Osteomyelitis treatment with antibiotic cement-coated plate fixation. Two case reports

Jorge L. Soutullo, Santiago Argüelles, Martín P. Rodríguez, Enrique Pereira
Hand and Upper Limb Team, Instituto de Tratamiento y Rehabilitación Articular (Buenos Aires, Argentina)

ABSTRACT

Treatment of osteomyelitis associated with osteosynthesis failure represents a real challenge for the orthopedic surgeon. Implant removal, surgical debridement of the affected area, and external fixation as a temporary stabilization method coupled with antibiotic therapy administered by the systemic route constitute the basis for the initial management of infections associated with implant failure. However, this combined management may prove inadequate to achieve complete control of the infection. The local use of antibiotic-loaded cement allows for maintaining a sustained agent release that reaches significantly higher concentrations than the minimum required bacterial inhibitory concentrations while reducing the associated systemic toxicity. We present two cases of osteomyelitis associated with osteosynthesis failure treated with a second osteosynthesis procedure with an antibiotic cement-coated plate. Infection control and bone union were achieved in both cases. The functional outcome was excellent with Quick-DASH scores of 6.3 and 4.5 points, respectively.

Key words: Osteomyelitis; antibiotic cement-coated plate, osteosynthesis failure.
Level of Evidence: IV

Empleo de osteosíntesis recubierta de cemento con antibiótico en el tratamiento de la osteomielitis. Presentación de dos casos

RESUMEN

El tratamiento de la osteomielitis asociada a la falla de la osteosíntesis representa un verdadero desafío para el cirujano ortopédico. El retiro del implante, la limpieza quirúrgica del área afectada y la fijación externa como métodos de estabilidad transitoria, sumados a la administración de antibióticos por vía sistémica son conductas habituales en el manejo inicial de la infección asociada a la falla del implante. No obstante, la suma de estas medidas puede no ser suficiente para controlar completamente el cuadro. El agregado local de cemento con antibiótico permite la liberación continua y sostenida del agente que alcanza una concentración local significativamente más alta que las concentraciones inhibitorias bacterianas mínimas necesarias, a expensas de una menor toxicidad sistémica. Se presentan dos casos de osteomielitis asociada a la falla de la osteosíntesis tratados mediante una nueva síntesis con placa revestida de cemento con antibiótico. Se logró controlar la infección y la consolidación ósea en ambos casos. El resultado funcional fue excelente con un puntaje QuickDASH de 6,3 y 4,5, respectivamente.

Palabras clave: Osteomielitis; placa recubierta; cemento con antibiótico; falla de osteosíntesis.
Nivel de Evidencia: IV

INTRODUCTION

Treatment of osteomyelitis associated with osteosynthesis failure represents a real challenge for the orthopedic surgeon. Implant removal, surgical debridement of the affected area, and external fixation as a temporary stabilization method coupled with antibiotic therapy administered by the systemic route constitute the basis for the initial management of infections associated with implant failure. However, this combined management may prove

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inadequate to achieve complete control of the infection. The local use of antibiotic-loaded cement allows for maintaining an agent sustained release that reaches significantly higher than the required minimum bacterial inhibitory while reducing the associated systemic toxicity.[1,2]

We present two cases of osteomyelitis associated with osteosynthesis failure treated with a second osteosynthesis procedure with an antibiotic cement-coated plate.

CLINICAL CASE 1

A 61-year old male with no relevant clinical history, who came to consult 6 weeks after an open reduction and internal fixation with plate and screws of his right ulna for a Monteggia fracture-dislocation. At the time of this consult, the patient had a temporary colostomy for an abdominal lesion. Physical examination revealed a swollen right elbow and forearm, a fistula in the surgical scar region with significant purulent-like drainage, severely limited passive motion of the elbow, and paralysis of the posterior interosseous nerve. The radiographic study revealed radial head anterior dislocation, ulna misalignment with non-union, and osteosynthetic material breakage (Figure 1). Lab findings were raised erythrocyte sedimentation rate (ESR) and increased C-reactive protein (CRP) levels.

