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SHOULD MAJORITY OF PROXIMAL HUMERUS FRACTURES IN PATIENTS ABOVE 60 YEARS BE TREATED BY OPEN REDUCTION INTERNAL FIXATION? LITERATURE REVIEW.

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SUMMARY

Proximal humeral fracture (PHF) is the third most common osteoporotic fracture after proximal femur and distal radius in patients above 65 years old. Treatment options remain variable depending on not very clearly defined indications yet. Surgery remains indicated in unstable displaced fractures, however its definition stays controversial. Some recent publications put in doubt the need of surgical treatment showing no statistical benefits of surgery versus conservative treatment. The goal of this study was to evaluate current literature regarding PHF treatment paying special attention for the studies concerning fractures' open reduction internal fixation (ORIF). All described surgical methods of treatment are not free from the complications. That is the reason why all options, including non-operative treatment should be considered and discussed with the patients. If operative treatment is chosen one physician should chose the fixation system that fits his skills the best. Our goal should be to minimize the soft tissue injury and to fulfill the crucial factors for stable, anatomic fixation – calcar and tuberosities reposition and stabilization. At this moment ORIF seems to fulfill this criteria the best, however the tendency to perform this in a minimally invasive fashion is visible. In our institution the arthroplasty remains an

CZY WIĘKSZOŚĆ ZŁAMAŃ KOŃCA BLIŻSZEGO KOŚCI RAMIENNEJ U CHORYCH POWYŻEJ 60. ROKU ŻYCIA POWINNA BYĆ LECZONA OPERACYJNIE STABILIZACJĄ WEWNĘTRZNĄ? PRZEGLĄD LITERATURY

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STRESZCZENIE

Złamania końca bliższego kości ramiennej są trzecim najczęstszym złamaniem osteoporotycznym, po złamaniu końca bliższego kości udowej i końca dalszego kości promieniowej, u chorych po 65 roku życia. Leczenie tych złamań budzi liczne kontrowersje, a wskazania do leczenia operacyjnego wciąż nie są jednoznacznie określone. Leczenie chirurgiczne jest wskazane w przypadku złamań przemieszczonych i niestabilnych, chociaż ich definicja wciąż nie jest precyzyjna. W ostatnich latach ukazały się publikacje poddające w wątpliwość skuteczność leczenia chirurgicznego – wyniki tych prac nie udowadniają wyższości leczenia operacyjnego nad leczeniem zachowawczym. Celem poniżej pracy jest przegląd literatury dotyczący złamań końca bliższego kości ramiennej ze szczególnym uwzględnieniem prac oceniających wyniki otwartej repozycji ze stabilizacją wewnętrzną tych złamań. Wszystkie opisane metody leczenia chirurgicznego nie są pozbawione potencjalnych powikłań – z tego względu wszystkie możliwe sposoby postępowania, łącznie z leczeniem nieoperacyjnym powinny być zawsze przedyskutowane z pacjentem. W przypadku decyzji o leczeniu chirurgicznym, decyzją chirurga powinno być wybranie systemu stabilizacji, który jest w ocenie chirurga najlepszy i najłatwiejszy technicznie

option for “massive” fractures, sometimes associated with dislocations and reverse arthroplasty seems to be more predictable system, particularly in elderly patients.

Keywords: proximal humerus fractures, ORIF, shoulder

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Introduction

Proximal humeral fracture (PHF) is the third most common osteoporotic fracture after proximal femur and distal radius in patients above 65 years old (Lee *et al.*, 2002). Only 15% of PHF are 3- and 4-part fractures, however 70% of these type fractures are reported in patients older than 60 years and 50% of them in patients older than 70 years (Court-Brown *et al.*, 2001). Incidence of these fractures has been gradually increasing – it was reported as 134.5 per 100 000 person/y in women and 49.2 in men in 2001, as in 2012 these values were respectively 174.6 in women and 68.1 in men, increasing 30% and 39% in each group (Sumrein *et al.*, 2017). Treatment options remain variable depending on not very clearly defined indications yet. Still about 80% of patients require non-operative treatment. Surgery remains indicated in unstable displaced fractures, however its

