

Biological Osteosynthesis in Midshaft

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Keywords

Anterior bridge plating; Intramedullary nailing; midshaft humerus fracture; DASH score; time for union; patient satisfaction

Abstract

The humerus is the longest bone in the upper extremity and plays a crucial role in the limb's capacity to function. Humerus Shaft Fractures Account for 1-2% of All Fractures in the Body. Open reductions & internal fixation with such a Dynamic compression plate, lock compression slab, aside a few minutes Dynamic Compression Plate, intra - medullary nail, or minimally invasive bridge plate is one common surgical therapy for humeral shaft fractures. Two techniques for Mid-shaft Humerus Fracture under the study include Intra-medullary nailing and Anterior Bridge Plating, both these fix two main fragments, while the intermediate fracture zone is left untouched. Intramedullary interlocking nailing acts as a load-sharing implant, whereas Anterior Bridge plating (ABP) employs the plate as just an extra-medullary splint. Problems with overhead motion were seen by patients whose incisions were nailed through the rotator cuff, although ABP offers benefits over the other method since it does not harm the rotator cuff. It also requires less time in surgery and fewer doses of radiation. Aim And Objectives: To compare the functional outcome of midshaft humerus fracture treated with anterior bridge plating and Antegrade intramedullary Interlocking nailing by evaluating the time of fracture union, comparing DASH score, evaluating the efficacy of each treatment modality in society (majority of which are farmers and labourers) -According to patient satisfaction. Material and methodology: this is a prospective comparative randomised study conducted in the department of orthopaedics, Krishna institute of medical sciences, Karad which includes 60 patients of midshaft humerus fracture treated with antegrade intramedullary nailing and anterior bridge plating (30 patients each). Results: The average age for Midshaft Humerus Fracture Treated with Antegrade intramedullary nailing was (37.4 ± 11.2) years with a range of 22-62 years and Anterior Bridge Plating was (39.2 ± 11.4) years with a range of 18-62 years. Male predominance was noted in case distribution. The most common occupation was Farmer for men and housewife for women. The affected side distribution with Antegrade intramedullary nailing was more on the right side and Anterior Bridge Plating was equal for the right and left sides. The Bending Wedge Fracture (AO Type 12.B2) was common. The most common Mode of Injury was Road Traffic Accidents. The average time for Union with Antegrade intramedullary nailing was (14.766 ± 3.170) weeks, whereas with Anterior Bridge Plating it was (12.00 ± 2.779) weeks. In our study, no intraoperative complications were seen. In Antegrade intramedullary nailing, there were 2 cases of infection, one of which was a superficial infection which healed with appropriate antibiotics as determined by culture and sensitivity and there was 1 case of non-union seen at 1-year follow-up. In Anterior Bridge Plating, there was 1 case of Postoperative radial nerve palsy which recovered on conservative management post-operatively with Cock up Splint. The average DASH Score for Antegrade intramedullary nailing was (12.76 ± 1.78) ; whereas for Anterior Bridge Plating, it was (10.29 ± 0.592) at 6 months postoperatively. Patient Satisfaction in Farmers and Laborers for Antegrade intramedullary nailing was 71.42% (10/14) whereas with Anterior Bridge Plating it was 100% (11/11) at 6 months postoperatively. Conclusion: Anterior bridge plating has better long-term functional outcomes than antegrade intramedullary nails in midshaft humerus fracture treatment due to less fracture healing time, less DASH score, and better patient satisfaction in the majority of the population.

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1. Introduction

The humerus is the main bone in the functional ability of the upper limb and the longest bone of the upper extremity. Of all the fractures in the body, Humerus Shaft fractures share about 1 to 2% of the share. Various techniques of treatment for humerus fractures have been described; each has some advantages over the other technique. The best method, however, of treatment of shaft of humerus fracture fixation remains debated. Minimally displaced humeral shaft fractures can be treated conservatively due to the high percentage of primary healing with conservative methods like "U" slab and cast, functional bracing or hanging cast. This results in immobilization for a long time and loss of reduction in the plaster cast leading to unsatisfactory results, such as malunion, with more than 10 degrees displacement, delayed union, non-union and shoulder and elbow discomfort. Operative management is advantageous due to early mobilization and patient comfort, but the outcome of operative management depends on the skill of the operating surgeon and is associated with postoperative complications like infections, nerve injuries etc. Open reduction & fixation with a Dynamic compressed plate, locked compression plate, aside a few minutes Dynamic Compress Plate, intramedullary nails, or minimally invasive bridge plate is one common surgical approach to treating humeral shaft fractures.

