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A STUDY ON STABILIZATION OF COMPOUND SMALL BONE FRACTURES OF HAND AND FOOT WITH JESS FIXATOR

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ABSTRACT

Background : The fractures of small bones of hand and foot should not be more complicated and damaging compared to the damage caused by the injury itself. The goal is to achieve good stability of the bone and joint, which allows early motion without resulting in the residual instability and malunion. These fractures of small bones of hand and foot can be treated with an external fixator that allows fracture reduction attaining normal alignment. we took up the study with an aim to access the overall function and complications in treating open small bones of hand and foot with JESS fixator.

Methods: We performed a prospective study on 20 adult patients (14 males and 6 females) with small bone fractures of hand and foot, who attended outpatient or admitted in inpatient in the department of orthopaedics, government general hospital, Kakinada from October 2017 to august 2019. We excluded closed fractures and severely crushed fractures with neurovascular and tendon injuries.

Results: Results are recorded based on ***Duncan et al.***[5] criteria for fingers. For toes, the results are graded based on a total active range of movements. Most of the cases (n=17) showed radiological union within 12 weeks. Two cases took more than 20 weeks to heal. Whatever be the radiological union, the frame is removed mostly by 15 days postop (n=18) and by a maximum period of 21 days (n=6). the results are found to be excellent in 40% of cases, good in 44% cases, fair in 8% and poor results are seen in 8% cases. We had extensor lag as the most common complication (60%, n=15), 2 cases with malunion (8%) and one case (4%) with superficial infection.

Conclusion: Hand serves many functions of precise movement, grip, grasp, touch etc. though these are small bones their fracture are not to be neglected and should be managed with utmost care. Jess is simple to operate, cheap, easily available, and has less complication rate. It makes the postoperative management simple and effective. It allows early mobilization, which prevents joint stiffness. Removing the frame at end of second postoperative week allows good functional results and doesn't compromise the stability of fracture.

KEYWORDS : Extensor lag, foot fractures, hand fractures, JESS, Joshi external stabilization system.

INTRODUCTION:

"Fractures of the hand can be complicated by deformity by no treatment, stiffness by over treatment, and both stiffness and deformity from poor treatment."--- ***Swanson.***[1] The principles of management should be focused in such a way that the surgery should not be more complicated and damaging compared to the damage caused by the injury itself. The goal is to achieve good stability of the bone and joint, which allows early motion without resulting in the residual instability and malunion. These fractures of small bones of hand and foot can be treated with an external fixator that allows fracture reduction attaining normal bone length via a rigid external support[2]. Mobilization of joints proximal and distal to the fracture can be done without causing additional tissue trauma, thereby preventing stiffness.[3,4]

There is very less literature on JESS fixator for hand fractures and most of the present studies include both closed and open fractures with a very smaller number of compound cases. Hence, we took up the study with an aim to access the overall function and complications in treating open small bones of hand and foot with JESS fixator.

MATERIALS AND METHODS:

Approval was obtained from the local ethical committee with number IEC/RMC/2017/308. 20 adult patients (14 males and 6 females) with small bone fractures of hand and foot, who attended outpatient or admitted in inpatient in the department of orthopaedics, government general hospital, Kakinada from October 2017 to august 2019, were prospectively recruited. Patients with age more than 12 years, with unstable, intraarticular, juxta-articular types were included. Closed fractures and severely crushed fractures with neurovascular and tendon injuries were excluded. Patients who gave informed consent to the procedure were included.