do wykonania. Celem chirurga powinno być zawsze odtworzenie anatomicznych stosunków końca bliższego kości ramiennej, ze szczególnym uwzględnieniem okolicy guzka większego i mniejszego oraz tzw. „ostrog” (calcar), przy jak najmniejszej traumatyzacji tkanek miękkich. Obecnie wydaje się, że otwarta repozycja i stabilizacja wewnętrzna są najlepszym sposobem, aby osiągnąć powyższe cele, natomiast wyraźnie widoczna jest tendencja w kierunku stabilizacji małoinwazyjnej. W naszym ośrodku endoplastyka barku pozostaje ostatecznością dla złamań „masywnych”, zwykle z towarzyszącym zwichnięciem barku. W takich przypadkach, endoplastyka odwrócona barku wydaje się być lepszym rozwiązaniem o bardziej przewidywalnym wyniku, szczególnie u pacjentów starszych.

Słowa kluczowe: złamania końca bliższego kości ramiennej, stabilizacja wewnętrzna, bark.

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definition stays controversial. Some recent publications put in doubt the need of surgical treatment showing no statistical benefits of surgery versus conservative treatment (Rangan *et al.*, 2015).

Radiological diagnostics

Routinely used X-Ray in AP and Y views are preferred methods for screening and basic information about PHF. Computed tomography (CT) with 3D reconstruction should be used to precisely evaluate the fracture type and to plan the treatment, especially if surgery is considered. CT also allows eliminating one other very important mistake – fixed posterior dislocation, possible to overlook if the quality of X-Rays is not perfect or when the physician is satisfied with fracture diagnostics confirmation after initial X-rays. It should be to remember

that PHF can be associated with posterior dislocation and physicians should look for this coincidence whilst diagnosing these fractures (Figure 1).

linked with bony fragments impaction or disruption (Resch, 2011).

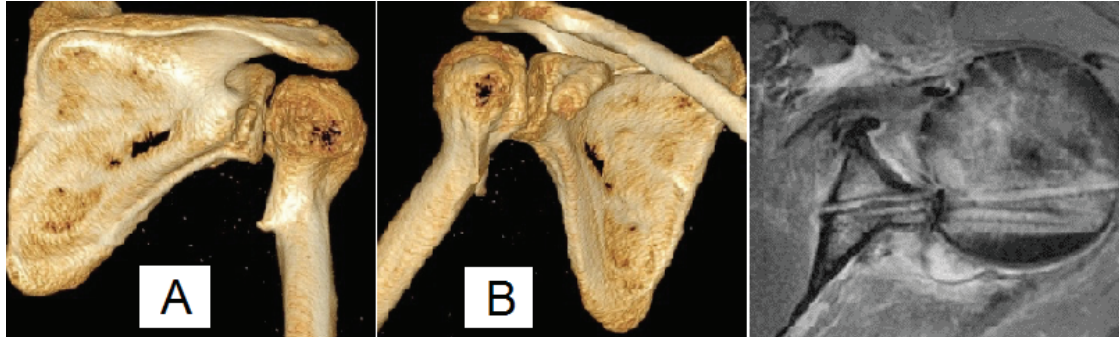


Figure 1. Cases of fixed posterior dislocation overlooked at first diagnostics. (A,B) CT 3D reconstruction of the patient treated conservatively for the humeral neck fracture; several months after initial trauma, when the fracture was consolidated his posterior humeral head dislocation was diagnosed. (C) MRI of the patient treated surgically with K wires fixation, the scan was performed after K-wires removal.

Classification

Lots of classifications were proposed, however the most useful for planning seem to be Hertel's and Resch's modification of Neer's system: four part of the proximal humerus (shaft, head, lesser and greater tuberosity) can be separated in several combinations (Hertel, 2005; Resch, 2011; Neer, 1970). Hertel's LEGO classification is composed of 12 combinations of 4 parts creating proximal humerus (Hertel, 2005). Hertel reported some important factors influencing the treatment options: quality of the medial hinge – calcar area seems to be one of the crucial points for the stability, length of the metaphyseal head extension, humeral head dislocation and/or split and presence of the humeral head compressive fracture – as points of risk for humeral head vascularity. He found the PHF jeopardized by poor results due to humeral head necrosis are those with medial calcar area shorter than 8 mm, medial hinge disruption (a distance between medial part of the head and shaft exceeds 2 mm) and all types of fractures with full separation of the head from any other parts of proximal humerus (Hertel, 2005). Resch also added another step to this evaluation: varus and valgus deformity

Aim

The goal of this study was to evaluate current literature regarding PHF treatment paying special attention for the studies concerning fractures' open reduction internal fixation (ORIF).

