informed consent was taken from all the study participants for participation in this study.

Inclusion criteria
Skeletally mature subjects with Gustilo type 1 open and closed fractures without neurovascular deficit.

Exclusion criteria
Comprised of Gustilo type 2 or 3 open fractures and neurovascular deficit. Preoperative planning: On admission of the patient, careful history was elicited followed by physical examination. Radiographs were evaluated for each patient for type and location of fractures. The patients were taken up for surgery after routine investigations and pre-anesthetic check-up, Stainless steel rush nails were used for all patients for both radius and ulnar repair. Nail diameters were 2.0 mm, 2.5 mm, 3.0 mm, or 3.5 mm, with nail lengths from 16 to 36 cm for all surgical procedures.

Prior to surgery length of the nail is determined directly by measuring uninvolved limb; Ulna from olecranon to ulnar styloid and Radius from radial head to radial styloid process. About ½ inch is subtracted from measurement to avoid risk of driving the nail through the end of the bone. Diameter is measured from the radiograph. Surgical technique for intramedullary nailing: Operations were performed through conventional approaches to radius and ulna, separate approach was used to avoid continuity of heamatoma of two fracture sites with possible synostosis. In fractures older than 10 days autogenous bone graft was taken from patients iliac crest.

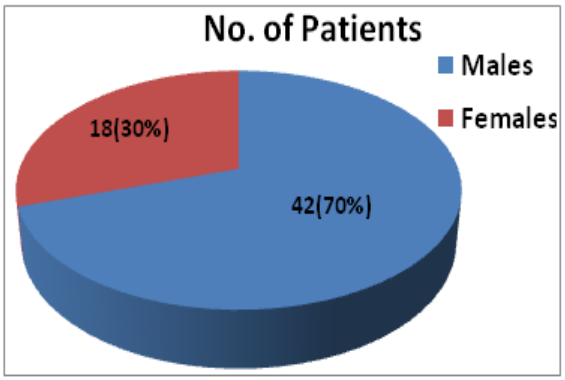
Post-operative care
all patients were immobilized with an AE slab and asked to perform active finger movements. Patients were discharged on the 7th day post-operatively. Suture removal was done in 2 weeks and another AE cast was applied with the elbow in 90° of flexion and the forearm in neutral rotation. Patients were evaluated at 6, 12 weeks and till union and then at 3 monthly intervals. When there is sufficient amount of callus usually at 8-10 weeks post-operatively, we removed cast and forearm was supported with forearm brace and patient was advised to perform elbow and wrist movement to avoid stiffness. External support was removed 8-12 weeks post-operatively. Results were assessed on the basis of the time to union, functional recovery and complications. Functional outcome was calculated using the system described by Anderson et al [8]

Table 1: Anderson criteria for functional assessment

Result	*Union*	*Flexion-Extension of Wrist Joint*	*Supination and pronation*
Excellent	Present	<10° loss	<25% loss
Satisfactory	Present	<20° loss	<50% loss
Unsatisfactory	Present	<30° loss	>50% loss
Failure	Non-union	With or Without loss of motion	With or Without loss of motion

3. Results

During the study period, 60 cases were selected in this study following inclusion criteria mentioned earlier. The mean age of study participants was 36.2 years (range: 18-60 years), with a mean age in males of 39.42 years and mean age in females of 35.2 years (range: 18-60 year).



Pie Chart: Males were predominantly affected 42 patients (70%) while female were 18(30%).

The right limb was fractured in 34 subjects (56.67%) and left limb was fractured in 26 subjects (43.33%). The most common mode of injury was road traffic accidents 40 patients (66.67%), followed by household/accidental falls 14 (23.33%), fall from bicycle 4(6.67%), machine accident 1(1.67%), lathi blow 1(1.67%). Majority of the patients were engaged in active life e.g farmers, labourers 44 patients (73.3%) the remaining were housewifes, students and unemployed 16 patients (26.6%).

Table 2: Type of Fracture

Type of Fracture	No. of Patients	Percentage
Transverse fracture of both bone	36	60%
Transverse fracture of either bone	18	30%
Oblique	2	3.33%
Communited	4	6.67%
Closed	48	80%
Compound Gustilo grade 1	12	20%

Majority of fractures were simple 48 patients (80%) and 12 patients(20%) had compound Gustilo grade 1. Transverse fractures were the most common type of fracture in the present study 36 patients (60%) while 18 patients (30%) had transverse fracture of one bone and oblique of other bone either radius or ulna, comminuted in 4(6.67%) and oblique in 2(3.33%).

