Use of Compression Plates for the Management of the Shaft of Humerus Provides Better Outcome as Compared to the Intra Medullary Nails: A Critical Analysis

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**INTRODUCTION**

The humerus serves as the origin and insertion site of many upper limb muscles that divide into the scapulohumeral muscles, anterior compartment muscles, posterior compartment muscles. The deltoid muscle, with each part inserting into the deltoid tuberosity of the humerus, allows internal/external rotation and abduction/adduction of the humerus. The pectoralis major muscle inserts into the intertubercular sulcus of the humerus and it allows adduction, flexion, extension, and medial rotation of the humerus. Four muscles form the rotator cuff insert onto the lesser tubercle of the humerus, facilitating internal rotation of the humerus and contribute to the range of motion along with other muscles. Anterior compartment muscles: The biceps brachii muscle is connected via a transverse humeral ligament which projects from the lesser tubercle to the greater tubercle of the humerus. The coracobrachialis inserts onto the humerus and its medial surface, and allows flexion and internal rotation. The brachialis muscle originates on the anterior surface of the distal humerus. The triceps brachii muscle contains three heads, with the medial head originating on the posterior aspect of the humerus, inferior to the spiral groove, and the lateral head originating on the posterior surface. The humerus along with the long head of the triceps, teres major and teres minor, form a quadrangular space through which the posterior circumflex artery and vein and radian nerve travel.

The first bone plate was apparently used in 1886, when Hansmann devised his retrievable plate. However, plates may well have been used earlier, because different kinds of metal devices were under trial even during American Civil War (1861 to 1865). Perhaps the first surgeon to use a true compression plate in the treatment of acute fractures was Danis in 1949. He did provide data on the fractures he had treated with compression plating. In Danis plate the head of axially oriented compression screw was so close to the bone that at operation it must have been difficult to apply a wrench and turn the screw. In Veneble modification of Dams plate described in 1851, the compression screw was oriented obliquely to make it more assessable, but this change made the junction between the compression screw and the threads of the anchoring screw insecure.

Internal fixation of fractures of long bones of extremity with plate and screws as a mode of treatment has evolved progressively since 19th century when Hugh Owen Thomas (1831-1891) stressed the importance of uninterrupted and prolonged immobilization in fracture treatment. In 1948 Eggers and Associates studied the effect of compression on healing of experimental fracture in animal and concluded that compression forces applied to healing bone fragments...
could influence the rate of healing. In 1949, Danis was the first surgeon to use a true compression plate in the treatment of acute fracture.

R.R. Loomer and P. Kokanet al., (1975) treated 29 cases of non-union of humerus shaft and evaluated the result regarding the method of treatment. They advised compression plating with cancellous bone graft. Compression plating not only achieves good results but also helped in early mobilization of joint which are prone to be stiff.

Sarmiento et al., (1977) treated fifty-one cases of fracture of the shaft of the humerus with the functional method consisting of a plastic sleeve and they concluded that functional bracing for the treatment of fractures of the humeral shaft are associated with a high rate of union, particularly when used for closed fracture.

Seidal in 1989 developed locking nail for the humerus. Closed nail techniques have decreased blood loss, infection rate and duration of stay in hospital. Furthermore there is a rigid fixation and no external splintage is required. But increased incidence of shoulder stiffness, mechanical problem and non-union has also been noted with this technique. Plating of humerus shaft fracture is the standard and time tested treatment.

The result of the first general study of various locking compression plates were published in 2003 by Sommer C et al., They concluded that the LCP was a technically mature and proven its worth in complex fracture situations and in revision operations after the failure of implant.

In 2004 Ring et al., treated 24 patients with osteoporotic delayed union (9 patients) and non union (15 patient) of the shaft humerus with locking compression plate. All fractures eventually healed and using a modification of the constant and Murley shoulder score the results were good or excellent in 22 patients and fair in 2 patients. They found that the construct provides stable fixation in patients with poor bone quality.

Gardner et al., (2005) studied the mechanical behaviour of locking compression plates in comparison to the dynamic compression plates. The findings in their studies indicated that locking compression plate constructs demonstrated subtle mechanical superiority as compared with the limited contact-dynamic compression plate. The locking compression plate specimens had less energy absorption and survived longer. Discordance of motion between measurement regions was observed only in the limited contact-dynamic compression plate torsion group, that could be caused by plate-bone slippage or bone-screw subcatastrophic failure. However, many other compared parameters were found to be similar, and the clinical significance of the few differences found between constructs mandates further investigation.