Material, methods and results

Treatment – indications for surgery

Indication to surgery according to Neer were displacement > 1 cm and angulation > 45° (Neer, 1970). Solberg reported the angulation > 20° could be the limit for non-operative treatment (Solberg *et al.*, 2009). Another factors influencing the treatment choice are patient related – expectations, general health status and bone quality. Last year's more controversies were set up after several publications showing no clear benefits after surgical treatment of PHF. PROPHER study showed prospective randomized trial conducted by 66 surgeons and 30 centers, with no difference in clinical outcomes in patients after surgical or conservative treatment (Rangan *et al.*, 2015). The complications rate was 24% in surgical group versus 18% in non-surgical group and 11 patients received secondary surgery after the initial treatment in both groups. The opponents of

this study underlined some imperfections in this trial methodology – the exclusion criteria for entry to the study were for example: associated dislocation (101 patients) or patients with clear indication for surgery (87 patients). Despite these methodological controversies this study confirms already existing doubts about surgical treatment (Rangan *et al.*, 2015). Handol and Brorson reported the results of meta-analysis including 31 controlled randomized trials (1941 participants) from 2001 to 2012. Their conclusion was very severe: “... surgery does not result in a better outcome at one and two years... and is likely to result in a greater need for subsequent surgery” (Handoll and Brorson, 2015). Hageman *et al.* reported also similar results in their case-controlled retrospective study composed of 33 patients in operative and nonoperative group (Hageman *et al.*, 2017). The results were comparable in both groups, however unplanned second operation after the initial treatment was necessary in 15% in the operative group and 6% in the non-operative group (Hageman *et al.*, 2017). Saharawal *et al.* in their meta-analysis found that patients with more complex fractures benefit more from surgical treatment: 4-part fractures got better results and less osteoarthritis or osteonecrosis (Sabharwal *et al.*, 2016). However 3-part fractures were reported to bring more risk for secondary intervention after initial internal fixation (Sabharwal *et al.*, 2016). Having been given all these information every physician should be very attentive and carefully discuss advantages and disadvantages of both operative and non-operative treatment. Nevertheless it is recommended to decide about PHF treatment quickly after the injury – in our department we believe the surgery should be performed within maximum 14 days from the trauma, as later it becomes difficult with more risk of intraoperative complications. Even in controversial cases, if non-operative treatment was already started (more than 14 days) it is usually continued and the results are observed

up to 1 year after the fracture – than in cases with poor results the reverse arthroplasty could be an option. From the other side it must be remembered that technical conditions for the surgeon to perform fixation or arthroplasty are usually the best within first days after trauma – that is why we emphasize the decision should be taken rapidly.

Non-operative treatment

If non-operative treatment is conducted it is composed of immobilization in slightly abduction pillow (10–15°) in neutral rotation for 4–6 weeks and very gentle immediate rehabilitation program focused on maintaining the mobility of the other joints (fingers, hand, wrist and elbow) and very slight pendulum exercises of the shoulder. This position of immobilization seems to be more adequate than simple “sling” position with the hand in internal rotation – it allows to lower the tension on greater tuberosity fractures and to avoid haling the shaft in internal rotation, which is important for restoring external rotation in future (Boileau *et al.*, 2011).