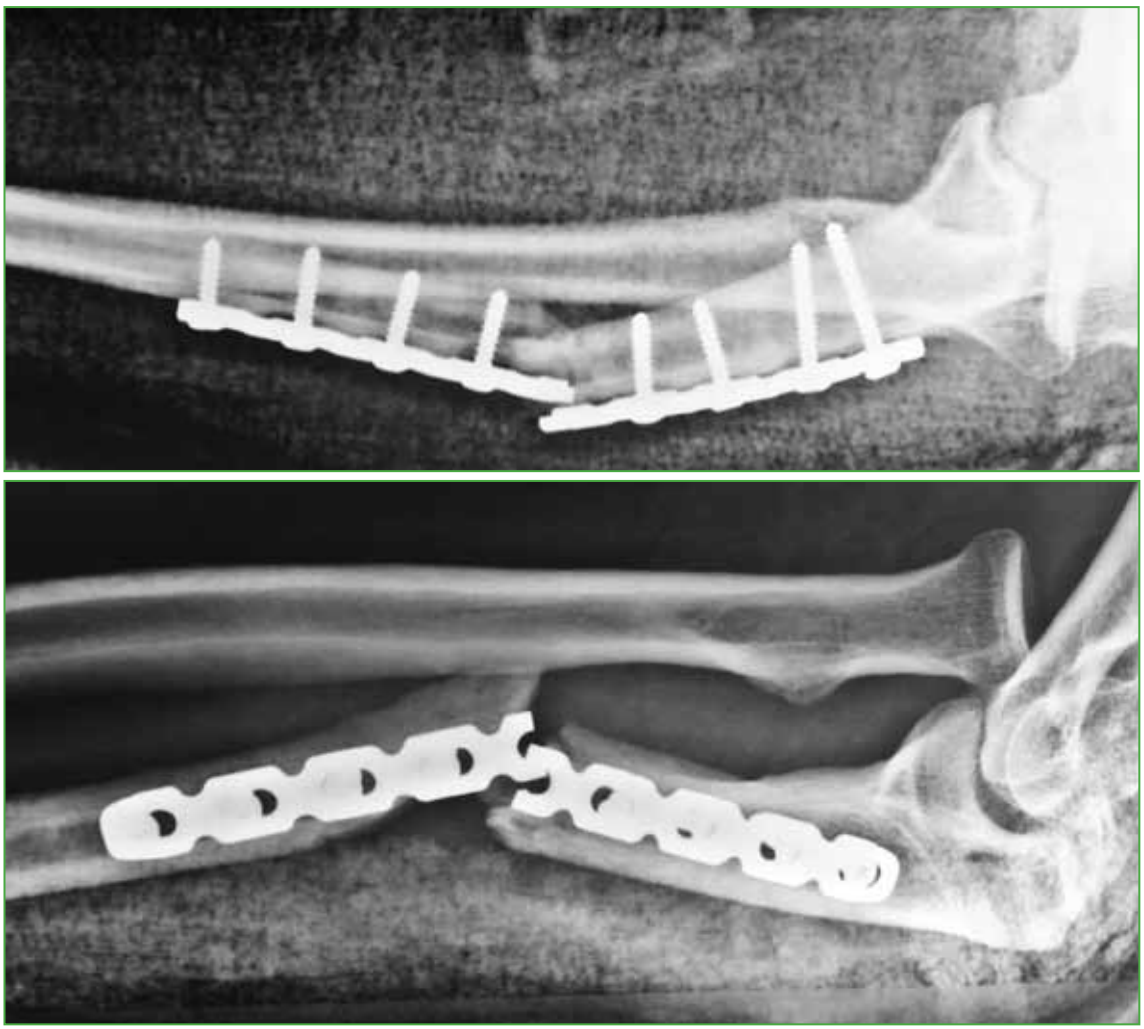

Figure 1. Right forearm X-rays showing osteosynthetic material breakage, misalignment, and radial head anterior dislocation.

Initial management included surgical debridement, osteosynthetic material removal, and open reduction and external fixation using an AO type rod system (Figure 2). The radiocapitellar joint was managed by closed reduction and multiple specimens for culture and histopathology were collected. Empiric therapy was instituted while awaiting the culture results, which revealed the presence of the following microorganisms: *Enterococcus faecalis*, *Enterobacter cloacae*, *Aeromonas hydrophila,* and *Pseudomonas aeruginosa*.