All wounds were meticulously examined to exclude any tendon, neurovascular injuries. Appropriate antibiotic dosage were given. Routine x-rays and investigations were done and preliminary wound wash was given. These were done under local anaesthesia with wrist block or ankle block. Wounds were again washed and debrided and then went for frame application. We always try not to span the joint where ever suitable. Atleast 2 pins for each fragment were preferred, unilateral biplanar frame more than uniplanar bilateral or unilateral uniplanar frames. The former allows flexibility to reduce fracture even after pin application. Two pins were applied in divergent manner at an angulation of 30-60 degrees where the fracture is juxta-articular and less space for 2 pins placement in linear fashion. Hence, "J", or Delta frames are preferred by us. Reduction was checked routinely under c-arm. After acceptable reduction, all the other joints of the finger not involved in the frame are immediately mobilized, and stability of the frame is confirmed. Wound dressing done. Regular pin site dressing is advised and active finger movements are encouraged. Patients are routinely followed up once weekly for 1month, monthly for 6 months, and later, once for 6 months. Around the 2nd follow-up i.e around 14th postoperative day, the frame was removed. After frame removal we took stress views of the fracture routinely. If there was an abnormal mobility or unacceptable displacement at the fracture site, then the fixator was reapplied, or secondary methods of fixation were considered if the wound had healed, depending on the fracture mechanics. The frame was removed under local anaesthesia and the finger is mobilized to avoid any reduced range of movement. Post-operatively they were followed for pin tract infection, pin loosening, joint stiffness, mal-union, osteomyelitis, and most importantly, for joint stiffness.

STATISTICAL ANALYSIS:

The data was entered into excel sheet. Analysis done using appropriate statistical software. All qualitative variables were expressed as proportions or percentages with 95% confidence interval and quantitative variables were expressed as mean with standard deviation.

RESULTS:

Of the 20 patients, most of the patients (70%) were in the age group between 21-40 years age group. The youngest was 13 years old, and the oldest was 55 years old. The mean age of the patients was 31.45 years. In our study, 70% are males and 30% females. This refers to the working population in the community. Majority are industrial workers (40%) and next majority are agricultural labour (30%). Most of the cases are due to a fall of heavyweight objects on hand or feet. Most of these cases are industrial and agricultural injuries (60%). Out of the 20 cases, 5 cases had associated injuries. There are two patients with head injury. One patient with right femur shaft fracture, one with right clavicle and one with left clavicle fractures. The majority of the small bone injuries are of hand injuries (n=15), three times more common than foot injuries. More than 50% of the cases are right-handed dominant (right hand and right foot) (60%). In hand, the most common small bone fractured is a proximal phalanx, around 44%, and the next is distal phalanx (8%). In the foot, the most common small bone fractured is also the proximal phalanx. All our cases of compound small bone fractures are of the proximal phalanx. Out of the 25 fractures, 10 cases (40%) are shaft fractures, 7 (28%) are juxta-articular, and 8 (32%) are intra articular. Most of the fractures are comminuted (28%) and transverse shaft fractures (28%). Most of the open fractures are Type II, comprising 64%. Most of the cases are operated on the same day and many within the first three days. Some cases (n=4) came late after four days of injury. 56% cases took 1-2 weeks for the soft tissue to heal. 36% cases took 2-4 weeks for the soft tissue to heal.to heal. 8% (n=2) cases took more than 4 weeks, as they were badly injured. Most of the cases (n=17) showed radiological union within 12 weeks. Two cases took more than 20 weeks to heal. Whatever be the radiological union, the frame is removed mostly by 15 days postop (n=18) and by a maximum period of 21 days (n=6). For one patient, the frame was removed on the 26th day due to the delay in wound healing(n=2).

Patients were followed up once weekly upto 1month, monthly for upto six months, and later once in six months. Minimum follow-up is upto six months in this study. The cases are followed for six months minimum except for 1 case. In this study, functional assessment was done basing on the total active range of motion of each injured finger separately, which includes adding up the active flexion of the metacarpophalangeal joint, proximal interphalangeal joint, and distal interphalangeal joint and then subtracting the sum of extension deficits of these three joints, based on **Duncan et al**[5 (table -1).] Similarly, for toe fractures the functional results were categorized based on the total active range of motion (table-2).

Fingers	Thumb	Result
220-260	120-140	Excellent
180-220	100-120	Good
130-180	70-100	Fair
<130	<70	Poor

Range of movement of toes	result
175 - 205	Excellent
145 – 175	Good
115 – 145	Fair
<115	Poor

Out of the 5 cases of proximal phalangeal fractures of the foot, 2 had excellent, and 3 had good results. Out of the two metacarpal fractures, 2 had good results. Out of the five middle phalangeal fractures of the hand, 3 had excellent, and 2 had good results. Out of the two distal phalangeal fractures of the hand, both had good results. Finally, the results are found to be excellent in 40% of cases, good in 44% cases, fair in 8% and poor results are seen in 8% cases. The most common complication was extensor lag (60%, n=15), 2 cases with malunion (8%) and one case (4%) with superficial infection.