Operative treatment

If surgery is indicated stabilization or arthroplasty remain the options. In PHF reduction and fixation two points remain crucial to restore the anatomy: 1) humeral head should be stabilized by proper repositioning of both tuberosities – they maintain the humeral head inside according to the “eggshell” model proposed by Hertel; 2) lack of medial calcar reposition and support seem to be a risk factor for destabilization. Several stabilization methods are proposed with ongoing discussion about superiority of one option over another. Resch recommends using minimally invasive system based on distally blocked (in the shaft) K-wires just to support the humeral head, that is kept in place by properly reduced tuberosities fixed with the cannulated screws (Resch, 2011). This percutaneous technique’s advantage is minimal morbidity that lowers the risk of fracture

site devascularisation. Advanced technical skills, higher dose of radiation whilst fluoroscopic control and slightly slower rehabilitation program remain disadvantages of this procedure. Bogner *et al.* reported 10.9% of revision rate in 4-part fractures in patients above 70 years old, however Ortmaier *et al.* stated the results were still better comparing the humerus block technique versus reverse arthroplasty (Bogner *et al.*, 2016; Ortmaier *et al.*, 2015). Another important disadvantage of this technique is fact the humerus block is not available on the market any longer, however the plans to restart its production are discussed. Hertel uses only small plate to support the greater tuberosity (as buttress plate) and separately fixes the lesser tuberosity to restore the stable support for the humeral head (Hertel, 2005). The above 2 techniques do not require very stiff fixation of the humeral head with the shaft – it is to emphasize that in osteoporotic fractures the humeral head bone support is very weak. Another option in PHF is using the angular stable plates, which is probably the most popular system of fixation (Nowak *et al.*, 2017). The angular screws placement in the plate gives better fixation of the humeral head to the shaft, however the need of proper tuberosities restoration remains unchanged. Additional sutures between rotator cuff tendons and the plate could release the tension from the tuberosities and make

the construct more stable. In case of massive bone loss some support for the humeral head, to fulfill the empty space (bone graft or some commercial devices) may be necessary to maintain the stability (Figure 2).

Many authors reports high number of complications (from 20% to 40%), particularly up to 25% of revisions, 23% of the screws cutout and humeral head avascular necrosis from 14% to 35% (Owsley and Gorczyca, 2008; Konigshausen *et al.*, 2012; Spross *et al.*, 2012). However it is to remember these studies reports the results of “first generation” technique. Gavaskar *et al.* reports the results of current – “second generation” technique that improved comparing to previously used fixation system (Gavaskar *et al.*, 2016). Some important steps are nowadays performed regularly whilst plate fixation: 1) inferomedial screw is known to be crucial for the stability of the calcar area – the distance from the calcar arch should not exceed 12 mm; 2) CaPo4 cement or some other solid structure (allograft, Da Vinci cage, etc) could be used in case of massive bone comminution creating empty space between tuberosities and humeral head; 3) endostaeal fibula allograft (cortical graft) in medial part of the fracture supports the calcar area in case of comminution; 4) traction rotator cuff sutures between anterior and posterior cuff tendons themselves as well as between tendons and plate are crucial

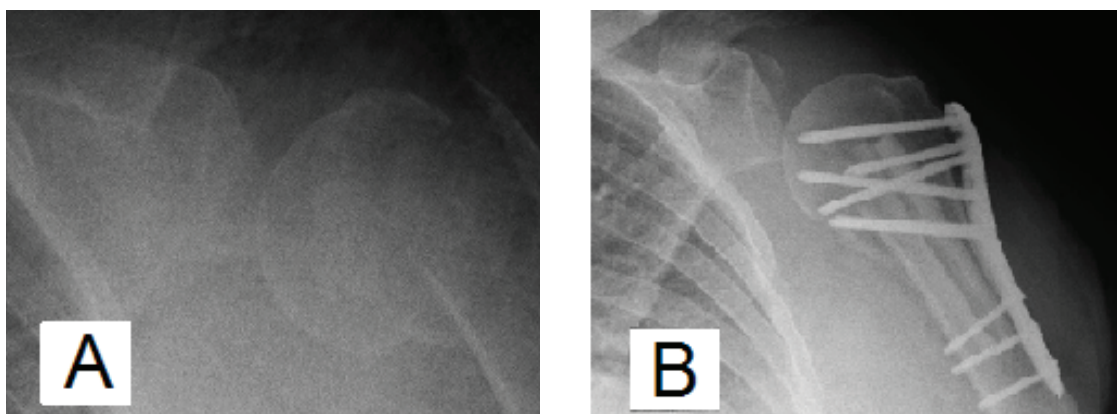


Figure 2. (A) Proximal humerus four part varus fracture. (B) Open reduction internal fixation with angular stable plate; 2 cortical allografts were used to reinforce calcar area; 2 calcar screws were introduced very closed to the calcar/medial hinge arch to maintain the reduction; tuberosities anatomic restoration.