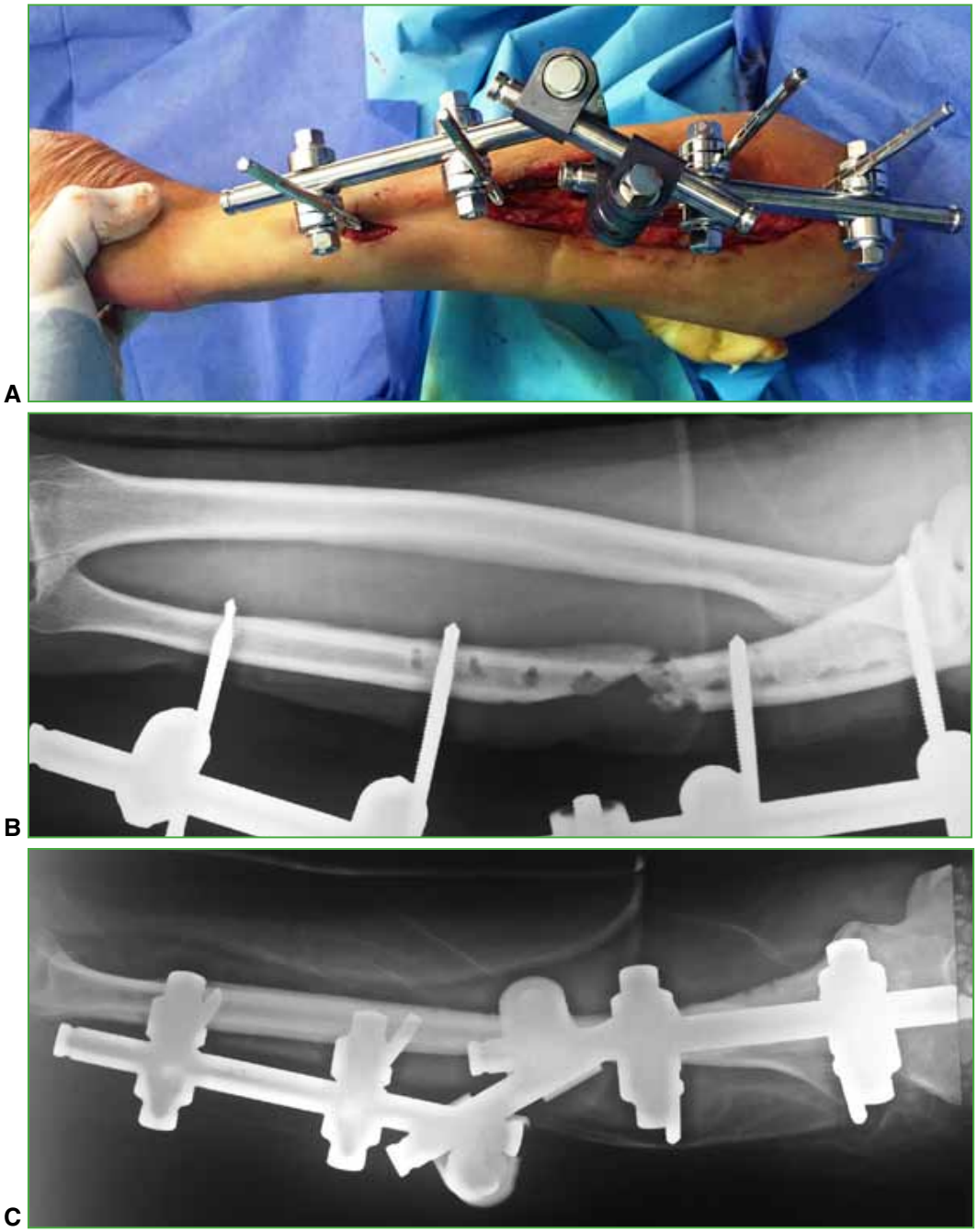

Figure 2. A. Intraoperative image. **B and C.** Right forearm X-rays following surgical debridement and external fixation.

After 5 weeks of specific antibiotic therapy, patient had decreasing ESR and CRP values and a favorable clinical evolution, and underwent a new surgical debridement, external fixation hardware removal, and a second osteosynthesis procedure with a 3.5mm plate coated with cement impregnated with vancomycin and tobramycin (as determined by the antibiotic sensitivity test results). An autogenous tricortical anterior iliac crest bone graft was used to fill the 2.5 cm ulnar bone defect (Figures 3 and 4).

Figure 3. A. Intraoperative photograph after removal of the external fixation. **B.** Tricortical anterior iliac crest bone graft. **C.** Cement coating of the plate while maintaining patency of the screw holes of the locking guides.

