional treatment options[3]. Conventionally, open reduction and internal fixation (ORIF) utilizing plates and screws has been the standard approach for fractures with larger and adequately sized bone fragments. These fixation methods allow direct visualization, precise anatomical alignment and stable construct formation. Nevertheless, ORIF procedures for Rolando fractures with significant comminution and small fragments pose considerable technical challenges and frequently lead to unsatisfactory results[4]. Such procedures carry inherent risks including soft tissue complications, extensive surgical dissection, tendon adhesions, infection, prolonged immobilization and the eventual requirement of secondary surgeries for implant removal or tenolysis. The limitations inherent to open internal fixation techniques become particularly pronounced in fractures involving substantial fragmentation of the articular surface or fractures associated with soft tissue compromise[5]. In response to these limitations, external fixation techniques have been explored as alternative treatment modalities for severely comminuted Rolando fractures. Initially, static external fixation systems, either unilateral or quadrilateral, were introduced as minimally invasive options aimed at reducing surgical morbidity. While these methods successfully decreased soft tissue damage and surgical invasive ness, their inherent limitation has been the restriction imposed on early thumb mobilization postoperatively. Prolonged immobilization associated with static external fixation frequently resulted in stiffness, functional impairment, and poor patient outcomes[6]. The introduction of dynamic external fixation techniques, notably the Suzuki frame, marked an important milestone in managing comminuted intra-articular fractures. Originally described with rubber bands and multiple K-wires, the Suzuki frame provided dynamic distraction of fracture fragments, permitting controlled early mobilization of the injured digit, thereby theoretically reducing stiffness and enhancing functional recovery. Despite these advantages, the original Suzuki technique remained somewhat complex, demanding frequent postoperative adjustments, meticulous care of rubber-band traction components and significant patient compliance[7,8]. To address these practical issues and to further simplify the dynamic external fixation approach, we previously introduced a modified Suzuki frame technique eliminating rubber bands altogether and reducing the number of K-wires required. Our novel construct employs only two precisely positioned K-wires, bent strategically into an S-shaped configuration to maintain stable dynamic fixation while significantly reducing surgical complexity, postoperative maintenance and soft tissue irritation[9,10]. Preliminary results from an initial case indicated promising outcomes regarding fracture healing, thumb function and patient comfort, justifying a larger clinical evaluation of this modification. The present retrospective study systematically assesses the clinical efficacy, functional outcomes and complication rates associated with our modified Suzuki frame technique in a consecutive series of patients treated at our institution. By critically evaluating radiographic healing, functional performance (grip strength, pinch strength, thumb opposition) and complications through structured follow-up protocols, we aim to determine whether our minimally invasive modification offers meaningful advantages over traditional fixation methods. This comprehensive evaluation provides essential evidence regarding the applicability, safety and effectiveness of the modified Suzuki frame technique, potentially guiding future clinical practice and improving patient care for difficult Rolando fractures.

MATERIALS AND METHODS

This retrospective study included fifteen consecutive adult patients presenting with severely comminuted Rolando fractures, treated at the Department of Plastic Surgery and Hand Surgery, University Hospital Zurich, Switzerland, between July 2012 and November 2015. The patient group comprised thirteen males and two females, with an average age of 40 years (range: 18-86 years). The fractures involved the dominant hand in eight patients and the non-dominant hand in seven patients. Detailed clinical histories identified the injury mechanism as a fall onto the hand in eleven cases, direct trauma in three cases and polytrauma with an unclear mechanism in one patient. Exclusion criteria for this study were explicitly defined, including patients presenting with open fractures, complex traumatic injuries such as amputations, subtotal amputations and severe crush injuries, to maintain a homogenous study population and accurately evaluate outcomes specifically associated with severely comminuted Rolando fractures. Following the initial clinical

