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The hybrid technique: Potential reduction in complications related to pins mobilization in the treatment of proximal humeral fractures

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Background: Proximal humeral fracture fixation has a high incidence of complications especially when pins are used in elderly patients. In 2005, we introduced a new technique that augmented osteosutures by using 2.5-mm fully threaded pins and an external fixator (hybrid technique). The purpose of this study is to compare the outcomes of the hybrid technique (HT) with traditional pins fixation.

Methods: A prospective nonrandomized study was organized on 2 consecutive series of patients: 51 patients treated with percutaneous fixation using 2.5-mm terminally threaded pins and 55 patients treated with the Hybrid technique. In both groups, an open reduction and osteosutures augmented with percutaneous fixation was used when closed reduction was insufficient to provide anatomical reduction. The patients were assessed at 6- and 12-month follows-ups using DASH score, Constant score, and Modified Constant score (MCS).

Results: Sixteen patients treated with traditional pins experienced complications compared to 6 patients in the HT group ($P = .006$). The revision rate was 19% for the traditional pins group and 4% for the HT group ($P = .04$). Pins migration affected 8 patients in the traditional pins group and 1 case in the hybrid group ($P = .01$). The MCS at the 12-month follow-up was 89 ± 9 in the HT group and 77 ± 14 in the traditional pins group ($P = .03$). The MCS was negatively affected by complications and malreduction ($P = .001$).

Conclusion: The study suggests that the HT is a valuable option for the treatment of proximal humeral fractures. It has benefits compared to the traditional technique.

Level of evidence: Level III, Retrospective Cohort Study, Treatment Study.

Keywords: Proximal humeral fracture; wires; external fixator; mininvasive technique; complications; pin migration; infection

The ideal management of complex proximal humeral fractures continues to be an issue of debate among orthopaedists. Choosing the correct treatment depends on patient-related factors as well as surgeon preference. An ideal treatment would be reproducible and also achieve a good equilibrium between anatomical reduction, secure fracture fixation, and soft tissue preservation. Furthermore, the potential complications of such a treatment should be easy to treat, thus reducing the revision rate.

In light of the Italian law, authors are not required to ask for approval for this type of study. However, each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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A stable fixation is mandatory for achieving good bone healing and allowing early mobilization. The proximal humeral locking plate has been shown to be one of the most secure devices when the aim is to foster stable osteosynthesis.[3,11,16,22,25] However, despite initial enthusiasm, several authors have recently raised some concerns regarding this technique.[1,10,15,28,35]

Less invasive techniques may ensure enough stability, at least in strong bone tissue, and more rarely require an aggressive second surgery for hardware removal.[4,8,17,18,20,29-32,36] However, the risk of infection, wire migration, and loss of reduction[17,29,36] are still negative factors that should be considered before choosing one of these less invasive techniques, especially when wires or pins are used.[17]

Like other less invasive techniques, percutaneous wire fixation has some potential advantages. However, a stable fracture fixation can be difficult to achieve, especially in patients affected by osteoporosis, as the wires are prone to migration. Furthermore, in the case of unstable fractures, an anatomical reduction involving tuberosities can be made difficult by closed reduction. In these cases, a combination of an osteosutures technique[8,9] and percutaneous fixation can be considered an appropriate treatment.

In 1998, we adopted a percutaneous pins fixation treatment, alone or in combination with osteosutures. However, we experienced some intraoperative insufficient fixation problems and postoperative complications, mostly related to pins migration in osteoporotic bone. In 2002, in questioning the safety of the technique, we arranged for this prospective study.

In 2005, with the specific aim of improving the safety of percutaneous pins fixation, we modified our traditional pins technique. We started using fully threaded pins augmented by an external fixator. This technique was called the hybrid technique (HT) because it includes some of the features of external as well as internal fixation.

In order to compare the clinical results of the 2 techniques, with particular emphasis on osteoporotic-related complications, another consecutive series of patients treated with the HT was included in the same prospective study.

Materials and methods

A prospective nonrandomized analysis was organized on 2 consecutive series of patients who were presented to our hospital between March 2002 and November 2008. From March 2002 to March 2005, 51 patients with a displaced proximal humeral fracture were scheduled for surgical treatment with closed or open reduction and percutaneous fixation, using 2.5-mm terminally threaded Schantz pins (with 25 mm of thread) (*Traditional Pins Technique group*). Starting in April 2005 we introduced the use of an external fixator and 2.5-mm fully threaded pins, which were developed in collaboration with Orthofix International (Orthofix™, Bussolengo, Italy). Fifty-five consecutive patients were treated with this device (HT group). Every patient in both groups was monitored prospectively with clinical and radiological follow-up at 6 and 12 months, respectively. In order to have a longer follow-up and to assess the rate of avascular necrosis, every patient was examined retrospectively between January and March 2006 (traditional pins technique group) and between September and November 2009 (HT group).

All patients had anteroposterior, transthoracic, or lateral ''Y'' view x-rays plus an axillary x-ray when tolerated by the patients. These were taken preoperatively and at each follow-up examination. X-rays were classified by 2 of the authors with a special interest in shoulder trauma. Fractures were classified according to the Neer[27] and AO[26] classifications. In the case of complex fractures, not well characterized by standard x-rays, a CT scan with 3-dimensional reconstruction was performed before planning surgery.

Indication for surgery was based on the Neer criteria.[27] Only patients who were older than 18 were included. All surgeries were performed by the 2 senior authors (MA and FC). The indication for percutaneous fixation did not change during the course of the study. Exclusion criteria were: 1) significant involvement of the proximal diaphysis (A3.3, B2.3, and C3.3 fractures); 2) involvement of the articular surface (C3.3 fractures). The excluded patients underwent plate fixation in the case of an involvement of the proximal diaphysis, or hemyarthroplasty in the case of involvement of the articular surface. For all the remaining fractures, a fixation with pins was always attempted regardless of the number of fragments involved and the risk of avascular necrosis. A preoperative diagnosis of poor bone quality was not considered as an exclusion criterion. In the case of intraoperative insufficient pin fixation related to poor bone quality or excessive fragmentation, the surgery was converted to plate fixation or hemyarthroplasty. These cases were considered intraoperative failures of the fixation device.

X-rays were taken on days 1, 7, 14, and 45 post-surgery. The pin sites were carefully cleaned and dressed once a week. On day 45, the pins were removed in the outpatient clinic by unscrewing them without the need for anaesthesia. In order to remove the pins with a 25-mm terminally threaded tip, a gentle pull on the pins was generally sufficient. Fully threaded pins required a drill to be removed.

The postoperative rehabilitation programme was identical for both groups. All the patients wore a shoulder immobilizer sling until day 45. Pendulum exercises were begun immediately after surgery and passive assisted range of motion exercises with up to 60° of elevation and abduction and external rotation to neutral were begun at 2 weeks postoperatively. Active assisted range of motion exercises were commenced once the sling had been removed. A standard physiotherapy programme for proximal humeral fractures was prescribed to all the patients and all were invited to attend the physiotherapy department of our hospital.

The outcomes at the 6- and 12-month follow-ups and during the last follow-up were measured using the DASH score,[19] Constant score (CS),[5] and modified Constant score (MCS).[12] The number of physiotherapy visits was also recorded. Follow-up examinations were performed by 1 researcher not involved in the surgery. The main outcome measure was the complication rate including: loss of fixation (with secondary displacement); pin migration (with or without fracture displacement); nonunion (no progression of radiographic fracture healing within 3 months of surgery); avascular necrosis of the humeral head, deep infection