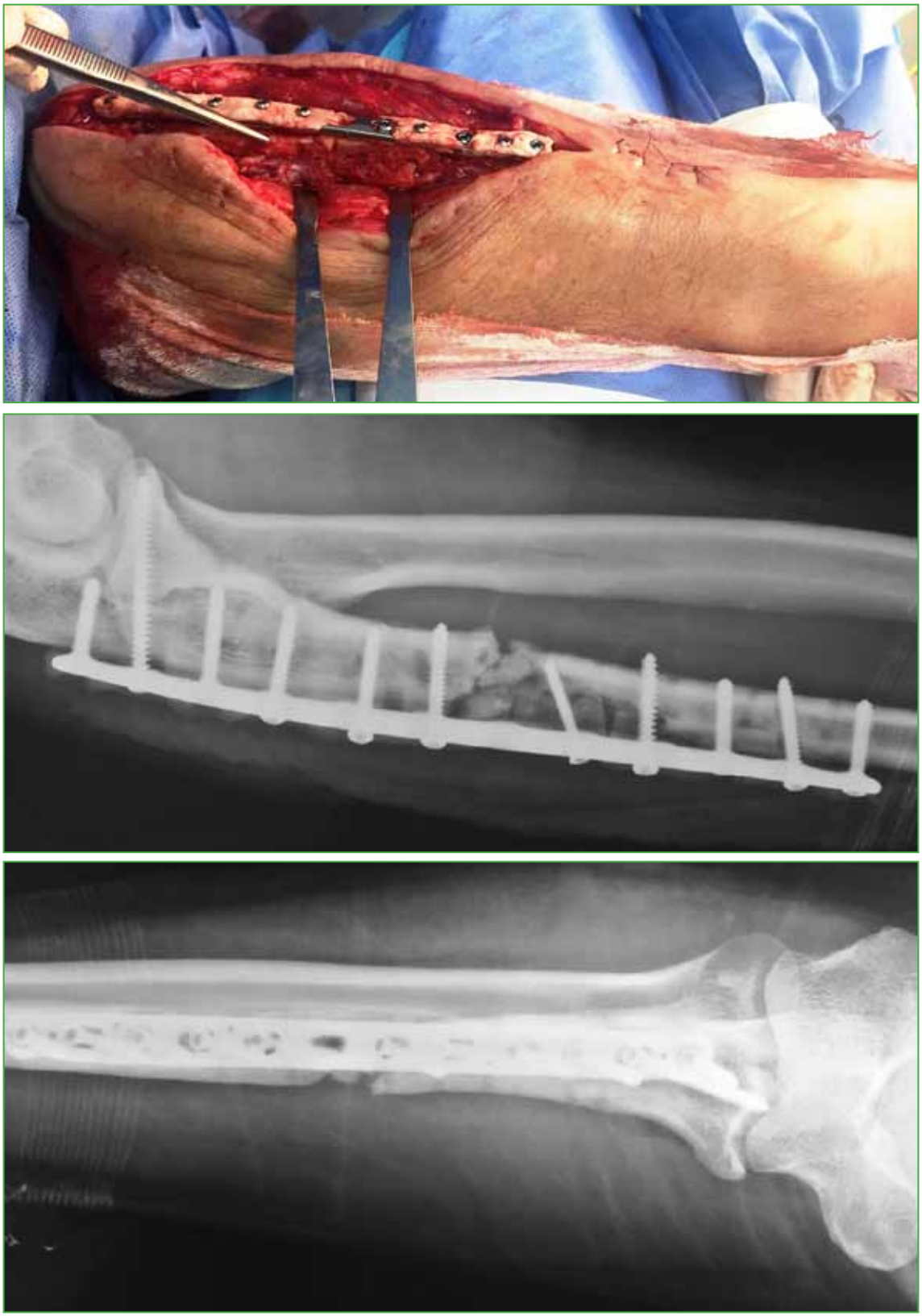

Figure 4. A. Intraoperative photograph showing the antibiotic cement-coated plate and the bone graft. **B and C.** Radiographic control.

The postoperative was uneventful. The patient was treated with long-arm immobilization for 3 weeks, after which he began physical therapy. His wrist was later immobilized with a short-arm splint as part of the management for the posterior interosseous nerve paralysis.

