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Original article

Plate fixation in periprosthetic femur fractures Vancouver type B1: preliminary report of macroscopic evaluation of the cement mantle and short literature review

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Summary. The goal of our preliminary report is to investigate hip stem stability and intra-operative cement mantle integrity after screw insertion in plate fixation of periprosthetic Vancouver B1 femur fractures. From a cohort of 50 patients with a periprosthetic femur fracture treated in our department from February 2012 until February 2017, we included in our study patients with a periprostethic Vancouver B1 femoral fracture in cemented hip arthroplasty and hemiarthroplasty, operated with ORIF using a 4.5/5.0 LCP Proximal Femoral Hook Plate ® (Synthes, Switzerland) with at least one screw perforating the cement mantle. Anteroposterior and lateral femur views and pelvis X-rays were performed preoperatively. The stability of the hip implant and the cemented mantle integrity was evaluated intra-operatively in a macroscopic way and with a post-operative X-ray in anteroposterior and lateral views. Only 7 patients satisfied the inclusion criteria; no lesion/break of the cement mantle occurred intra-operatively at any step during drilling or screw insertion, also confirmed with C-arm assessment. No cases of stem mobilization were found and cement mantle integrity was maintained in every case. Insertion of screws around a cemented stem for plate fixation in periprosthetic femur fractures Vancouver type B1 could be considered a safe procedure. However, further and more extended studies are necessary for proving additional knowledge at the evaluation of the cement mantle in osteosynthesis procedures. (www.actabiomedica.it)

Key words: cement mantle; periprosthetic Vancouver B1 femur fractures; hip stem stability

Introduction

The incidence of periprosthetic fractures after hip arthroplasty is continuously rising because of an increasing number of hip joint replacements and an enhanced survivorship of the eldery population. Previously reported studies showed an increased risk of periprosthetic femoral fractures in uncemented stems compared to cemented implants (1, 2). Currently, cemented stems are still considered to be one of the most reliable materials available for the treatment of osteoporotic hip fractures. Periprosthetic femoral fractures represent a serious complication for elderly patients (1, 2). Plate fixation in Vancouver type B1 periprosthetic femur fractures with cemented stem is a very common approach for the elderly (3-7). The use of screws perforating the cement mantle is a common treatment option when a plate fixation is performed. The goal of this preliminary report is to investigate hip stem stability and intra-operative cement mantle integrity after screw insertion in plate fixation of periprosthetic Vancouver B1 femur fractures.

Material and methods

We retrospectively evaluated the treatment results in a cohort of 50 patients with a periprosthetic femur fracture treated at San Carlo Borromeo Hospital from February 2012 until February 2017.

The informed consent of all the patients was obtained about the use of clinical data for scientific publication.

The periprosthetic femoral fractures in this study were classified according to the Vancouver classification. Inclusion criteria of the study were: (1) Periprostethic Vancouver B1 femoral fractures (a fracture around or just below to a stable stem) in cemented hip implants, including both total hip arthroplasty and hemiarthroplasty, operated with (2) ORIF using a 4.5/5.0 LCP Proximal Femoral Hook Plate® (Synthes, Switzerland) (3) with screws (one at least) perforating the cement mantle.

The exclusion criteria were (1) periprosthetic fractures on uncemented hip implants and (2) Vancouver B femoral fractures with no screws perforating the cement mantle.

The X-rays of the patients were obtained from the Picture Archiving and Communication System (PACS) of our Institute. Anteroposterior and lateral femur views and pelvis X-rays were performed for each patient preoperatively.

The stability of the hip implant and the cemented mantle integrity was evaluated intra-operatively by performing a mobilization test of the involved femoral stem by using a farabeuf or a lambotte clamp. In the post-operative X-ray in anteroposterior and lateral views, subjective loosening signs of the femoral stem was investigated.

All patients were in supine position on a radiolucent table. Mainly extended lateral approach to the femur was performed with minimal invasive plate osteosynthesis (MIPO) technique used in some cases. A 4.3 mm or a 3.2 mm drill was used to perforate the femoral bone and the cement mantle. Cephazoline (2 gr) was administered 30 minutes prior to skin incision for infection prophylaxis. For thromboembolic prophylaxis we administered low molecular weight heparin subcutaneously (according to the patient's weight) until the full weight bearing was reached.

Results

The final cohort of our study consisted of 7 patients who actually satisfied the inclusion criteria, specifically 6 women and 1 man, with a mean age of 85.6 years (range 58-97) at the time of surgery. 4 monocortical screws and 10 bi-cortical screws were implanted in the cement mantle. All bi-cortical screws were positioned distal to the stem, 3 mono-cortical screws were placed around the stem and the 1 remaining was put proximal to the stem. Time from admission to surgery was on average 5.8 days (range 2-7 days).

