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THE RESULTS OF INTERNAL FIXATION OF PROXIMAL HUMERAL OSTEOPOROTIC FRACTURES WITH PHILOS LOCKING PLATE

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SUMMARY

***Background**: In the last fifty years since plate and screw osteosynthesis has been implemented in fracture treatment, osteosporotic bone fractures were observed as a special problem. Due to special histologic, anatomic, physical and biomehanic properties of osteoporotic changed bone the laws of biomechanics suggest that stable osteosynthesis for osteoporotic bone is necessary to increase the contact surface of metallic implants and bone and the stability of the screw-plate-bone compound. There are numerous surgical techniques and methods for treatment of osteoporotic proximal humeral fractures. Every surgical procedure has to establish anatomical reduction and stable fixation that will enable early mobilisation.*

***Subjects and methods:** The aim of this study was to present results of internal fixation of proximal humeral osteoporotic fractures with PHILOS locking plate. Between 2007 and 2012, a total of 67 patients older than 65 years with closed proximal humerus fractures underwent surgical treatment with PHILOS plate system (Synthes, Switzerland). 42 patients were operated with deltopectoral approach and 25 with deltoid split approach. After a mean follow up period of 14.68 (6-28) months functional and radiologic results were assessed.*

***Results:** We noted 9 postoperative complications related to surgical technique (1 intraarticular screw placement, 1 displacement in major tuberculum fragment, 1 displacement in major tuberculum fragment along with oblique placement of the plate, 2 cases of inadequate reduction, 1 case of humeral head avascular necrosis, varus humeral head fixation in 3 cases). None of the patients developed superficial or deep surgical infection. There was no nonunions. In the final evaluation, the Constant shoulder score was 91.75 (72-100).*

***Conclusions:** In this study PHILOS locking plate showed good applicability, respecting bone biologic properties because of negligible interference with blood supply of the humeral head. There was no requirement to shape the plate enabling stabilization at constant angles as clear benefit of this plate. All that enables early mobilisation, and no implant insufficiency resulting in satisfactory treatment results and high Constant shoulder scores.*

***Key words:** proximal humerus fracture - osteoporotic fracture - locking compression plate – PHILOS - deltopectoral approach - deltoid split approach*

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INTRODUCTION

Osteoporotic bone fracture treatment represents a problem especially in osteosynthesis. Ever since osteosynthesis has been implemented in fracture treatment, in the last fifty years, osteoporotic bone fractures represent special problem (Struhl et al. 1990, Flahiff et al. 1995). Connection between plate and screw is accomplished with screw head and the edge of the plate's hole. Rotational strength of the compound depends on the size of the screw tightening force and friction factor of metal on metal. Since the clamping force of the screw is limited with ten times lower strength of cortical bone than the metal and metal on metal friction factor is extremely small, the friction is the mechanism of attachment, and that is not enough. This combination results in loosening of the bone-implant complex wich leads to screw pullout and the mobility of the plate so the stability of the fracture is lost (Chen et al. 2009).

When bone is osteoporoticly changed, cortical bone is thinner and cancellous bone is built of thin trabeculae so the bone tissue is fragile due to lower density and changed trabecular built. Osteoporotic bone is less susceptibile to deformation, it has significantly lower elasticity module. Beacuse of that the junction between bone and plate is unstable and the screw in osteoporotic bone doesn't have secure and stable foothold. Local contact between the screw and the bone is small, and soon after osteosynthesis it begins to loosen with all the negative consequences (Jensen et al.1990, Drew & Allcock 2002, Schandelmaier et al. 2001). Developed and sturdy cortex and developed and dense cancellous bone allow less strain on the contact surface of the screw and the bone, thereby ensuring stable foothold of the screw and high pressure between the bone fragments and a reduced ability for the emergence of osteolysis and microfracture on the contact surface. The laws of biomechanics suggest that a stable osteosynthesis of osteoporotic bone is necessary to increase the contact surface of metallic implants and bone or increase the stability of the screw-plate-bone compound (Frigg 2003, Gautier & Sommer 2003).

The increase of contact surface can be achived with modified osteosynthesis and application of bone cement in cortical screw bedding. With this procedure, after polymerisation, bone cement signifficantly increases the level of contact and rigidity between bone and implants which increases the stability of fragments (Wenzl 2004, Miller & Goswami 2007). As we learned the biology of bone healing we became aware that it is of crucial importance to maintain local biologic conditions, especially bone viability, in order to preserve factors that are needed for fracture healing (An 2002, Šišljagić et al. 2009, 2010). Osteoporotic fractures are significant in overall morbidity of population in developed countries. Osteoporosis affects almost 75 million people in Europe, USA and Japan. More than 6 milllion osteoporotic fractures are reported in Europe and USA anually. About 6-10% of those patients require additional procedures which implies demanding, longlasting and expensive treatment. Conesquences are chronical problems like aches and physical and psychosocial disability. With longer lifespan of population there is dramatic increase of musculosceletal diseases. In year 2000 cost of osteoporotic fracture treatment in Europe was 31.7 bill € and it is estimated that by the year 2050. those expences will be 76.7 bill € (Kanis 2005).