Radiographic bone healing was observed at week 24 (Figure 5). The patient made a full neurological recovery. At the 1-year follow-up control, the patient had no evidence of infection. ESR and CRP values were normal. The Quick-DASH score was 6.3. Implant removal was performed 18 months after surgery with culture-negative results (Figure 6).

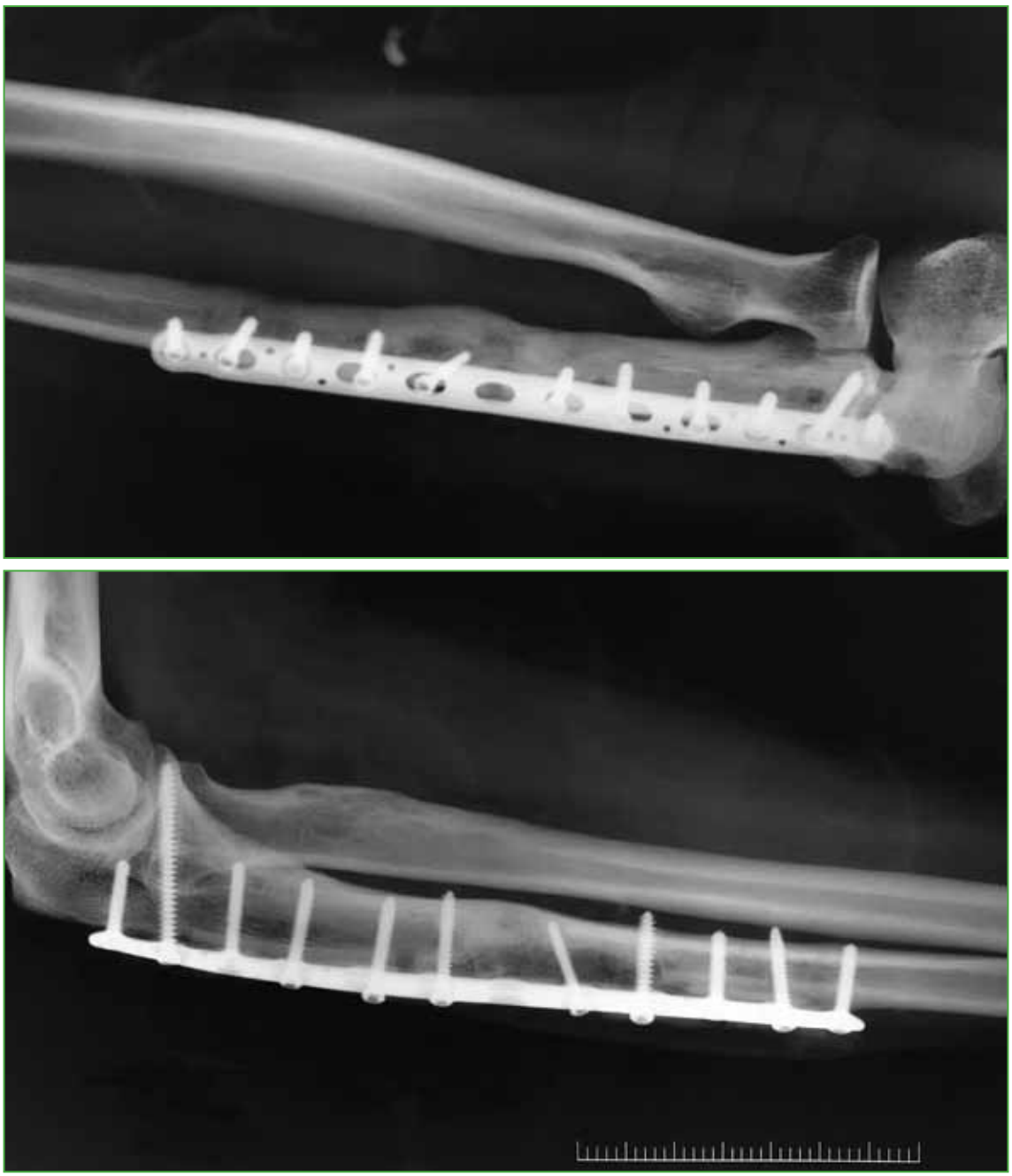

Figure 5. A and B. Radiographs from the 24-week follow-up control showing graft integration and fracture union.