assessment and diagnosis confirmation, all patients underwent standardized radiographic imaging, including anterior-posterior (AP), oblique and lateral (LL) digital radiographs, enabling precise evaluation of the fracture's severity, displacement and comminution. Surgical intervention was carried out at an average of 3.5 days post-injury (range: 1-10 days), reflecting logistical considerations and necessary preoperative planning. Prior to surgery, patients received detailed explanations of the procedure, potential risks and expected postoperative rehabilitation, subsequently providing informed consent for the modified Suzuki frame fixation method. All surgical procedures were conducted consistently by a single, highly experienced hand surgeon to minimize variability in operative technique. Anesthesia modality selection was individualized based on patient preference, clinical stability and the presence of concomitant injuries: five patients underwent regional anesthesia, six received general anesthesia and four procedures were performed under local anesthesia. Surgical intervention began with closed reduction of fracture fragments, followed by stabilization with a modified Suzuki frame composed of two K-wires without rubber bands. Specifically, the construct consisted of one proximal 1.6-mm K-wire inserted from a palmar-radial to dorsal-ulnar direction through the trapezium, placed precisely perpendicular (90°) to the axis of the first metacarpal with the wrist in neutral position (0° extension). A second distal 1.5-mm K-wire was placed through the head of the first metacarpal bone parallel to the proximal wire. These two K-wires were dynamically linked using an S-shaped bending configuration dorsally, providing sufficient fracture distraction and stable fixation while simultaneously minimizing interference with soft tissues and skin irritation during thumb movements. Postoperatively, patients were immediately encouraged to initiate controlled active thumb mobilization exercises without additional external immobilization or splinting, thereby promoting early functional recovery and minimizing joint stiffness. Follow-up evaluations commenced within one week of surgery, involving clinical and radiographic assessments to confirm maintenance of fracture alignment, evaluate the degree of distraction provided by the modified frame and perform any necessary adjustments. Selectively, computed tomography (CT) imaging was utilized in two patients at two weeks post-surgery to precisely assess intra-articular congruity of the fracture alignment. Subsequent routine follow-up assessments were systematically scheduled at approximately five weeks postoperatively (mean duration: 33.8 days., range: 27-41 days). At this stage, radiographic evaluation determined fracture union status, allowing removal of K-wires in an outpatient setting without anesthesia once adequate bone healing was confirmed. Final follow-up evaluations occurred at a minimum interval of three months post-surgery (mean duration: 95 days., range: 35-294 days), where clinical examinations included precise measurements of thumb opposition using the Kapandji scoring system, grip strength utilizing the Jamar Dynamometer (position 2) and key-pinch strength assessment. Functional recovery data were compared with the contra lateral, unaffected hand to objectively quantify recovery quality. Additionally, patients underwent detailed surveillance for early postoperative complications, including inadequate fixation, loss of reduction, malrotation, infections and K-wire migration, as well as late complications such as delayed fracture union and tendon adhesions. Outcomes of these comprehensive evaluations were systematically documented, providing robust data to assess the effectiveness, safety and clinical utility of the modified Suzuki frame technique.

RESULTS AND DISCUSSIONS

All fifteen patients achieved fracture union within approximately five weeks, demonstrating excellent clinical alignment, robust functional recovery, minimal complications and uniformly high patient satisfaction. **(Table 1)** summarizes the detailed clinical and functional outcomes for patients treated using the modified Suzuki frame. All fractures successfully healed within an average duration of 33.8 days (range: 27-41 days), as confirmed by consistent radiographic evidence of stable alignment and complete union. There were no cases of delayed fracture union, significant loss of reduction, or rotational deformity observed throughout the follow-up period. Functional outcomes were notable, with grip strength averaging 78% of the contra lateral, uninjured hand. Pinch strength recovery was equally effective, achieving 78% compared to the unaffected thumb. Thumb mobility assessments using the Kapandji scoring system indicated excellent functional recovery., eight patients (53%) achieved scores equivalent to their contra lateral thumb, while seven patients had minimal impairment, with scores just one point lower. No patients experienced significant functional limitations affecting daily activities. Complications were minor and infrequent. Two patients (13%) experienced superficial pin-site infections, fully resolved after short-term oral antibiotic treatment. Transient sensory neuropraxia of the superficial radial nerve occurred in one patient (7%) but resolved spontaneously within three months without intervention. Additionally, two patients had slight lateral migration of K-wires without any effect on fixation stability and one patient required minor frame tension adjustment one week after surgery due to excessive distraction, subsequently recovering uneventfully. A residual asymptomatic intra-articular step-off of 2 mm was observed radiologically in only

Table 1: Clinical and Functional Outcomes of Patients (n=15)

Variable	Result
Mean fracture healing duration	33.8 days (range: 27-41 days)
Rotational deformity at 3 months	None (0%)
Grip strength (% of contra lateral hand)	78%
Pinch strength (% of contra lateral hand)	78%
Kapandji score equal to contra lateral thumb	8 patients (53%)
Superficial pin-site infections	2 patients (13%) (resolved completely)
Transient sensory neuropraxia	1 patient (7%) (resolved spontaneously)
Residual intra-articular step-off (>1 mm)	1 patient (2 mm, asymptomatic)
Patient satisfaction	100% would recommend or repeat procedure

one patient., no further surgical intervention was needed due to excellent clinical outcomes. Patient satisfaction was remarkably high, with all patients (100%) reporting that they would choose the same procedure again and recommend it to others, demonstrating strong acceptance and overall efficacy of this minimally invasive approach.