DISCUSSION:

When there is a compound injury of the hand and foot, the tissues suffer a lot of insults. The process of transportation itself adds trauma, jeopardizing the already precarious blood supply. On reaching the emergency room, the wound is thoroughly washed with peroxide, etc., that adds damage to the viable tissues. Further intramedullary application of k wires may take the superficial infection into the medullary canal and may lead to osteomyelitis. Furthermore, the use of k wires for intramedullary fixation may lead to rotation of the distal fragment while drilling when held improperly. This leads to the kinking of the remaining vasculature, or they may go into spasm, leading to gangrene of the distal fragment Hence, there is a dire need to use a technique that leads to the reduction of the fracture fragments, holding them in proper alignment without further damaging the local biology at the fracture site. The jess fixator serves most of this purpose. Stability is increased by using more pins, and spacing between the pins should be the maximum possible.

We applied different types of frames for different types of fractures. We always tried not to span the joint as it gives a poorer result.

In this study, the safe zones advised by ***Dr.B.B.Joshi*** [6], were followed which reduces the soft tissue complications due to pin placement to negligible. We used dorsolateral pins (k wires) in all our frame constructs at proximal and middle phalanges. Though this may impale the lateral band or oblique retinacular ligament, it recovers its function after removal of the frame.

As most of the compound fractures have a precarious blood supply, applying a collateral fixator is always a threat to the neurovascular structures on either side of the phalanx. Secondly, it needs a perfect reduction of the fracture before the application of the pins because after the application of even one pin in the wrong direction will force the fracture into mal-reduction. Thirdly, it hinders the free movement of the adjacent fingers, mostly when applied for proximal phalangeal fractures.

Most of the cases were treated with "J" fixator or Delta fixator. Its advantages are that the fracture fragments are free for manipulation after the application of the pins. As it is applied in the dorsolateral or dorsomedial aspects of the phalanges, there is less chance of tendon injury, minimal or no damage to the neurovascular bundle, and less interference with the adjacent phalanges. It is easy to manipulate the fracture fragments to attain reduction and gives a stable frame construct once the frame is tightened to allow for the early mobilization.

In a study done by *Drenth and Klasen*[7], the mean age was 35 years out of the 33 patients that he fixed with a mini external fixator. Most of the cases involve shaft of which most are comminuted and short oblique fractures. The dominant hand was involved in only 30% of cases. In *Drenth and Klasen*[7] studies, the frame was removed at an average period of 3-11 weeks for a phalangeal fracture and 2-12 weeks for metacarpal fractures. the mean period of treatment of phalangeal fractures was 7 months and metacarpal fractures was five months. The mean follow- up was 4.4 yrs. 8 out of the 9 fractures of the middle phalanx and 12 of the proximal phalangeal fractures including one intra-articular fracture (n =20) had excellent or good results. Of the eight patients with fair or poor results, five had an injury to the tendon. One patient with a poor result had injuries to both the extensor and flexor tendons. 11 cases out of 36, had partial and total stiffness. six patients had loosening of one of the pins.

In a study by ***SW Parsons et at*** [4], the fixators were removed at the clinical union. This was observed at a mean of 4.8 weeks (range 3-8 weeks) in metacarpal and 4.5 weeks (range 3-8 weeks) in phalangeal fractures.

In a study by ***Mishra AK et al.***[8], the JESS fixator was removed after 6 weeks interval with immediate vigorous mobilization of the joints of hands and wrist was done.

In these previous studies conducted on the JESS fixator, the frames were applied for around 4 to 6 weeks. However, we observed that this prolonged time of applying the frame is leading to adjacent joint contractures. Though the patients were advised to move the joint adjacent to fracture as soon as possible with the frame in- situ, he/she will not move the joints as advised due to pain caused by sliding of the skin and the tendons past the pins. Hence, we observed that the patient develops stiffness of the adjacent joints in the next visit, and even more stiffness at the time of removal of the frame at 4-6 weeks, which is challenging to overcome by physiotherapy. This is significantly important in compound fractures than in simple fractures.

