



A Prospective Cohort Study on Philos Plating for Proximal Humerus Fractures: Functional and Radiological Outcomes

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Abstract

Background: Displaced proximal humerus fractures are a therapeutic challenge, especially in patients with poor bone quality. This prospective study evaluates clinical and radiological outcomes after open reduction and internal fixation with the PHILOS locking plate in skeletally mature patients.

Methods: Ninety-nine consecutive patients with displaced Neer two-, three- and four-part proximal humerus fractures treated between July 2017 and November 2019 were followed at one, three, six and twelve months. Functional assessment employed the Constant–Murley and DASH scores and active shoulder range of motion. Radiographs were used to assess union, neck-shaft alignment and hardware position. Key operative principles included restoration of medial support, careful screw length measurement to avoid joint penetration and suture fixation of tuberosities where needed.

Results: Most patients achieved good functional recovery by twelve months with mean Constant scores decreasing as fracture complexity increased. The overall complication rate was 19.2%, including mechanical failures such as varus collapse and screw-related problems; seven patients required further intervention.

Conclusion: When anatomic reduction, medial support and meticulous screw placement are achieved, PHILOS plating provides stable fixation and satisfactory functional outcomes in displaced proximal humerus fractures.

Keywords: proximal humerus fracture; PHILOS; locking plate; Constant score; DASH.

AIMS & OBJECTIVES

Aim: To evaluate functional outcomes and complications following PHILOS locking plate fixation in displaced proximal humerus fractures and to identify technique-related factors associated with mechanical failure. Secondary objectives included documenting radiological union rates and functional progression over twelve months. Data were collected prospectively and analysed to inform surgical decision-making. Carefully.

Introduction

Proximal humerus fractures [1] are a frequent injury encountered in orthopedic practice, representing a significant proportion of upper limb fractures in adults. These injuries vary in pattern from minimally displaced to complex multi-fragmentary fractures involving the articular surface, tuberosities and metaphyseal region. Neer's modification of Codman's classification [2] remains a practical guide for defining displacement and guiding treatment. While non-operative treatment suits stable, minimally displaced fractures, displaced two-, three- and four-part injuries commonly require



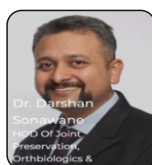
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DOI: <https://doi.org/10.13107/jmt.2021.v07.i01.154>

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operative fixation [3] to restore anatomy and shoulder function. Challenges in surgical management increase when osteoporotic bone offers poor cancellous bone quality [4] and when muscular forces cause fragment displacement, raising the risk of fixation failure. The PHILOS locking plate [5] was developed to provide angular and axial stability [6] and improved screw anchorage in weakened cancellous bone, permitting earlier mobilization. Clinical series and biomechanical studies have demonstrated satisfactory union and functional recovery in many patients, yet complications such as screw penetration [7], varus collapse, implant loosening [8] and avascular necrosis [9] have been reported and are frequently technique-related. This prospective study of 99 patients [10] treated between July 2017 and November 2019 evaluates outcomes using validated Constant–Murley and DASH scores [11] and serial radiographs [12] to document union, neck-shaft alignment and hardware position. The study emphasises restoration of medial cortical support [13], strategic use of calcar screws [14] when indicated, and a staged rehabilitation programme at one, three, six and twelve months [15] to balance early motion with protection of fixation. Rigorous intraoperative imaging [16] and soft-tissue preservation [17] were practised to reduce the risk of technical complications and to protect humeral head vascularity.

Materials and methods

This prospective study enrolled consecutive skeletally mature patients presenting with displaced Neer two-, three- and four-part proximal humerus fractures who underwent open reduction and internal fixation with a PHILOS locking plate after institutional review board approval [18]. Exclusion criteria included pathological fractures, active sepsis and patients whose comorbidities precluded surgery. Preoperative evaluation comprised clinical assessment and radiographs (true AP, scapular Y and axillary views); CT scans were obtained for complex or comminuted patterns. Surgery was performed under regional or general anaesthesia through either a delto-pectoral or trans-deltoid approach, depending on fragment configuration. Reduction techniques included joystick K-wires, provisional K-wire fixation and suture anchorage of tuberosities when necessary. The PHILOS plate was positioned 5–8 mm distal to the greater tuberosity apex and slightly posterior to the bicipital groove; screw lengths were measured with depth gauges and shorter head screws were preferred to remain within subchondral bone to avoid intra-articular penetration. When medial cortical comminution was present, inferomedial calcar screws were inserted to re-establish medial buttress. Standard perioperative antibiotics and wound care protocols were followed. Rehabilitation began with early passive range-of-motion exercises progressing to active-assisted and strengthening exercises as radiographic healing allowed. Patients were evaluated at one, three, six and twelve months using DASH and Constant–Murley scores and serial

radiographs to assess union, neck-shaft angle and hardware integrity. Statistical analysis used SPSS with significance set at $p < 0.05$.