to reconstruct the proper position of the tuberosities and to release the traction forces (Gavaskar *et al.*, 2016; Euler *et al.*, 2016; Namdari *et al.*, 2012; Russo *et al.*, 2013). If these rules were added to simple ORIF with angular stable plate the number of complications dropped to 11.5%, osteonecrosis to 3.8%, varus collapse to 7.7% and the number of reoperations to 11.5%, which is better than in previously reported studies (Gavaskar *et al.*, 2016; Sproul *et al.*, 2011). It is also to notice the technique of plate fixation improves and it becomes possible to perform this procedure using a “minimally invasive” technique with a small incision to slip it under the skin and deltoid muscle and to fix it distally percutaneously (Acklin and Sommer, 2012). Another way of fixation could be straight intramedullary nail. It is to notice the bend nails are risk factor for rotator cuff symptoms due to the entry point through the supraspinatus tendon insertion (Lopez *et al.*, 2014; Nolan *et al.*, 2011). It is very often a treatment of choice for 2-part fractures, less often in 3-part fractures. The advantage of the nail is good stability with less soft tissue stripping comparing to the plates, particularly in cases when it is performed without opening. However using the nails in 4-part fractures is technically demanding due to very poor quality of the humeral head, so in our institution we do not recommend this fixation in such cases. There is no clear advantage of plates or nails above each other. Zhu *et al.* reported similar results in treatment of 2-part fractures, however less complications were reported in nail stabilization (Zhu *et al.*, 2011). Gadea *et al.* found the type of fixation (nails versus plates) was less important than the quality of the fracture reduction. They reported that in cases of preserved medial hinge the plate fixation gave better results than nails stabilization (Gadea *et al.*, 2016). All above mentioned fixation techniques are to consider as long as there is still some healing potential. If the risk of humeral head necrosis is very elevated shoulder hemiarthroplasty

or reverse shoulder prosthesis should be the option. According to Hertel the risk of necrosis increases in the fractures with the humeral head isolated from the other parts of the proximal humerus with a metaphyseal extension below 8 mm, the humeral head split or dislocation and medial hinge/calcar disruption (Hertel, 2005). In osteoporotic bone the healing potential of the tuberosities in hemiarthroplasty is low, so it should be considered rather for younger patients. Some reports has already proven the outcome after hemiarthroplasty depends on tuberosity healing and rotator cuff sufficiency – it has also been shown the higher age of patients the lower Constant score values (Namdari *et al.*, 2013; Boileau *et al.*, 2011; Boileau *et al.*, 2002). In patients above 70 years old, especially in the women, the reverse shoulder prosthesis should be considered as main option in the presence of above mentioned risk factors. However it is to remember the complications rate after reverse shoulder arthroplasty was evaluated from 0% to 67% (Acevedo *et al.*, 2014). Despite the complications other studies support the use of reverse shoulder arthroplasty in elderly patients, showing better results than in patients with hemiarthroplasty (Sebastia-Forcada *et al.*, 2014; Bonnevalle *et al.*, 2016).

Discussion and conclusions

It is to emphasize all described surgical methods of treatment are not free from the complications. That is the reason why all options, including non-operative treatment should be considered and discussed with the patients. If operative treatment is chosen one physician should chose the fixation system that fits his skills the best. Our goal should be to minimize the soft tissue injury and to fulfill the crucial factors for stable, anatomic fixation – calcar and tuberosities reposition and stabilization. At this moment ORIF seems to fulfill these criteria the best, however the tendency to perform this in a minimally invasive fashion is visible. In

our institution the arthroplasty remains an option for “massive” fractures, sometimes associated with dislocations and reverse arthroplasty seems to be more predictable system, particularly in elderly patients.

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