Table 3: Bone grafting required in Patients

Bone Grafting	*No. of Patients*	*Percentage*
Primary	14	23.3%
Secondary	2	3.33%

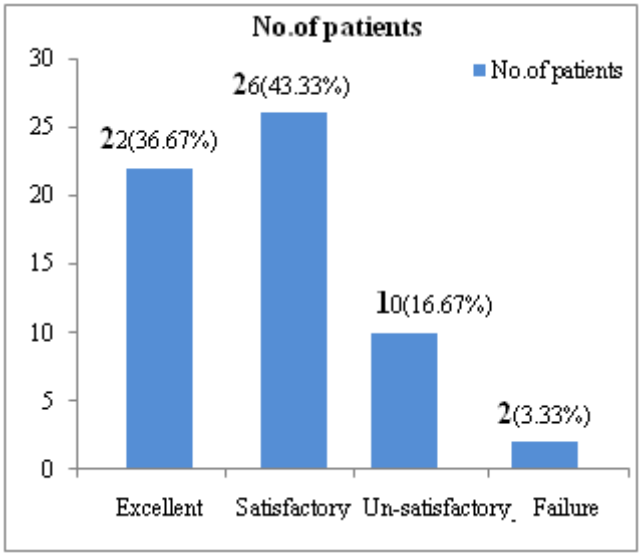
Primary Bone grafting was required in 14 patients (23.3%) and secondary bone grafting in 2 patients (3.33%).

Mean time of the union is 14.8 weeks (range: 12-18 weeks), No intraoperative complication occurred and Cast support was maintained for a mean of 7.5 weeks (range: 6-10 weeks) after that forearm brace was applied for a mean period of 6.1 weeks and continued until the radiographic union was seen.

Table 4: Complications

Complications	*No. of cases*	*Percentage*
Non-union: Both Bones	0	0
Non-Union:Ulna alone	2	3.33%
Infection:Superficial	3	5%
Infection:Deep	0	0
Implant bending	1	1.67%
Protusion of nail	1	1.67%
Radio-Ulnar synostosis	0	0

2 patients developed nonunion of the ulna while one patient had protusion of nail from ulnar side and one had ulnar nail bending,3 patients developed superficial infection while none developed deep infection.



Graph Chart Showing Results as per Anderson criteria

Figure 1: Pre-operative Xray

Figure 2: Post-operative Xray

Figure 3: Pre-operative Xray

Figure 4: Post-operative Xray

Figure 5,6,7,8: Showing Supination, Pronation, Extension, Flexion of Patient

Figure 9: Xray showing ulnar nail bent with union

Figure 10: Xray showing ulnar non union

4. Discussion

Plate fixation has been considered the gold standard for fixation of both bone forearm fractures. Several studies have shown good results.[5,9] Possible complications include compartmental syndrome, delayed union or non-union and difficulty in removing re-fractures after extraction of the plate long duration of operation, long exposure and striping of more soft tissue.[5,7] A high frequency of intraoperative nerve injuries has also been reported. The reported incidence of transient dorsal nerve palsy is 7-10% of all patients with radius fracture treated by plating. Incidence of radio-ulnar synostosis of the plate fixation is reported in the literature is 2-9%. [5,8] On the other hand, intramedullary fixation is comparatively a simpler technique requiring inexpensive surgical devices and also leads to less soft tissue damage, total cost of rush nail instruments amounts to nearly 5000 rupees, while cost of plate and instruments varies from 15000 to 25000 thus intramedullary fixation has wider practical utility and this should be kept in mind while treating poor patients in a developing country like India to carter to the needs of the common man most of which are ruralities.

The mean age of study participants was 36.2 years (range: 18-60 years), with a mean age in males of 39.42 years and mean age in females of 35.2 years (range: 18-60 year), similar observations has been reported by Patwa et al[10], Ghosh et al[11]. Males were predominantly affected 42 patients (70%) while female were 18(30%), similar findings has been reported by Ghosh et al[11] and lil et al[4]. The right limb was fractured in 34 subjects (56.67%) and left limb was fractured in 26 subjects (43.33%), similar finding in Ghosh et al[11] ,Kose et al[12]. The most common mode of injury was road traffic accidents 40 patients (66.67%) and majority of the patients were involved in active life style 44 patients (73.3%), similar findings in Gadegone et al[2].