Two techniques for Mid-shaft Humerus Fracture under study include Intra-medullary nailing and Anterior Bridge Plating. The plate is used as an extra-medullary splint in anterior bridge plating (ABP), where it is fastened to the two primary pieces and the intermediary fracture zone is not treated at all. Two tiny incisions, one proximal and one caudal to the fracture site, are made to try anatomic removal of the shaft pieces. This is a cutting-edge method for treating broken humeral shafts. Nailing the entrance via the rotator cuff caused problems with overhead activities, whereas conventional plating required accessing the fracture site and fixing it. The rotator cuff is not damaged and the fracture site is not opened during ABP, making it the superior method. Moreover, there is less need for blood loss, radiation dose, and surgical

time. Intramedullary nailing has been shown to successfully sustain non-displaced fracture hematomas and reduce surgical trauma.

The Disability of Arm, Hand, and Shoulder (DASH) questionnaire is used to evaluate functional results after any of the two procedures. Several orthopaedic surgeons have discussed why ABP has a better functional result than other procedures for treating midshaft humerus fractures.

Aim: To compare the functional outcome of midshaft humerus fracture treated with anterior bridge plating and Intramedullary Interlocking nailing.

Objective: To evaluate the time of union of fracture at 6 weeks and then every month till 6 months, compare a range of motion of adjoining joints (shoulder and elbow), compare outcome under the following criteria – DASH score, evaluate the efficacy of each treatment modality in farmers and labourers - According to patient satisfaction

2. Material and method:

The present study is a Prospective Randomised Comparative Study. The present study was steered at the Orthopaedics Department, Krishna Hospital and Medical Research Centre, KIMS, Karad, Maharashtra. It was steered in on patients attending orthopaedics OPD and casualty and getting admitted. The sample size of the study will be 60 cases of Midshaft Humerus Fracture in total with 30 cases Operated with Anterior Bridge Plating and I.M. Nailing, alternatively.

Inclusion Criteria: Age above 18 years, Patients of any sex, Patients having comminuted / transverse / segmental / oblique shaft fracture, Patients who are fit for surgery, Patients fulfil the above-mentioned criteria and are willing to participate in the study

Exclusion Criteria: Compound fracture (Gustilo Anderson Type 2 and above), Pathological fractures, Patients with Neurovascular deficit, Patient Unwilling to participate in the study, Patients unfit for surgery,

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Age below 18 years, existing shoulder and elbow pathologies.

Statistical Analysis: Data organization and Scrutiny was done using InStat and SPSS version 21(Statistical Package for the Social Sciences) software.

Ethics Approval: Clearance was obtained from the Ethics Committee, Krishna Hospital of Medical Sciences, Karad.

Post-Operative Protocol:

Time	Intramedullary Nailing	Anterior Bridge Plating
Immediate Post-Operative	Shoulder Pouch	Shoulder Pouch With Immobiliser
Post-Operative Day 3	Remove Pouch and Start Flexion, Extension Movements at Elbow and Wrist Joint	Sarmiento brace
4 Weeks Post Operatively	Gradual Adduction / Abduction, Flexion / Extension at shoulder joint (Rotational movements were started last)	Elbow-Limited Range Flexion Extension Forearm-Supination Pronation Wrist-Flexion, Extension

Post Operative radiographs immediately postoperatively, 6 weeks, and then every month for 6 months. Intravenous antibiotics are given for 5 days, the Wound/suture site is inspected at POD-2, and Suture removal is to be done on 12-14 postoperative days.

Follow Up Protocol: Clinical signs of fracture healing: No tenderness at fracture site indicates Union, Localized rise of temperature was checked; Radiological signs of Fracture healing: Fracture was pronounced united by radiological signs, Union was pronounced when bone gaps were filled with bone trabeculae, Post-operative X-rays were checked at 6 weeks and then every month till 6 months. The X-rays were checked in two views – AP/lateral views; Union is pronounced when 3 out of 4 cortices are united. DASH Score at 6 weeks, 3 months and 6 months visit:

Surgical techniques: ANTERIOR BRIDGE PLATING: Patient is positioned supine with arm in 60° abduction. Regional Block / General Anesthesia is given. Then scrubbing, painting, and draping are done.