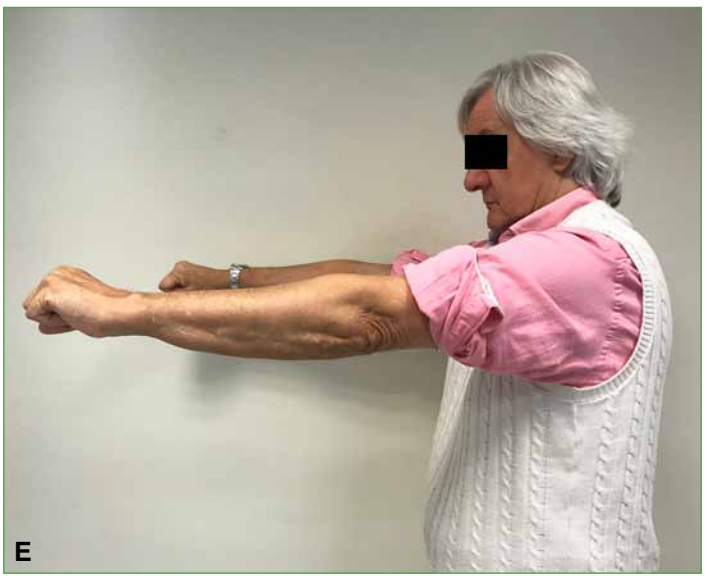

Figure 5. C-F. Physical examination from the 24-week follow-up control.