In 2005. Tzu-Liang Hsu et al., conducted a retrospective study to evaluate the treatment of aseptic non-union of the humeral shaft with a compression plate and cancellous bone graft. They found that all nonunion fractures united within an average of 16 weeks (range, 10-26 weeks). Complications included 4 patients with temporary radial-nerve palsies, and 3 patients with wound infections. At the final follow-up, shoulder and elbow functions of the operated limbs were all satisfactory. They, therefore, concluded that use of fixation plate with supplemental cancellous bone graft is a reliable and effective treatment for nonunion of a humeral shaft fracture.

In 2006 F Leung and Sp Chow said locking compression plates is effective device for use as a bridging device in treating comminuted fractures, its usage in simple fractures and its superiority over conventional plating systems is yet to be proved. Well documented clinical trials of locking compression plating are needed before guidelines on its application can be drawn.

In 2006, Niemeyer P et al., described that locking compression plate is represented by combination of two completely different anchorage techniques and two opposed principles of osteosynthesis in one implant. It combines the principles of conventional plate synthesis for direct anatomical reduction with those of bridging plate osteosynthesis.

Bhandari et al., (2006) conducted a metanalysis on comparing compression plating with respect to the intramedullary nailing of humeral shaft fractures in order to consider the improved treatment effect. Theyy found that the plate fixation reduced the risk of shoulder problems in comparison to the intramedullary nails. They also found that there was a risk reduction of 74% for reoperation when plate fixation was employed. Hence, the authors concluded that the plate fixation of humeral shaft fractures might reduce the risk of reoperation and shoulder impingement.

A biomechanical study on LCP conducted in (2006) by Ahmed M et al., opined that if LCP is being used then it is desirable to place the plate at or less than 2 mm from the bone as it maintain the periosteal blood supply to the bone beneath the plate and also allows a mechanically stable environment at the fracture site to allow fracture healing.
Raghvendra S et al., (2007) followed up 36 patients with fractures of shaft of the humerus in a prospective study. Eighteen patients each underwent open reduction and internal fixation with compression plating and antegrade interlocking nailing. Though there was no significant difference between plating or nailing in terms of time to union, compression plating is the preferred method in the majority of fractures of the shaft of the humerus with better preservation of joint function and lesser need for bone grafting for union.\textsuperscript{xix}

Singisetti et al., conducted a prospective comparative study to compare the surgical outcomes of intramedullary nailing as compared to locked compression plating in the humerus shaft fractures. Functional scoring criteria were used for postoperative assessment and the average follow-up period was one year. A higher rate of excellent and good results and a tendency for earlier union was seen with the plating group as compared to the intramedullary nailing group.\textsuperscript{xvi}

Heineman et al., in their study comparing plate fixation or intramedullary fixation of humeral shaft fractures found that statistically insignificant differences between plates and nails in the treatment of humeral shaft fractures. Small Sample size, study heterogeneity, and methodological limitations argue strongly for a definitive, large trial. They recommended that the trial should be a randomized controlled trial with appropriate allocation of patients and binding of patients and care providers and outcome assessors, and that it should include patient’s important outcomes.\textsuperscript{xxi}

In a meta-analysis done by Kurup et al., in the year 2011 for comparing surgical fixation through the compression plating versus locked intramedullary nailing for humeral shaft fractures in adults, the authors found that that intramedullary nailing was found to be associated with an increased risk of shoulder impingement, with a related increase in restriction of shoulder movement and need for removal of metalwork as compared to locking compression plates. There was insufficient evidence to determine if there were any other important differences, including in functional outcome, between compression plating and locked intramedullary nailing for humeral shaft fractures.\textsuperscript{xxii}

In a review of fixation of osteoporotic fractures in the upper limb with a locking compression plate, V Neuhaus (2012) et al., stated that Locking Compression Plate (LCP) has the advantageous feature that screws can be locked in the plate leaving an angular stable construct. Thus, the osteoporotic fractures of the proximal humerus and distal radius are ideal settings/ indications for LCP utilization in the upper extremities, as the angular stability provided by the locking compression plate allows stable fixation and early functional mobilization.\textsuperscript{xxiii}