Proximal humeral fractures include fractures of humeral head, anatomical and surgical neck fractures as well as greater and lesser tubercle fractures. Complex injuries can include all these structures combined with subluxation or luxation of humeroscapular joint (Andrew & Crenshaw 2003). Proximal humeral fractures comprise aproximatelly 5% of all fractures and incidence is higher among women and in older age group. In older women osteporotic proximal humeral fractures are twice as common than in men. Incidence is rising with age. 87% of all osteoporotic fractures happen after falling in walking level. The fractures are more complex as the osteoporosis gets more severe (Court-Brown 2001).

Proximal humeral fractures are mainly treated conservatively, however there are cases when surgical procedure has to be done whether it is osteosynthesis or shoulder prostheses. There is no unique algorythm how to treat these fractures.

Widely used classifications for proximal humeral fractures are according to Neer and according to AO. In clinical practice Neer classification is preferable but the main objection is that it is subjected to personal opinion of surgeon while it is very usefull in treatment planing. This classification is based on number and displacement of four anatomical parts of proximal humerus which is devided in: humeral head, greater and lesser tubercle and proximal humeral diaphysis. Every displacement bigger than 1cm and angulation greater than 45 degrees is accountable so the fracture can be twoparts, threeparts or fourparts.

Unlike Neer classification there is also AO classification that is very practical. Type A is extraarticular fracture with one fragment (it can be tubercle fracture or impacted metaphyseal fracture or displaced metaphyseal fracture). Type B is extraarticular fracture with two or three parts (impacted metapyseal fracture, non impacted metaphyseal fracture or fracture combined with shoulder dislocation). Type C fractures are intraarticular fractures (minor dislocation, dislocation with impaction or dislocated fracture with shoulder dislocation) (Neer 1970, Nho et al. 2007).

There are numerous surgical techniques and methods for treatment of proximal humeral fractures. Every surgical procedure has to establish anatomical reduction and stable fixation that will enable early rehabilitation. Until locking plates have been invented there was no big success in treating proximal humeral fractures particulary in osteoporotic bones (Kenneth et al. 2008). In last two decades knowledge about bone healing teaches us that it is not only stable fixation responsible for bone healing but also the conservation of biological integrity of the bone itself (Becker & Stein 2009).

Before development of locking compression plate (LCP) there was idea of "biologic osteosynthesis" and construction of implant that would maintain biologic intergrity of the bone (Frigg 2003). Conventional method of direct bone healing with interfragment compression was inadequate when treating comminuted metaphyseal and osteoporotic fracture while LCP was superior in treating precisely these fractures and in all fractures with need for preservation of fragment vascularisation (Lill et al. 2003, Perren 2002). The aim of this study was to analyze the results for treatment of proximal humerus osteoporotic bone fractures treated with PHILOS plate system.

SUBJECTS AND METHODS

Between September 2007 and December 2012, a total of 112 patients underwent surgical treatment with PHILOS plate system (Synthes, Switzerland). The study was approved by the Ethics Committee of the University Clinical Hospital Split. All participants signed a statement of informed consent after getting acquainted with the details of the study. PHILOS system consists of titanium, preformed, angular stable LCP plate, designed for internal fixation of proximal humeral fractures. 67 older then 65 years and patients who had longer than 6 months follow up and who fulfilled the inclusion criteria were taken into the study.

Inclusion criteria:

- Closed proximal humerus fracture (AO/ASIF bifocal, unifocal, intraarticular);
- Fractures not treated with conservative means;
- Patients older than 65 years.

Exclusion criteria:

- Pathologic fractures;
- Patients with primary or metastatic tumors;
- Fractures with nonunion.

In order to completely analyse the fracture type AP and transthoracic lateral imaging was used, and CT scans were used only in selected cases. Using X-rays, all fractures were classified according to AO/AIF classification (Müler et al. 1990) (Figure 1). Computer tomography was used only in selected cases to evaluate the extension to the articular surface and to evaluate the amount of major tuberculum displacement in comminuted fractures. All operations were controlled using fluoroscopy (Figure 2, Figure 3). After a mean follow up period of 14.68 (6-28) months the functional and radiologic results were assessed.