In a study done by ***L.E Claes, J.L.Cunningham*** [9] showed that the healing time of fracture is actually earlier than that suggested by radiographic assessments and that the strength of fracture callus is not in correlation with that of the radiographic picture. Hence, in our study, we tried to keep the time for frame removal to be minimum and balancing between early active mobilization and stability of the fracture.

The frame was removed at around two weeks post-operative period, and radiographs were taken by subjecting the fracture under deforming forces. We observed that there is no or minimum displacement at the fracture site when subjected to moderate stress, when the frames were removed at two weeks postoperative period, in most of the cases. If there was any re-fracture, secondary methods of definitive fixation were considered, as, by that time, the wound may heal.

Irrespective of the fracture union, the frame was removed at around 12-15 days in around 72% of cases.

In a study by ***SW Parsons et at*** [4], there were two pin-track infections, one of which settled on antibiotic therapy and the other on the removal of the fixator at the union.

In a study by ***Mishra AK et al.***[8], there were two pin-track infections, one of which settled on antibiotic therapy and the other on the removal of the fixator at the union. Two patients with proximal phalangeal fractures were left with 20" of angulation into extension.

In our study, there are mainly two important complications mentioned in many of the studies. Firstly, the decreased range of motion and other is pin tract infection.

Most of the cases developed a decreased range of motion. Extensor lag was the most observed complication, even after good physiotherapy. 60% of cases developed an extensor lag of varying range. Even in the remaining cases, there is a slight amount of extensor lag of 10-20 degrees. In most of the studies, they included both closed and compound fractures out of which they reported that the restriction of motion is more with compound than with closed fractures. However, in our study, we took only compound fractures. This might be a reason for the apparently high cases with restriction of movement. However, the range of decrease in the movement is less in most of our cases.

None of our cases developed complete stiffness. This can be attributed to the immediate postoperative allowing of movements and faster removal of frame and allowing active movements.

Compound cases are by themselves a threat for movements of the fingers involved, as they are more prone to adhesions formation and skin contractures.

Another significant complication is pin tract infection and its complications.

This is the leading complication in many external fixators. In our study, there was no pin tract infection. The superficial infection we had was of the compound wound with serous discharge and not from the pin tract. It resolved uneventfully with regular dressings and oral antibiotics but led to the retaining of the fixator for a prolonged time. Summing up, there are poor results with a range of motion of 100 degrees.

This least rate of pin tract infection can be attributed to that of the early removal of the frame, even before the pin tract infection is developed.

Malunion was seen in 2 cases. This inappropriate position may be due to a lack of accurate reduction or post-reduction collapse. Axial or rotational malunion resulted from the inadequate reduction, mostly in cases with comminuted fractures and multiple fractures. None of the malunions are significant in causing disability in the present study.

Strengths of our study are that it is a prospective study, and the same surgical team does all the cases. It includes only compound fractures and not closed fractures. Small sample size, less follow up, and non-randomized sample are its weaknesses.

A) clinical picture with compound wound. B) Showing preoperative radiograph of the comminuted proximal phalanx fracture of index finger of right hand. C) postoperative radiograph showing JESS fixator holding fracture in good reduction. D,E,F) intraoperative picture of the finger, with "J" frame applied showing good flexion and extention range of movement. G) showing stress views of the finger after removing the frame on the 15th postoperative day. There is minimal displacement of the fracture even after removal of frame early.

A,B) clinical pictures of the flexion and extention of the finger after removal of the frame on 15th day. C) comparision of both hands postoperatively after fixator removal.

CONCLUSION:

Hand serves many functions of precise movement, grip, grasp, touch etc. though these are small bones their fracture are not to be neglected and should be managed with utmost care. Jess is simple to operate, cheap, easily available, and has less complication rate. It makes the postoperative management simple and effective. It allows early mobilization, which prevents joint stiffness. Removing the frame at end of second postoperative week allows good functional results and doesn't compromise the stability of fracture.

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