Mean time of the union is 14.8 weeks (range: 12-18 weeks), similar findings were obtained in Ghosh et al[11] with union in 14.32 weeks, In Kose et al[12] union achieved in 11.3 weeks, in Gadegone et al[2] average union achived in 14 weeks, In lil et al[4] average union time was 12.8 weeks. Primary Bone grafting was required in 14 patients (23.3%) as they have presented late in the hospital more than 10 days after injury and secondary bone grafting in 2 patients (3.33%) who had ulnar non union in whom the ulnar rush nail was removed and open reduction and internal fixation with plating with autogenous bone grafting from iliac crest was done and union was achieved later on in both the patients. Other complications involved superficial skin infection in 3 patients (5%) which improved with appropriate antibiotics after culture sensitivity and none patient had any deep infection. One patient had bending of ulnar nail patient was labourer by occupation and started to lift heavy weight before union resulting in bending of ulnarl nail, adequate immoblisation was done in above elbow cast and union was obtained but resulted in restriction of activities in the patient (>50% loss of supination and pronation) and had not satisfactory result. One patient had ulnar protrusion of the rush nail. Cast support was maintained for a mean of 7.5 weeks (range: 6-10 weeks) after that forearm brace was applied for a mean period of 6.1 weeks and continued until the radiographic union was seen,similar findings were supported by Ghosh et al[11], Lil et al[4]. Union was achieved in 58 out of 60 patients (96.67%) and as per Anderson criteria Excellent to satisfactory results in 48 out of 60 patients (80%), similar results have been found inGadegone et al [2] and Ghosh et al[11].

5. Conclusion

Use of rush nail continues to have predictable and good results. Complication rates are lower when compared to plate osteosynthesis although application of Above elbow cast after nailing is a downside of this procedure. The rush nail has still a future in repair of forearm fractures considering its low complications rates, cost and acceptable results in a developing country where financial matters are to be considered.

References

[1] Singh RP, Sharma M. Primary internal fixation of fracture both bones of forearm by intramedullary nailing. J Inst Med2007;29:2-25.
[2] Gadegone W, Salphale YS, Lokhande V. Screw elastic intramedullary nail for the management of adult forearm fractures. Indian J Orthop 2012;46:65-70.
[3] Saka G, Sağlam N, Kurtulmuş T, Özer C, Uğurlar M, Akpınar F. Interlocking intramedullary ulna nails in isolated ulna diaphyseal fractures: A retrospective study. Acta Orthop Traumatol Turc 2013;47:236-43.

[4] Lil NA, Makkar DS, Adatia AA. Results of closed intramedullary nailing using Talwarkar square nail in adult forearm fractures. Malays Orthop J 2012;6:7-12.
[5] Ozkaya U, Kiliç A, Ozdoğan U, Beng K, Kabukçuoğlu Y. Comparison between locked intramedullary nailing and plate osteosynthesis in the management of adult forearm fractures. Acta Orthop Traumatol Turc 2009;43:14-20.
[6] Lee YH, Lee SK, Chung MS, Baek GH, Gong HS, Kim KH. Interlocking contoured intramedullary nail fixation for selected diaphyseal fractures of the forearm in adults. J Bone Joint Surg Am 2008;90:1891-8.
[7] Hidaka S, Gustilo RB. Refracture of bones of the forearm after plate removal. J Bone and Joint Surg1984;66:1241-2.
[8] Anderson LD, Sisk D, Tooms RE, Park WI 3rd. Compression-plate fixation in acute diaphyseal fractures of the radius and ulna. J Bone Joint Surg Am 1975;57:287-97.
[9] Rehman S, Sokunbi G. Intramedullary fixation of forearm fractures. Hand Clin. 2010;26(3):391-40.
[10] Patwa JJ, Vaidya DD. A Study of two hundred consecutive cases of closed intramedullary nailing of radius and ulna. Indian jour Orthopaedics1990; 24(2):169-72.
[11] Ghosh S, Chowdhury A, Chaudhuri A, Datta S, Roy DS, Singh A. Rush nail and management of fracture both bone forearm. Jscisociety2014;41(3):167-72.
[12] Köse A, Aydin A, Ezirmik N, Can CE, Topal M, Tipi T. Alternative treatment of forearm double fractures: new design intramedullary nail. Arch Orthop Trauma Surg. 2014;134(10):1387–1396.

Author Profile

Dr. Kanwarjit Singh Sandhu is working as Assistant Professor, Govt. Medical College Patiala-147001, Punjab (India). His area of intrest is Trauma Management

Dr. Girish Sahni is working as Assistant Professor, Govt. Medical College Patiala-147001, Punjab (India). His area of intrest is Trauma Management