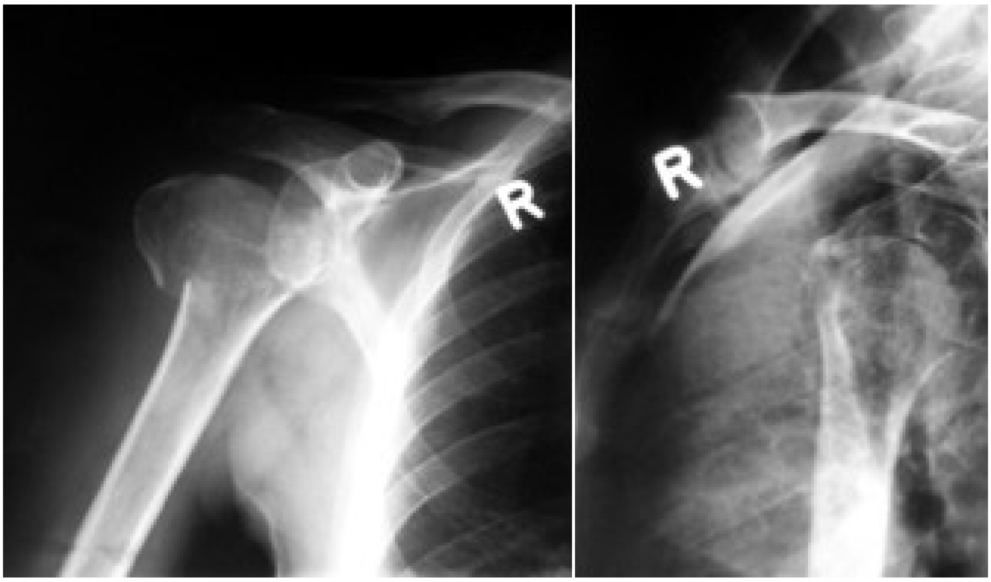

Figure 1. X –ray before operation

Figure 2. Fluoroscopy during the operation

Figure 3. X-ray after operation

Surgical treatment

In the surgical treatment of proximal humeral fractures, most surgeons prefer the deltopectoral approach due to their education and habits. The deltoid splitting approach is a good choice especially in comminuted fractures or where the trabecular fragments are displaced, combined with miimally invasive technique. We used both approaches. The patients were positioned in the beach chair position (Figure 4). 42 patients underwent deltopectoral approach and 25 underwent deltoid split approach with minimally invasive technique (Figure 4). In proximal humerus fractures, after the fracture site was exposed, reduction was enabled with a K-wire under fluoroscopy and with ethibond sutures passed through the rotator cuff tendons. The PHILOS plate was positioned lateral to the bicipital groove and distal to the major tuberculum, and the correct position was checked with fluoroscopy. The tubercular fragments and rotator cuff tendons were fixated using sutures passing from these structures and the plate. Finally, fracture reduction and screw length were assessed with fluroscopy (Figure 2). Preoperative and postoperative images of our cases are shown in Figures 1 and 3. After fracture fixation, shoulder AP and neutral position X rays were taken as the shoulder was internally rotated, externally rotated and neutral. The limit of shoulder movement was controlled for the presence of impingement.

Postoperative treatment

Following stabilization with PHILOS, the shoulder was immobilized with a shoulder-arm sling for 2-3 days.