Intraoperative fluoroscopy with C-arm and direct macroscopic evaluation was used to assess the stability of the hip implant and the cement mantle integrity. Follow-up anteroposterior and lateral X-rays were done postoperatively.

No lesion/break of the cement mantle occurred intra-operatively at any step during drilling or screw insertion, also confirmed with C-arm assessment. No cases of stem mobilization were found and cement mantle integrity was maintained in every case (Figg. 1a, 1b, 1c, 1d).

Discussion

First reports on periprosthetic femoral fractures (PFF) predate the modern Total Hip Replacement (THR) designs. First publication was a 70 patient follow-up in 1954 (8). Complications related to use of metal in bones was published in 1957, where the importance of mechanical stresses and strains as contributors to metal loosening or failure was noted (9). The first successful cemented THR system created by Charnley in 1962 was the golden standard for many years coming (10-12). The incidence of periprosthetic fractures around the femur continues to rise due to increasing numbers of primary and revision THRs performed each year (13). Relative and established risk factors for periprosthetic fractures include age, sex, gender, index diagnosis, presence of osteolysis, presence of aseptic loosening, specific type of implant used and revision THR (14-16).

Current surgical treatment options of PFF are widely based on the Vancouver classification system

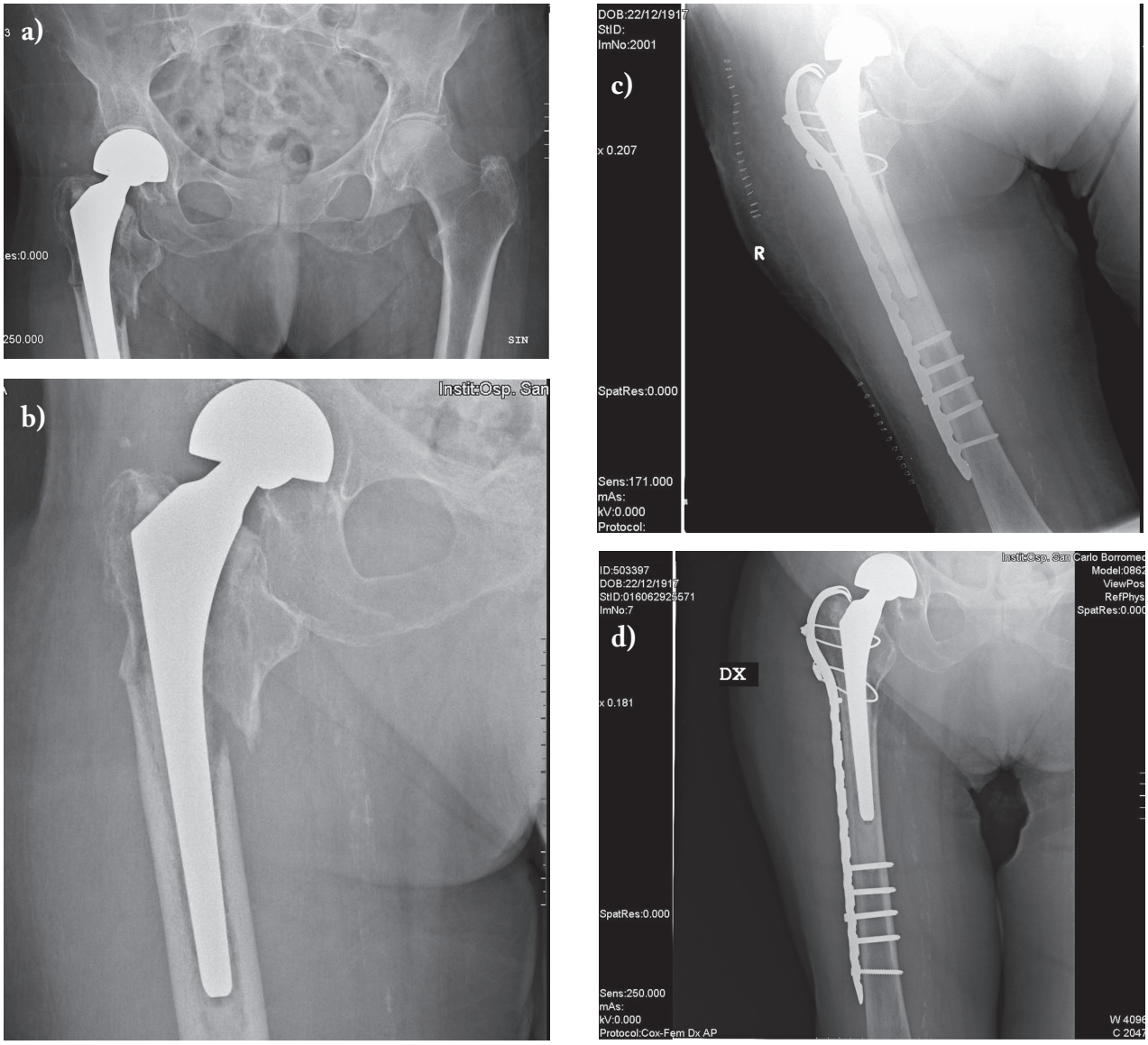

Figure 1. a, b) Preoperative images of a 98 years old female patient with a periprostetic fracture with suspect of subsidence and stem loosening. Only after intra-operative evaluation of the stem's stability the fracture was classified as Vancouver B1. c) After the insertion of one bicortical and one unicortical screw around the cement mantle, intra-operative macroscopic evaluation didn't reveal stem's instability. d) X-rays at 8 months follow-up show a stable cemented stem with a hook plate and screws