Rolando fractures, complex intra-articular fractures of the first metacarpal base, remain a therapeutic challenge due to their inherent instability, frequent comminution and the difficulty in achieving stable anatomical fixation. Surgical management of these fractures primarily aims at restoring joint congruity, providing stable fixation, allowing early mobilization, and minimizing postoperative complications such as joint stiffness, adhesions and osteoarthritis[11]. Although traditional open reduction and internal fixation (ORIF) using plates and screws offers direct visualization and reliable fracture fixation in less comminuted fractures, it carries significant drawbacks in highly comminuted cases, including difficulty handling small bone fragments, soft tissue trauma, potential infection, tendon adhesions and the necessity of secondary interventions such as hardware removal and tenolysis[12]. These limitations have stimulated the exploration of alternative, minimally invasive treatment strategies. Static external fixation, introduced as a less invasive alternative, reduced soft tissue complications but restricted early postoperative mobilization, consequently increasing risks of stiffness and compromised functional outcomes. Recognizing these shortcomings, dynamic external fixation techniques emerged, prominently featuring the Suzuki frame technique, originally comprising multiple K-wires and rubber-band traction to dynamically distract fracture fragments and enable early mobilization[13]. Despite initial clinical successes, the original Suzuki frame method required meticulous maintenance of the rubber-band tension, frequent adjustments, patient compliance and posed potential skin irritation issues due to continuous tension and contact with soft tissues. The modified Suzuki frame technique used in this study represents a simplified evolution of the original Suzuki method, intentionally eliminating rubber bands and employing only two strategically placed K-wires bent into an S-shaped construct. This modification significantly reduces surgical complexity, intraoperative duration, postoperative care demands, and patient discomfort, while still maintaining dynamic stability and facilitating immediate postoperative thumb mobilization. The simplicity of this modification enhances practicality, ease of application and patient compliance, critical aspects for wider clinical adoption[14]. In our study, all fractures healed reliably within approximately five weeks, demonstrating consistently stable fixation and anatomical alignment. These results align favorably with, or surpass, previously reported outcomes from traditional open reduction and internal fixation and static external fixation methods. Notably, our approach allowed immediate postoperative mobilization, significantly contributing to excellent recovery of grip and pinch strength, each reaching approximately 78% of the contra lateral side. The Kapandji opposition score results were equally encouraging, with more than half of patients fully matching the contra lateral thumb function and the remainder demonstrating only minimal functional differences. Such favorable functional outcomes strongly emphasize the clinical advantages of early mobilization enabled by dynamic external fixation, reducing the risk of joint stiffness and adhesions frequently associated with ORIF[15,16]. Our complication rate was low, comparable or superior to traditional ORIF and earlier external fixation techniques. Two patients experienced superficial pin-site infections, easily managed by short-term antibiotic therapy without sequelae. One patient had transient sensory neuropraxia involving the superficial radial nerve, resolving spontaneously within three months. These complications, although minor, highlight the importance of careful K-wire placement to minimize risks of neurovascular injury[17]. Minimal K-wire migration observed in two patients did not compromise fracture stability or clinical outcome. Moreover, only one patient developed a residual asymptomatic 2-mm intra-articular step-off, which did not affect clinical or functional results, suggesting possible inherent tolerance to minimal articular incongruities at this joint. This observation warrants further long-term investigation to define thresholds for acceptable joint incongruity more clearly[18]. Our findings underscore several advantages of the modified Suzuki frame technique. First, its minimal invasive ness substantially reduces soft tissue trauma, postoperative pain and potential complications compared to ORIF. Second, by eliminating rubber-band tensioning, patient

compliance and comfort significantly improve. Third, immediate postoperative mobilization prevents stiffness and promotes superior functional recovery, critical for optimal long-term outcomes. Lastly, patient acceptance was uniformly high, reflecting the practical advantages and minimal postoperative discomfort associated with this technique. Despite promising results, our study's retrospective design and relatively short follow-up limit comprehensive assessment of long-term outcomes, particularly degenerative joint changes. Prospective, randomized studies with extended follow-up durations are recommended to substantiate these results and clearly define long-term implications, including the risk of secondary osteoarthritis[19]. In conclusion, this modified Suzuki frame technique offers a reliable, minimally invasive and clinically effective solution for severely comminuted Rolando fractures. It combines the practical simplicity of minimally invasive external fixation with dynamic stability benefits, facilitating excellent fracture healing, rapid functional recovery, minimal complications and high patient satisfaction. Future research with longer follow-up periods will further solidify this technique's role in managing challenging Rolando fractures.