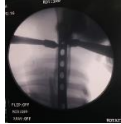




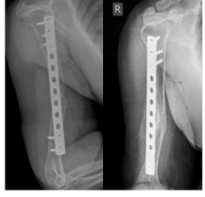
Under the C-arm picture, the placement of an appropriate-sized plate on the patient's upper arm is verified. The Dynamic Compression Plate with the narrowest holes measures in at only 4.5 mm. The insertion of the Pectoralis Major muscle is a common location for the proximal portion of the plate. The plate's proximal end is positioned close to the coronoid fossa's superior edge. A 3-5 cm incision is made 5 cm distal to the acromion process, between the lateral border of the deltoid as well as the proximal section of the biceps. About 4-5 cm proximal to a flexor crease, a 3-4 cm cut was made distally, at the lateral edge of the biceps brachii. Once the biceps brachii are retracted, the Musculocutaneous nerve is exposed and the brachialis muscle is superimposed on top of it. After then, the nerve is pulled back.

After the bone is visible, the brachialis muscle is cut along the middle. The brachialis muscle protects the radial nerve. A 4.5mm Quasi Dynamic Pressure Plate is inserted via the proximal incision and into a tunnel made beneath the brachialis. At the distal wound, the radial nerve is located and protected from the plate's edge. Elbow varus/valgus, arm length, and rotation may be corrected by traction, counter-traction, and

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manipulation. C-arm imaging is used to confirm the reduction, and this is done by moving the C-arm itself rather than the humerus bone. At least two screws are used to secure the plate in place at each of its front and posterior edges. Out of the 2 distal-most holes 2nd most distal hole is drilled with a 3.2mm drill bit and an oversize screw is placed bicortical with some gap left behind between the screw head and the plate.

After placing the first screw the second screw is placed at 2nd most proximal hole unicortically. Positioning of the plate and reduction at the fracture site is verified and both the screws are tightened. Holes at far ends are drilled and bicortical screws are placed of appropriate lengths. The oversized screw is replaced with accurate sizes. Closure of the wound is done in layers.

				
Position of arm and incision marking with appropriate plate size	Incision	Plate Insert		Confirm Under Fluoroscopy
				
Distal Screw Placement	Preoperative x-ray	Immediate post-operative x-ray	6 weeks post-operative	6 months post-operative

Post-Operative Range of Motion At 6 Months



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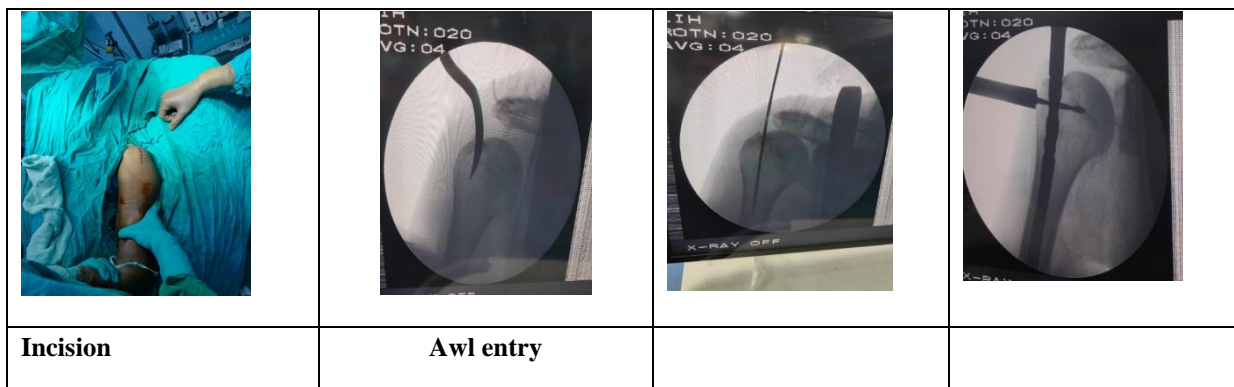
2)Antegrade Intramedullary Nailing:

Surgical Procedure: Before initiating closed antegrade nailing, traction must be used to get the humerus to the right length and into the right position. The recommended length for the nail's distal end is 1cm to 2cm above the olecranon fossa.