(17). Vancouver type B fractures divide to subgroups depending on the stability of the femoral stem and bone stock. Unfortunately it is not always possible to assess the stability of the stem prior to surgery. In 2009, a study was published revealing 20% unstable femoral stems on initially diagnosed Vancouver Type B1 fractures (18). Many publications recommend the use of plate osteosynthesis for Vancouver Type B1 fractures as opposed to revision of stem for unstable Type B2 and B3 types (19-22). Different types of plates were tested over the past 2 decades with combination of cables, cerclages, locking screws, hook plates etc., with

no widely accepted guidelines of our knowledge. Debates are focused on the different types of fixation to proximal femur as the stable stem can be compromised from the use of screws.

Biomechanical studies also were conducted to assess the stability of different types of plate osteosynthesis. Lever et al. utilized 12 pairs of human cadaveric femurs for 3 different plate fixation systems and concluded that screw plate fixation systems provided more mechanical stability compared to cable plate systems (23). Kampshoff et al. assessed the cement mantle integrity after screw insertion and concluded that bicortical screws passing through the cement cause cracks and further can destabilize the stem (24). The authors noted that the use of a unicortical screw is a much safer option with lower pullout resistance.

Giesinger et al. conducted another biomechanical study on 17 synthetic femurs and found no cracks in cement mantle after bicortical screw insertion (25). Difference is that they used same diameter drill bit and screw inserted right after the screw size was measured. The biomechanical studies conclude that longer clinical trials are needed in vivo to investigate long-term stem stability. New plate designs with variable-angle locked plates with bicortical proximal screws showed significantly greater load-to-failure ratios when compared to unicortical or cable fixation types (26). The screw holes in this system are placed outside the midline of the plate allowing angling of the screws and bicortical purchase. Weak points of this study were the use of synthetic bones and cementless stems.

Lewis et al. conclude in a recent biomechanical study that proximal femoral stability of cemented periprosthetic fracture is improved with tangentially directed bicortical locking screws as compared to unicortical screw or cable fixation (27). Further prospective studies with big samples and long term follow-up will help in choosing the correct algorithm of treatment and establish guidelines for clinical practitioners.

In our experience, osteosynthesis around cemented prostheses is very challenging to manage, as it is difficult to achieve a placement of bicortical screws around a cemented stem. The difficulty of screw placement has lead to the development of new plate designs allowing angular positioning of the screws and the use of cerclages and cables has been controversial. Screw placement around a cemented stem sometimes gives excellent grip but it may compromise the cement mantle and may lead to cement fragmentation and failure with subsequent mobilization of the femoral stem.

Summarising, the use of unicortical screws alone or together with cables provide additional resistance to lateral bending or torsion when a plate is used, compared to cables alone. It is easier to place unicortical screws around the cement mantle rather than adjusting them around a cemented stem and this concept should be further investigated. If rigid proximal fixation is required, an effort should be made to obtain bicortical fixation. Newly designed implants are necessary to obtain bicortical locking screws directed tangentially to the hip stem. A major concern is the loosening of the construct, caused by screw penetration and cracking of cement mantle.

Moreover, clinical experience of intraoperative procedures should be reported in the studies, as only a few are available, basically reporting the results of drilling and screwing the femoral cement mantle around prosthesis. Many Authors performed the evaluation of the cement mantle in periprosthetic femur fractures. We underline that our preliminary report is the first one that evaluates in vivo the integrity of the cement mantle in plate fixation of periprosthetic femur fractures. It's very important, as these fractures are becoming more common due to increase of average life expectancy.

In our study we had no cases of macroscopic cracks in the cement mantle or stem mobilization, even when bicortical screws were used. Unfortunately, only 7 patients met our inclusion criteria; another remark is that we probably need at least a 1 year follow up after plate fixation, to check what happens after weight bearing.

In the future we expect the development of higher speed drills, which may also help in this process.

Conclusions

The use of screws around a cemented stem for plate fixation in periprosthetic femur fractures Vancouver type B could be considered a safe procedure. However, further and more extended studies are necessary

for proving additional knowledge at the evaluation of the cement mantle in osteosynthesis procedures.

Conflict of interest: None to declare

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