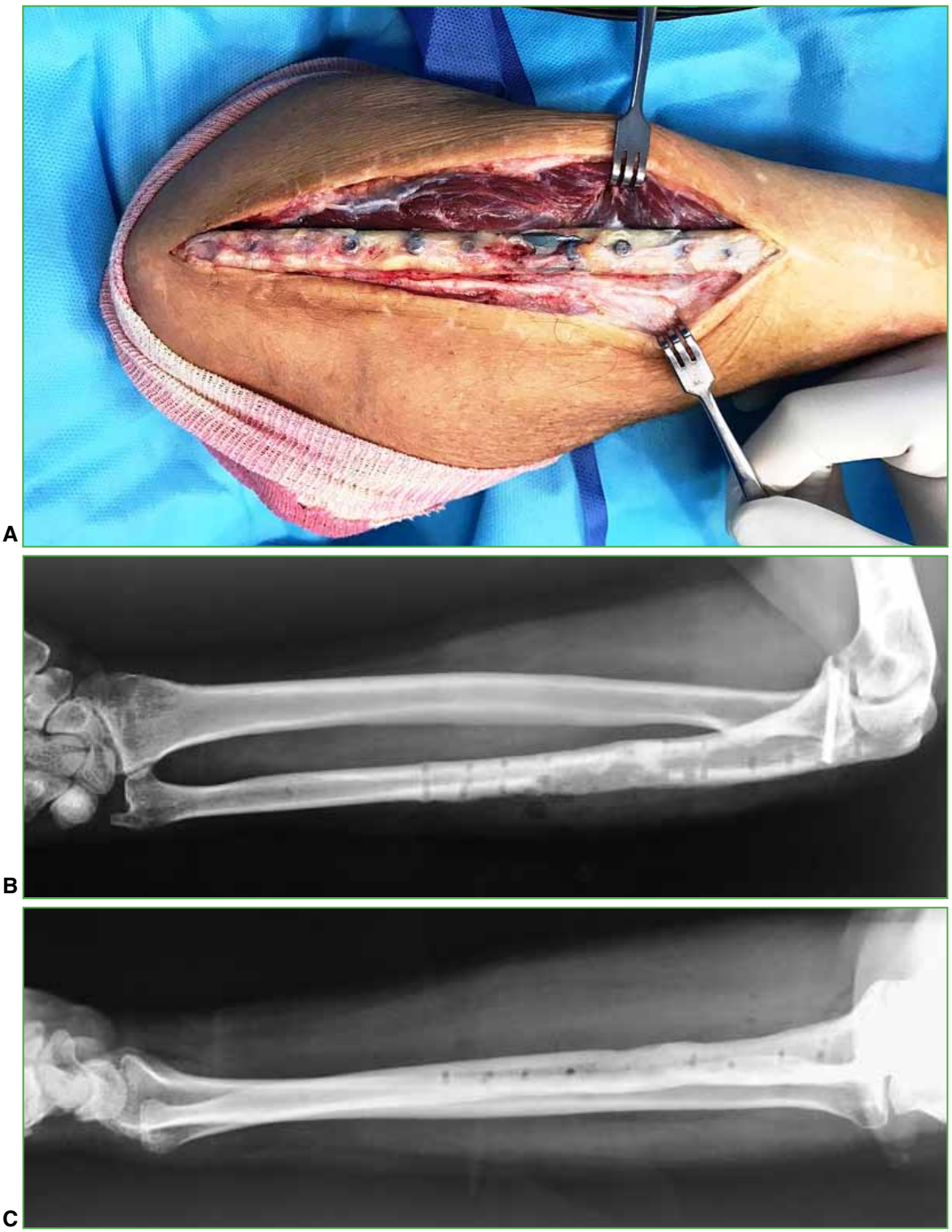

Figure 6. Implant final removal, 18 months after surgery. **A.** Intraoperative image **B and C.** Radiographic control.

CLINICAL CASE 2

A 56-year old male with no relevant clinical history, who presented with right elbow pain and functional impairment 5 weeks after an open reduction and internal fixation with double-plate and screws for a right distal humerus fracture. Physical examination reveals right elbow erythema and swelling, and severely limited active motion (Figure 7). The radiographic study revealed loss of reduction and implant failure (Figure 8). Lab findings were raised WBC, ESR, and CRP values.

Figure 7. Photograph showing erythema and swelling in the surgical scar region.

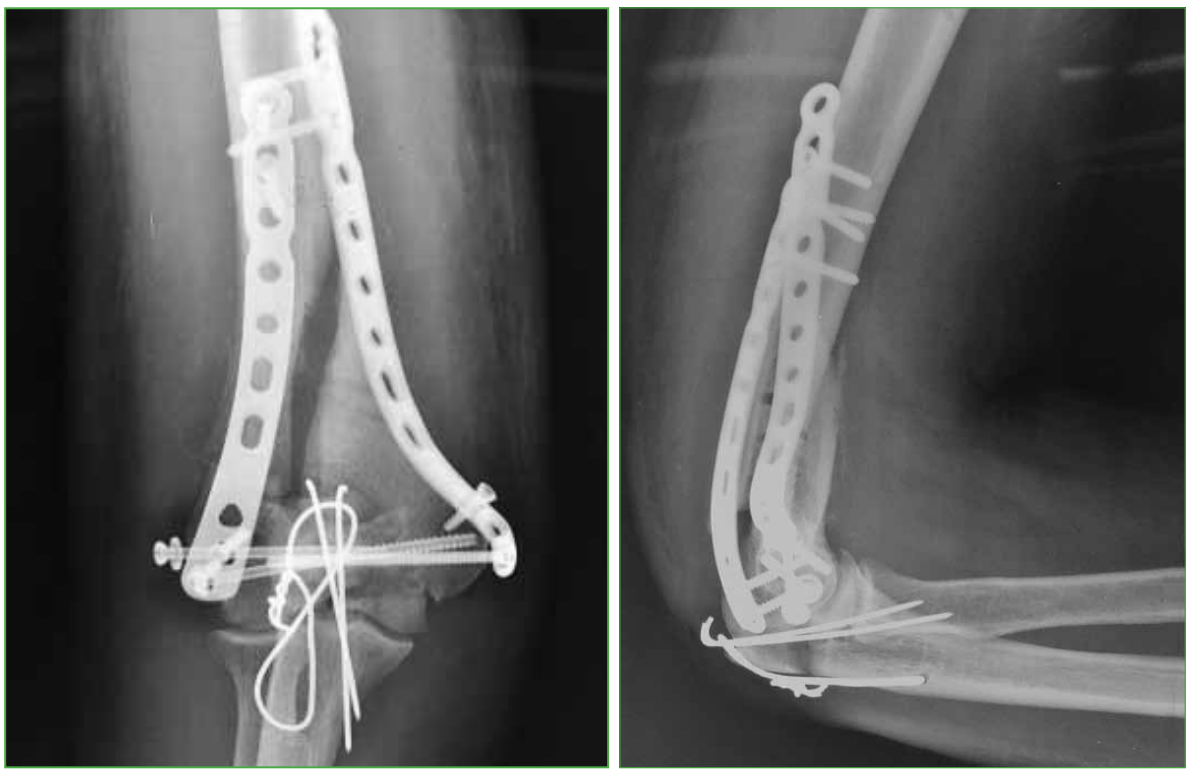

Figure 8. Right forearm radiographs showing internal-fixation failure.