Positioning and preparing the patient: The patient's head is rotated to the other side while he's in the beach chair posture so that more of his shoulders are seen. The elbow is flexed 80°–90°, the arm and hand are pointed upwards, and the shoulder is in an

anatomic position to create the rotational configuration.

Approach: An incision is created in the skin, starting at the acromion's anterolateral point and continuing distally until it is centered over the larger tuberosity's apex. The supraspinatus tendon is exposed by cutting through the fascia above the deltoid and slicing along the tendon's fibers using a sharp knife. Then retract both edges of the tendon with stay sutures and then expose a small part of the humeral head cartilage medial to the greater tuberosity

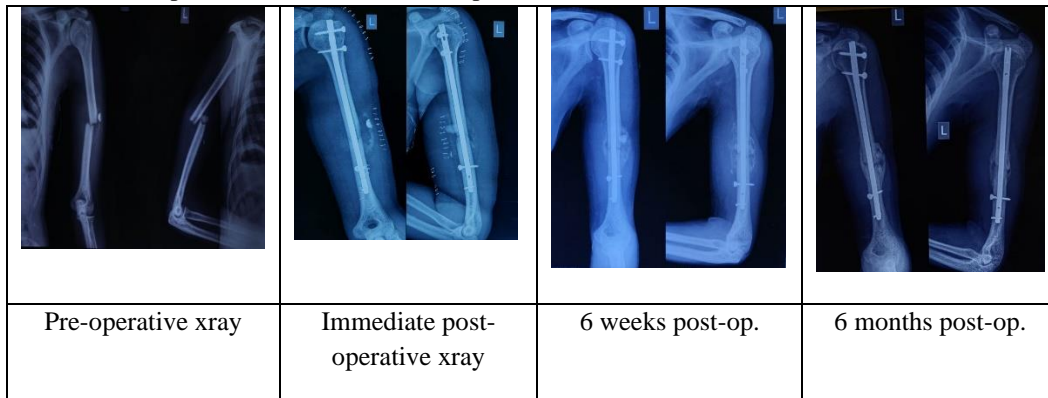


Template the nail to be buried in the bone proximally to reduce subacromial impingement, and insert it such that its point of insertion is malleolus to the tip of a greater tuberosity, which is lateral to the axis of a medullary waterway in the AP view and in line with the axis in the Lateral view (to reduce rotator cuff damage). The entrance hole is created with a tiny, curved awl medial to the end of the larger tuberosity. An picture intensifier has shown this to be true. To ensure the nail will enter the middle of the humerus, the entry site should be centered on AP/lateral views. The curved awl is removed, and a guide rod for a 2.4 mm ball-nosed reamer is inserted. The image intensifier is used to verify that the guide wire is positioned in the middle of the medullary canal. The tip of a guide wire is positioned between 1 and 2 centimeters proximal to the olecranonfossa after being inserted into the distal fragment. Overlap a second guide rod coming proximally from the humeral entrance portal and position the distal end of the first rod 1cm to 2cm distal to the olecranon fossa. To get the proper nail length, measure the overlapping guide rod and deduct 50 mm. The humerus is reamed over its entire length in 0.5mm increments over a 2.4mm

ball-nose reamer guide rod. The nail was reamed to be 1mm bigger than the desired diameter. A nail guide rod of the same diameter (2.40mm) takes the place of the ball-nose reamer guide (3.18mm). Disconnecting the medullary exchange tube. When the guiding rod has been removed, a quasi humeral nail is placed under x-ray control. To the proximal drill guide, we fasten the chosen nail. The proximal nail curve should point laterally, and the outrigger handle should be kept away from the patient. To prevent splintering the distal humerus, the nail is pushed distally until it is 1 to 2 centimeters from the olecranon fossa. Using AP/Lateral views on imageintensification, the nail's location in the distal fragment may be double checked. Locking at both the proximal and distal Proximal and distal locking screws, measuring 3.8mm and 3mm, secure the nail. The jig on the nail is used to insert the proximal screw. An either a posterior or an anterior insertion portal is created, and the patient is positioned supine with the shoulder abducted at an angle of 60 degrees. The oval distal screws hole in the nail is then oriented in an anteroposterior direction. Sometimes distal lateromedial locking screw needed to be put in. The screw is inserted using the free hand

technique under Carmguidance. The closure is done in layers taking care not to forget to repair the rotator cuff which had been spitted earlier as failure to repair

the cuff leads to some loss of motion at the shoulder joint and this will affect the functional out come.