Malhar N Kumar et al., (2013) conducted a follow up study of the outcome of the use of Locking compression plates for humeral nonunion following failed internal fixation in which implants other than LCP had been used. Main outcome measurements included radiographic assessment of fracture union and pre and postoperative functional evaluation using the modified Constant and Murley scoring system. They concluded that Locking compression plating and cancellous bone grafting was a reliable option for achieving union in humeral diaphyseal nonunion with failed previous internal fixation and resulted in a good functional outcome in patients with higher physiological demands.\textsuperscript{xxv}

In 2013, a study conducted by Soumya Ghosh et al., they have compared locking plate with intramedullary nailing in 60 humeral shaft fractures through which they suggested that LCP shows early union and excellent-to-good functional outcome in 73% than intramedullary interlocking nail in 60%.\textsuperscript{xxvi}

In a meta-analysis conducted by Guo-dong Liu et al., in 2013, a comparison between the outcomes of intramedullary nailing and plate fixation in the treatment of humeral shaft fractures was done. The results showed that the delayed healing rate of the humeral shaft fractures was lower in plat fixation as compared to intramedullary nailing. Hence, they concluded that plate fixation was a better modality as compared to intramedullary nailing.\textsuperscript{xxvii}

A study done by Azboy et al., in 2013 compared the results of the locking compression plate (LCP) and the dynamic compression plate (DCP) in the treatment of diaphyseal forearm fractures in adults and, thereafter, defined the indications for the use of the LCP. Patients were assessed using the Grace-Eversmann criteria and the Disabilities of the Arm and Shoulder and Hand questionnaire during the final follow-up. Union was achieved in all patients. No significant difference was found regarding the time to union between the groups. No significant difference existed between the 2 groups in terms of Grace-Eversmann criteria and Disabilities of the Arm and Shoulder and Hand scores. The results of these different fixation methods for forearm fractures in adults were similar. Hence the authors concluded that the correct selection and application of surgical technique was more important than the type of plate used.\textsuperscript{xxviii}

Patel et al., (2014) conducted a systematic review to determine the functional outcomes and complications of intramedullary nailing in comparison to the plate fixation for both-bone diaphyseal forearm fractures. The main purpose of the study was to systematically search for and critically appraise articles comparing functional outcomes, radiographic
outcomes and complications of nailing and plating for both-bone diaphyseal forearm fractures. They found that there were no statistically significant differences in functional outcome or time to fracture union between plating and IM nailing. No consistent difference was found in complication rate, fracture angulation, shortening or rotation. Better cosmesis and shorter duration of surgery was noted in the intramedullary nailing group. Post-operative radial bow was significantly abnormal in the intramedullary nailing groups, but did not affect forearm movement. Based on similar functional and radiographic outcomes, the authors concluded that nailing seemed to be a safe and effective option when compared to plating.\textsuperscript{ xxvii }

One systematic review of overlapping meta-analysis was conducted in 2015 by Jia-Guo Zhao to compare intramedullary nailing with plate fixation for humeral shaft fractures. This systematic review was performed according to the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA). The best available evidence suggested that the differences between intramedullary nail and plate fixation were not significant in fracture union, radial nerve injury, and infection. But intramedullary nail significantly increased the risk of shoulder complications (shoulder impingement and restriction of shoulder movement) and reoperation. They concluded that plate fixation is superior to intramedullary nail for the treatment of humeral shaft fractures.\textsuperscript{ xxix }

A study was conducted by Yu Fan et al., in 2015 to compare the management of humeral shaft fractures with intramedullary interlocking nail versus locking compression plate. The outcome was assessed in terms of intraoperative blood loss, operative time, hospital stay, union time, union rate, functional outcome, and incidence of complications. No statistically significant difference was found regarding the union rate. The average union time was found to be significantly lower for the intramedullary interlocking nail compared with the locking compression plate. The incidence of complications such as radial nerve palsy was found to be higher with the locking compression plate compared with the intramedullary interlocking nail.\textsuperscript{ xxx }