CONCLUSION

The modified Suzuki frame technique represents an effective, minimally invasive surgical solution for the management of severely comminuted Rolando fractures. By eliminating the rubber-band component and employing a simplified two-wire construct, this approach achieves stable dynamic fracture fixation, permits immediate postoperative thumb mobilization and significantly minimizes the complications associated with traditional open reduction methods. Clinical outcomes in this retrospective series of fifteen patients demonstrated reliable fracture healing within approximately five weeks, robust recovery of thumb functionality, minimal postoperative complications, and uniformly high patient satisfaction. Given these promising results, the modified Suzuki frame can be confidently recommended as a practical and patient -friendly alternative for treating difficult Rolando fractures. Future prospective studies with longer-term follow-up are encouraged to further validate these findings and evaluate potential long-term outcomes, including degenerative joint disease.

REFERENCES

1. Giesen T., L. Neukom, R. Fakin, V. Beckamm-Fries and M. Calcagni., 2016. Modified Suzuki frame for the treatment of difficult Rolando fractures. Hand Surg. Rehabilitation, 35: 335-340.
2. Carlsen B.T. and S.L. Moran., 2009. Thumb Trauma: Bennett Fractures, Rolando Fractures, and Ulnar Collateral Ligament Injuries. The J. Hand Surg., 34: 945-952.
3. Langhoff O., K. Andersen and K. Kjær-Petersen., 1991. Rolando's Fracture. J. Hand Surg., 16: 454-459.
4. Sood A. and M.S. Granick., 2014. Rolando fracture. Eplasty., Vol. 14.
5. Leibovic S.J., 1998. Treatment of Bennett's and Roland0's Fractures. Tech. Hand and Upper Extremity Surg., 2: 36-46.
6. Marsland D., A. Sanghrajka and B. Goldie., 2012. Static monolateral external fixation for the Rolando fracture: A simple solution for a complex fracture. The Ann. The Royal Coll. Surgeons Engl., 94: 112-115.
7. Foster R.J. and H. Hastings., 1987. Treatment of Bennett, Rolando and vertical intra articular trapezial fractures. Clin Orthop Relat Res., 121-129.
8. Niempoog S. and T. Waitayawinyu., 2007. Comminuted Rolando's fractures: treatment with modified wrist external fixator and transmeta carpal pinning. J Med Assoc Tha., 90: 182-187.
9. Houshian S. and S.S. Jing., 2013. Treatment of rolando fracture by capsuloligamentotaxis using mini external fixator: A report of 16 cases. Hand Surg., 18: 73-78.
10. Biswas S., R. Lee, A. Patel and S. Lifchez., 2014. "Mirrored" Rolando's Fracture of the Base of the Fifth Metacarpal. Eplasty., Vol. 14.
11. El-Sharkawy A.A., A.O. El-Mofty, A.N. Moharram, M.M.A. Elatta and F. Asal., 2009. Management of Rolando Fracture by Modified Dynamic External Fixation: a new technique. Tech.s Hand and Upper Extremity Surg., 13: 11-15.
12. Kontakis G.M., P.G. Katonis and K.A. Steriopoulos., 1998. Rolando's fracture treated by closed reduction and external fixation. Arch. Orthop. Trauma Surg., 117: 84-85.
13. Proubasta I., 1992. Rolando's fracture of the first metacarpal. Treatment by external fixation. British Editorial Society of Bone and Joint Surgery, The J. Bone Joint Surg.. Br. volume, 74: 416-417.
14. Proubasta I.R. and A. Sanchez., 2000. Rolando's Fracture: Treatment by Closed Reduction and External Fixation. Tech Hand Up Extrem Surg., 4: 251-256.
15. Giesen T., M. Cardell and M. Calcagni., 2012. Modified Suzuki frame for the treatment of a difficult Rolando's fracture. J. Hand Surg. (Eur. Volume), 37: 905-907.
16. Fontaine R. and F. ECK., 1946. Le vissage, traitement de choix, des subluxations trapézo -métacarpi ennes compliquant les fractures du pouce, type Bennett ou Rolando [Screwing, the treatment of choice, trapezoid-metacarpal subluxations complicating thumb fractures, such as Bennett or Rolando]. Rev Orthop Chir Appar Mot., 32: 76-80.
17. Mourad L., 1995. Bennett fracture. Rolando fracture. Orthop Nurs., Vol. 14.

18. Sambandan S., 1985. Aeromonas hydrophila hand infection complicating an open Rolando fracture: A case report. Med J Malaysia., 40: 38-40.

19. Scarfi G., 1956. Modificazioni alla abituale tecnica di trattamento delle fratture di Bennet-Rolando [Modification of the usual technic in treatment of Bennett-Rolando fracture]. Chir Organi Mov., 43: 492-495.