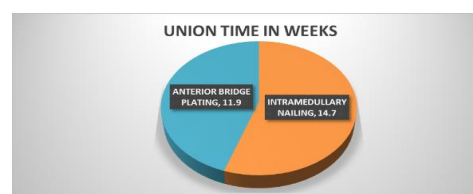
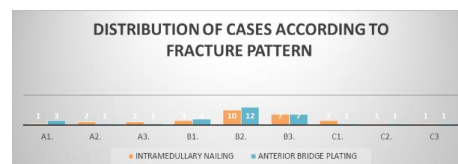
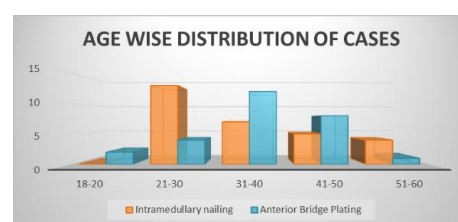
Post Operative Range Of Motion At 6 Months



3. Observations and results:

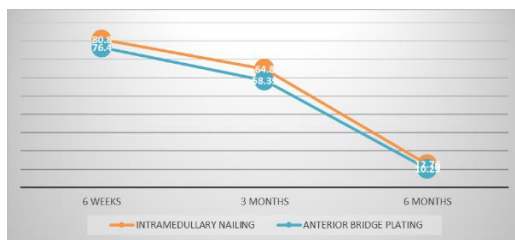
The average age for Midshaft Humerus Fracture Treated with Intramedullary nailing was (37.4 ± 11.2) years with a range of 22-62 years; whereas the average age for Humerus Fracture Treated with Anterior Bridge Plating was (39.2 ± 11.4) years with a range of 18-62 years; and the Age of the patients in both study groups were comparable. was with Male predominance. the data was found not significant. This implies in both the studies, similar gender-wise studies are comparable. The most common occupation was Farmer for men and housewife for women. The affected side distribution for Intramedullary nailing was more on the right side, whereas for Anterior Bridge Plating it was equally distributed on right and left sides. The Bending Wedge Fracture (AO Type 12.B2) was common for both treatment modalities. The Chi-square test was applied to the data with no significant association. The most common Mode of Injury for Patients was Road Traffic Accidents. The average time for Union for Intramedullary nailing was

(14.766 ± 3.170) weeks; whereas the average age for Anterior Bridge Plating was (12.00 ± 2.779) weeks; $(p=0.007, t=3.595)$ the data is significant.

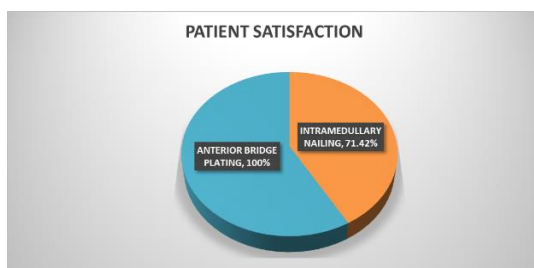


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In Intramedullary Nailing, there were 2 cases of superficial infection which healed with appropriate antibiotics as determined by culture and sensitivity. 1 case of non-union was tagged at 1-year follow-up. In Anterior Bridge Plating, there was 1 case of Postoperative radial nerve palsy which recovered on conservative management post-operatively with Cock up Splint. The average DASH Score for Intramedullary nailing was (80.60 ± 3.25) ; whereas the average DASH Score for Anterior Bridge Plating was (76.40 ± 1.67) at 6 weeks postoperatively ($p < 0.001$, $t=6.468$) is highly significant; The average DASH Score for Intramedullary nailing was (64.80 ± 4.56) , whereas average DASH Score for Anterior Bridge Plating was (58.39 ± 1.29) at 3 months postoperatively ($p < 0.001$, $t=6.468$) is highly significant; The average DASH Score for Intramedullary nailing was (12.66 ± 1.78) ; whereas average DASH Score for Anterior Bridge Plating was (10.29 ± 0.592) at 6 months postoperatively ($p < 0.001$, $t= 7.082$) is highly significant.