Review of literature

Locking plate fixation was introduced to address the shortcomings of conventional plating in osteoporotic and multifragmentary proximal humerus fractures. Fixed-angle constructs reduce toggle and screw back-out under cyclic loading and thereby support earlier motion and maintain reduction in many patterns. Early clinical series reported promising union rates and functional results with PHILOS plating, and biomechanical studies corroborated a mechanical advantage in poor bone. Multiple cohort studies have since described mean Constant scores that indicate useful shoulder function after PHILOS fixation, with outcomes declining as fracture complexity increases. Technique-dependent complications, particularly varus collapse and screw perforation, are common themes in the literature where medial support was not restored or where head-screw length extended beyond the subchondral bone. Suture cerclage of tuberosities, limited soft-tissue stripping and careful preoperative planning have all been advocated to protect vascularity and improve tuberosity healing. Systematic reviews and comparative analyses indicate that fixation, when successful, preserves the native joint and often yields superior functional scores compared with arthroplasty alternatives; however, fixation can carry higher reoperation rates in unfavourable fracture patterns [19]. Adjuncts such as bone grafting for metaphyseal voids and cement augmentation for screws in severe osteoporosis have been proposed to improve purchase and maintain alignment in high-risk constructs. Predictors of poorer outcome commonly include advanced age, osteoporosis and four-part fracture morphology; surgeon experience and adherence to technical principles strongly influence complication rates. Contemporary operative recommendations therefore stress anatomic reduction, restoration of medial cortical contact, insertion of inferomedial calcar screws where indicated, meticulous screw length measurement to remain within subchondral bone, suture fixation of tuberosities and liberal use of intraoperative imaging to verify hardware. Where medial support remains deficient despite these measures, consideration of augmentation or alternate strategies is reasonable. Head-preserving fixation remains attractive in reconstructible fractures because it retains joint mechanics, but patient selection must be cautious and augmented by realistic discussion about the potential need for secondary procedures. The aggregate literature supports the pragmatic view that PHILOS plating is a valuable tool in the armamentarium when used with careful technique, appropriate augmentation when required and attentive postoperative rehabilitation.

Results

Ninety-nine patients completed follow-up. The mean age was 48.4 years; there were 58 males and 41 females. Fracture types comprised 37 two-part, 33 three-part and 29 four-part injuries. The dominant side was involved slightly more often. Most patients had hospital stays of seven days or less. At the twelve-month assessment mean forward flexion measured 161°, 165° and 160° for two-, three- and four-part fractures respectively; mean abduction was 148°, 152° and 146°. Mean Constant scores were 83.24 for two-part, 80.79 for three-part and 74.52 for four-part fractures. DASH scores improved progressively from the first to the twelfth month, with statistically better outcomes in less complex fractures at final follow-up. Overall 19 patients (19.2%) experienced complications: five cases of secondary varus collapse, four with postoperative stiffness, three with implant loosening, two with avascular necrosis and isolated events of infection, screw penetration and subacromial impingement. Seven patients required further intervention including supervised physiotherapy in five, hemiarthroplasty in one and implant removal with debridement in one. There were no nerve injuries reported. Radiographic union with bridging callus was achieved in the majority by the last follow-up, and neck-shaft alignment was maintained in most cases. Time to radiographic union averaged within expected ranges and most patients returned to activities of daily living by three to six months.

Discussion

In this series PHILOS plating provided satisfactory head-preserving fixation with early mobilization and functional recovery for most patients. Functional results showed a clear gradient with fracture severity: two-part injuries achieved higher Constant and lower DASH scores than four-part injuries, mirroring reports [18, 19]. Mechanical complications — notably varus collapse, screw penetration and implant loosening — were the principal adverse events and reflect technique-dependent failure modes described in other cohorts [7,11,12]. Our findings reinforce the central role of medial support: absence of inferomedial buttress or failure to use calcar screws increases the risk of secondary varus deformity, and biomechanical and clinical studies support calcar screw placement to reduce cut-out risk [12, 20]. Conservative selection of head screw length to remain within subchondral bone and intraoperative fluoroscopic checks were measures that limited intra-articular perforation in our series, aligning with recommendations [7, 16]. Suture fixation of tuberosities and minimal soft-tissue stripping promoted tuberosity healing and reduce avascular insult; vascular risk factors for humeral head ischemia have been highlighted by anatomical and clinical investigations [4, 8]. Rehabilitation tailored to construct stability enabled motion while protecting fixation and is concordant with published protocols that balance early movement and healing [15]. Limitations include single-centre

design, modest sample size and a mean follow-up of twelve months, which may under-represent late complications; similar caveats are noted in systematic reviews and comparative studies [13, 19]. Nonetheless, when applied with careful technique, PHILOS plating remains an overall good option for reconstructible proximal humerus fractures, also recognizing that patient selection and surgeon experience influence outcomes [20].

Conclusion

PHILOS locking plate fixation provides a reliable head-preserving method for displaced proximal humerus fractures when careful anatomic reduction and restoration of medial support are achieved. Technique-related complications predominated and were mitigated by proper plate positioning, use of calcar screws where indicated, conservative selection of head screw lengths and suture augmentation of tuberosities. Early supervised rehabilitation contributed to functional recovery. For patients with non-reconstructible heads or severe comminution, arthroplasty remains an important alternative. Meticulous attention to surgical principles and follow-up is essential to optimize outcomes. Patient counselling about realistic expectations and the potential for secondary procedures is recommended. Indeed. Amen.

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Conflict of Interest: Nil
Source of Support: None

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Year of Acceptance of Thesis: 2019

How to Cite this Article: Verma D, Pradhan C, Patil A, Puram C, Sonawane D, Shyam A, Sancheti P | A Prospective Cohort Study on Philos Plating for Proximal Humerus Fractures: Functional and Radiological Outcomes | Journal of Medical Thesis | 2021 January-June; 7(1):9-12.