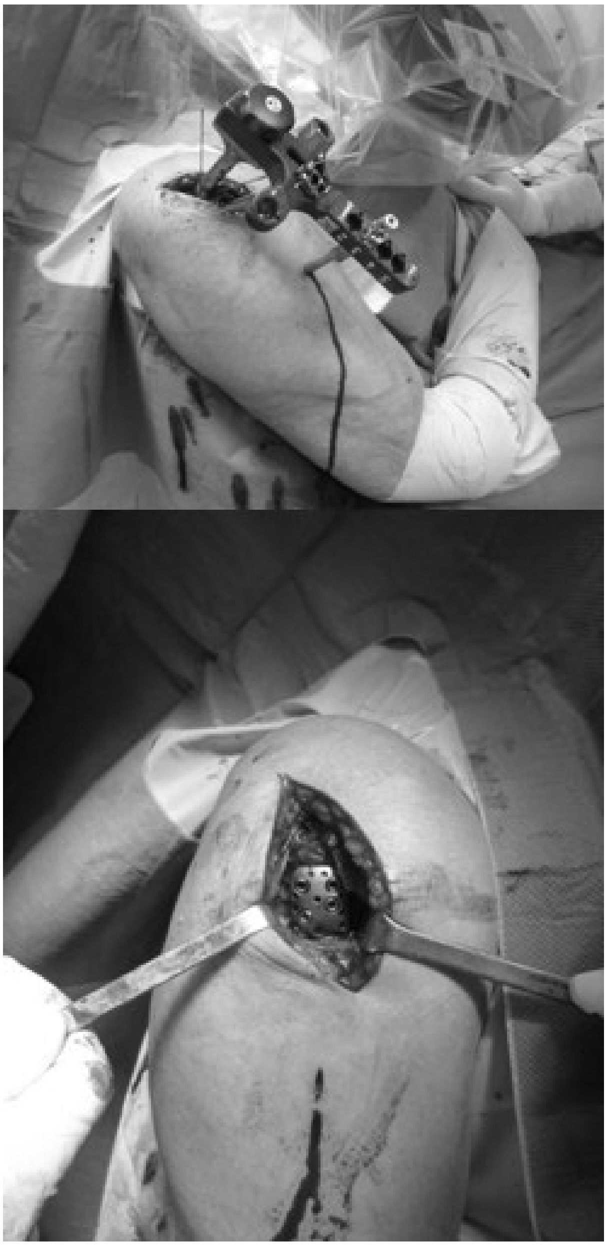

Figure 4. Patient in beach chair position and deltoid split approach (minimaly invasive)

Subsequently, passive motion exercises were initiated with 90° abduction and anteflexion. Active pendular and circular motions of the arm were prescribed. Active assisted and passive exercises were used during the first two weeks, and 3 weeks later active motion was started. On the 6th postoperative week, daily activities were allowed. After the postoperative control on the 6th week, subsequent visits were organized in 3, 6 and 12 months and in patients with longer follow up, annually. Regular X rays were obtained to control the plate position and healing. The range of motion in the shoulder joint was recorded. The patients were evaluated with the Constant score (Constant & Murley 1987) on the postoperative 6th week, 3rd and 6th month.

RESULTS

After a mean follow up of 14.68 (6-28) months, radiologic and functional evaluations were made. During follow up, intraarticular screw placement was seen in 1 patient (deltopectoral aproach), displacement in major tuberculum fragment was seen in 1 case (deltopectoral aproach), displacement in major tuberculum fragment along with oblique placement of the plate was seen in 1case (deltopectoral aproach). Inadequate reduction was seen in 2 cases (2 deltopectoral aproach) and avascular necrosis the haed of the humerus in 1 case. In three cases, as an early postoperative complication, it was seen that the head was fixed in the varus position (2 deltoid aproach,1 deltopectoral aproach). None of the patients developed superficial or deep infection. None of the scars required revision. The deltoid muscles were weak initially, however returned to normal after rehabilitation. In all shoulders, the suprascapular nerve was functional, and normal power was demonstrated after rehabilitation. In the final evaluation, the Constant shoulder score was 91.75 (72-100).

DISCUSSION

In osteoporotic individuals, the risk of implant loosening and failure is higher due to poor bone quality (Cordasco & Bigliani 1997). Excellent results began to be reported after the introduction of the PHILOS plate, a new internal fixation system developed by the AO/ASIF group for the treatment of proximal humerus fractures which enables angled fixation using multiple interlocking screws (Frigg 2003, Lill et al. 2003). The screws in the humeral head are locked to the plate and cannot move backwards, a significant advantage in osteoporotic bones. It also enables the placement of screws in different directions (converging or diverging). The low profile minimizes the risk of impingement (Ring & Jupiter 2003, Peter et al. 2005, Koukakis et al. 2006).

PHILOS plate is made of titanium, and therefore lighter than other implants. It has a good biocompatibility. The locking screw and plate system is a reliable internal fixation method for all age groups, if attention is paid to technical details and the tubercular fragments are reduced with sutures fixed to the plate. Easy applicability, biologic property due to the lack of interference with blood supply of the humeral head, no requirement to shape the plate and the achievement of stabilization at constant angles are the benefits of this plate. All screws and the plate move as a single structure. Complications related to the plate are very few, therefore it is possible to avoid most of the complications of traditional plating. In the treatment of osteoporotic fractures, it is superior to other osteosynthesis techniques since it allows early motion and there is no implant insufficiency. Except from implant choice reason for high Constant scores in our study group is also related to adequate surgical technique, good follow-up and rehabilitation.

CONCLUSION

In this study a total of 67 patients older than 65 years with closed proximal humerus fractures were treated with PHILOS plate system. In the final evaluation, after rehabilitation and mean follow up of 14 months the Constant shoulder score was satisfactory for treatment of this kind of injuries in all patients. We emhasize practical and technical benefits and rare complications related to implant. We therefore believe that PHILOS plate is a good internal fixation material for the osteosynthesis of proximal humerus fractures in patients of all ages, especially in the population older than 65, combined with adequate surgical technique, rehabilitation and follow up.

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Conflict of interest : None to declare.

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