Patient Satisfaction in Farmers and Laborers for Intramedullary nailing was 71.42% (10/14) and for Anterior Bridge Plating was 100% (11/11) at 6 months postoperatively.



Discussion: our analysis is as follows

1) Age –In the study, the average age for Intramedullary nailing was (37.4 ± 11.2) years with a range of 22-62 years; whereas the average age for Anterior Bridge Plating was (39.2 ± 11.4) years with a

range of 18-62 years; with ($t=0.6010$, $p=0.5501$) **not significant**; and the Age of the patients in both study groups were similar.

In the study conducted by *Dr Nagesh Rajendra Desai* et al., In a 2014 study comparing the results of treating humeral shaft fractures with dynamic compressive plating and intramedullary interlocking nailing, the intramedullary linking group had a mean age of 34.94 years (range 23—70 years). The average age of patients in the 2011 research "Minimally intrusive plate osteosynthesis in humerus diaphyseal fractures," by Shetty MS et al., was 39 (the age range covered by the study was 22-70). Patients' mean ages were 38 years old in Mohammed Ibrahim et al 2018's research on noninvasive anterior bridge plating for humerus shafts fractures (range 24 to 60 years).

2) Sex Distribution –The gender-wise distribution for Intramedullary nailing and Anterior Bridge Plating was Male predominance. On the Chi-square test applied to the data, ($p=0.7656$, $q=0.08$) the data was found not significant. This implies in both the studies, similar gender-wise studies are similar.

In the study conducted by Dr Nagesh Rajendra Desai, "A Comparative Study of Functional Outcomes of Fracture Shaft Humerus In Adults Treated With Dynamic Compression Plating And Interlocking Nailing", 2014; among the study subjects, for intramedullary nailing 15(50.0%) were male while remaining 15 (50.0%) were female.

In the study conducted by Shetty MS et al., Minimally invasive plate osteosynthesis for humerus diaphyseal fractures, 2011; among the study subjects, 19 (59.4%) were male while the remaining 13 (40.6%) were female. In the study conducted by Abhishek S. Mahajan et al., "Is Anterior Bridge Plating for Mid-Shaft Humeral Fractures a Suitable Option for Patients Predominantly Involved in Overhead Activities? A Functional Outcome Study in Athletes and Manual Laborers, 2016; 36 (75.0%) were male while the remaining 12 (25.0%) were female."

3) Mode of Injury –In our study, Road Traffic Accident is the most common cause of injury in Midshaft Humerus Fractures. In the study conducted by Shetty MS et al., Minimally invasive plate osteosynthesis for humerus diaphyseal fractures,

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2011; it was seen that 26 (81.2%) cases had Road Traffic Accident, 4 (12.5%) cases had fallen from a height and 2 (6.3%) cases had direct blow/assault. In the study conducted by Abhishek S. Mahajan et al., "Is Anterior Bridge Plating for Mid-Shaft Humeral Fractures a Suitable Option for Patients Predominantly Involved in Overhead Activities? In a Functional Outcome Study in Athletes and Manual Laborers, 2016, it was seen that 25 (52.1%) cases had Road Traffic Accidents, 13 (27.1%) cases had fallen from a height and 10 (20.8%) cases had Direct blow/assault."

In the study conducted by Dr Nagesh Rajendra Desai, "A Comparative Study of Functional Outcomes of Fracture Shaft Humerus In Adults Treated With Dynamic Compression Plating And Interlocking Nailing, 2014;" it was seen that 7 (46.66%) cases had Road Traffic Accident, 6 (40.0%) cases had fallen from a height and 2 (13.33%) cases had Direct blow/Trauma.

4) Complications: no intraoperative complications were seen. Postoperative complications: In Intramedullary nailing, there were 2 cases of infection, one of which was a superficial infection which healed with appropriate antibiotics as determined by culture and sensitivity; and there was 1 case of non-union that was tagged at 1-year follow-up.