Ravi Shankar et al., in 2015 assessed the effectiveness of locking versus dynamic compression plates in the management of diaphyseal humerus fractures. The outcome was assessed in terms of the union time, union rate, functional outcome, ROM and the incidence of complications. Functional outcome was assessed using the Romen’s et al., series grading system. Though the average union time and recovery of range of motion was found to be better for locking compression plate as compared to dynamic compression plate, it was not statistically significant. Complications such as infection were found to be higher with dynamic compression plate as compared to locking compression plate. The study proved that the locking compression plate could be considered a better surgical option for the management of diaphyseal fractures of the humerus as it offered a short union time and lower incidence of serious complications like infection.\textsuperscript{ xxxi }

Ramo L et al., (2017) conducted randomised controlled trial on 80 patients comparing the effectiveness and cost effectiveness of surgical and conservative treatment of humeral shaft fractures. They concluded that operative treatment result in earlier recovery and more satisfied patients than non operative treatment at 6 weeks to 6 months, but the differences are clinically and statistically insignificant at 12 months.\textsuperscript{ xxxii }

In a study conducted by Michele Bisaccia et al., (2017), they aimed to compare Intramedullary Nailing, Locking Compression Plating, and External Fixation in the treatment of diaphyseal fractures of the humerus of adult patients. They followed up clinically and radiographically at 1.3, 6 and 12 months. ASES and SF-36 were used as rating scales for complications. The treatment of humeral shaft fractures showed overlapping results with the use of plates, of intramedullary nails, or with the external fixator. Hence, they concluded that the choice of which technique to use should be determined on the experience of the operator and patient compliance.\textsuperscript{ xxxiii }

A study done by Naseer et al., in 2017 aimed to determine the effectiveness of locking compression plate (LCP). The functional outcome was evaluated in terms of Disability of Arm, Shoulder and hand (DASH) score and Grace and Eversmann criteria. They concluded that the high rate of union along with good functional outcome and minimal complication could be achieved in patients with diaphyseal wedge fractures of long bones when managed with locking compression plate.\textsuperscript{ xxxiv }

In 2018, B Mahender Reddy compared the results of the use of compression plating as compared to closed interlocking nail, in the treatment of humerus shaft fractures. While good results were seen in 43% of the cases treated with interlocking nailing, 48% of the cases treated with compression plating showed good results. The author concluded that the compression plates had better outcomes and fewer incidences of complications as compared to IL nailing.\textsuperscript{ xxxv }

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\textsuperscript{ xxvii } Sharma SK, Hmlyan Jr Med Surg; Vol-2, Iss- 6 (Nov-Dec, 2021): 52-58

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In 2020, Yavuz Akalin et al., conducted a single-centre prospective randomized study to compare the radiological and clinical outcomes of interlocking nail (ILN) and locking plate fixation (LCP) for humeral shaft fractures. The functional outcomes were evaluated using the Disabilities of the Arm, Shoulder, and Hand (DASH), American Shoulder and Elbow Surgeons (ASES), the University of California at Los Angeles (UCLA) shoulder scores, and Short Form-36 (SF-36) questionnaires, and pain was assessed with visual analogue scale (VAS). They found that the LCP group had significantly better shoulder function than the ILN group, whereas the ILN group had significantly less pain, with similar complication rates.

In 2021, Mohammed Othman et al., conducted a clinical trial to compare the outcome of interlocking intramedullary nailing versus plating of diaphyseal humeral shaft fracture. They reported that intramedullary nail fixation for humerus was the treatment of choice in osteoporotic bone, less rate of infection less blood loss, however it was found to be associated with higher incidence of shoulder discomfort, and more malunion and non-union rate as compared to locking plate compression technique.

Andrews R Stephens et al., in 2021, assessed the cost effectiveness of the use of plate construct as compared to intramedullary nailing by estimating the surgical encounter total direct costs (SETDC) for humeral shaft fractures. Our study found that the total direct costs for humeral shaft fracture fixation was greater for intramedullary nailing than for the plating technique. They suggested that the surgeons should take these findings into consideration when consenting patients with humeral shaft fractures for the appropriate fixation type.

CONCLUSION

Use of compression plates is better than intra-medullary nailing for the management of fracture of shaft of humerus. The clinical outcome and the quality of life is satisfactory when a compression plate is used as compared to intra-medullary nailing.

REFERENCES


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