In the study conducted by Dr Nagesh Rajendra Desai et al., "A Comparative Study of Functional Outcomes of Fracture Shaft Humerus In Adults Treated With Dynamic Compression Plating And Interlocking Nailing," 2014; it was observed that 1 (16.66%) case had superficial infection, 1 (16.66%) case had delayed union and 1 (16.66%) cases had shoulder stiffness for the intramedullary group. In this study Anterior Bridge Plating, there was 1 case of Postoperative radial nerve injury which recovered on conservative management post-operatively with Cock up Splint. Similar results were seen in the study conducted by Abhishek S. Mahajan et al., "Is Anterior Bridge Plating for Mid-Shaft Humeral Fractures a Suitable Option for Patients Predominantly Involved in Overhead Activities? In a Functional Outcome Study in Athletes and Manual Laborers, 2016"; it was observed that 2 (4.17%) cases had a superficial infection, 2 (6.1%) cases had minimal restriction of

shoulder movement, 2 (4.17%) cases had tingling over the forearm, 1 "(2.08%) case had hypertrophic scar while no patients had deep/systemic infection or major neurovascular injury. At the final follow-up, 45 patients (93.7%) joined their regular jobs. The remaining 3 patients (6.25%) had to change their jobs (2 patients were cases of non-union) because of pain, lack of power and tightness in the surgically treated limb."

5) Dash Score -The average DASH Score for Intramedullary nailing was (80.60 ± 3.25); whereas the average DASH Score for Anterior Bridge Plating was (76.40 ± 1.67) at 6 weeks postoperatively; ($p < 0.001$, $t=6.468$) is highly significant. The average DASH Score for Midshaft Humerus Fracture Treated with Intramedullary nailing was (64.80 ± 4.56); whereas the average DASH Score for Midshaft Humerus Fracture Treated with Anterior Bridge Plating was (58.39 ± 1.29) at 3 months postoperatively; ($p < 0.001$, $t=6.468$) is highly significant.

The average DASH Score for Humerus Fracture Treated with Intramedullary nailing was (12.76 ± 1.78); whereas the average DASH Score for Humerus Fracture Treated with Anterior Bridge Plating was (10.29 ± 0.592) at 6 months postoperatively; ($p < 0.001$, $t= 7.082$) is highly significant. In the study conducted by Malleswara Rao Perumalla Venkata Naga et al., "A comparative study on the fixation of fracture shaft of the humerus in adults by compression plate and intramedullary interlocking nail", 2018; the average DASH score of the patients treated with Intramedullary nailing was (37.168) at 3 months postoperatively. The DASH Score was comparable. In the study conducted by Dr Nagesh Rajendra Desai et al., A Comparative Study of Functional Outcomes of Fracture Shaft Humerus In Adults Treated With Dynamic Compression Plating And Interlocking Nailing, 2014; the average DASH score of the patients treated with interlocking nailing was (44.13) at 6 months postoperatively. The DASH Score was comparable.

In The Study Conducted by Dr Nishant Vidhyadhar Shivadeet al., A Study of Functional Outcome of Shaft Humerus Fracture Treated with Anterior Bridge Plating; The Average DASH Scores for Anterior

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Bridge Plating Were (13.66 ± 0.983) At 3 Months And (10.48 ± 1.108) At 6 Months

6) Evaluation of the Efficacy of Each Treatment Modality In Farmers And Laborers- Patient Satisfaction in Farmers and Laborers for Intramedullary nailing was 71.42% (10/14); whereas for Anterior Bridge Plating it was 100% (11/11) at 6 months postoperatively;

In the study conducted by Abhishek S. Mahajan, “Is anterior bridge plating for midshaft humeral fractures a suitable option for patients predominantly involved in overhead activities? A functional outcome study in athletes and manual labourers” – Patient Satisfaction in Manual Laborers and athletes for Humerus Fracture Treated with Anterior Bridge Plating in farmers and labourers was 89.6% (43/48) at 1-year postoperatively.

In the study conducted by Dr Nagesh Rajendra Desai et al., “A Comparative Study of Functional Outcomes of Fracture Shaft Humerus In Adults Treated With Dynamic Compression Plating And Interlocking Nailing, 2014”; out of 15 patients 4(26.66%) were complaining of some pain in the operated side shoulder at the end of the study(6 months) with intramedullary interlocking nailing and 11(73.33%) patients did not have any similar complains.

4. Conclusion:

Anterior bridge plating has better long-term functional outcomes than Antegrade intramedullary nailing in midshaft humerus fracture treatment due to minimal disturbance of primary fracture hematoma and no associated rotator cuff morbidity with less union time, less DASH score and better patient satisfaction rate in the population.

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