The patient underwent surgical debridement, including collection of multiple specimens for culture and histopathology. Postoperative empiric therapy was instituted while awaiting the culture results, which revealed the presence of *Staphylococcus epidermidis* in all sample tissues.

Clinical evolution was favorable. After 9 days of specific antibiotic therapy, patient had decreasing ESR and CRP values, and underwent a one-stage revision procedure, which included surgical debridement, original fixation hardware removal (Figure 9), and a new reduction and fixation procedure using plates coated with antibiotic-impregnated cement (with vancomycin and tobramycin as determined by the antibiotic sensitivity test results) (Figure 10).

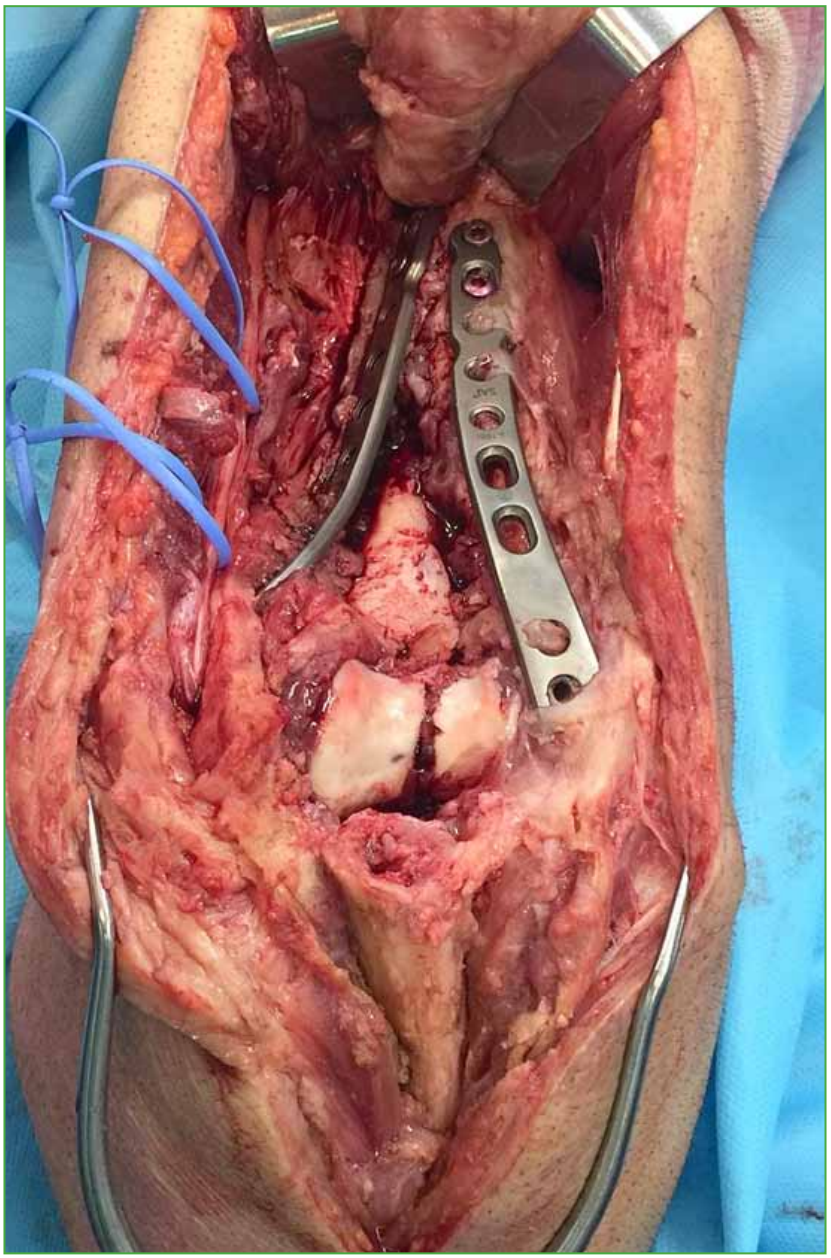

Figure 9. Intraoperative image showing fracture-line reduction loss.

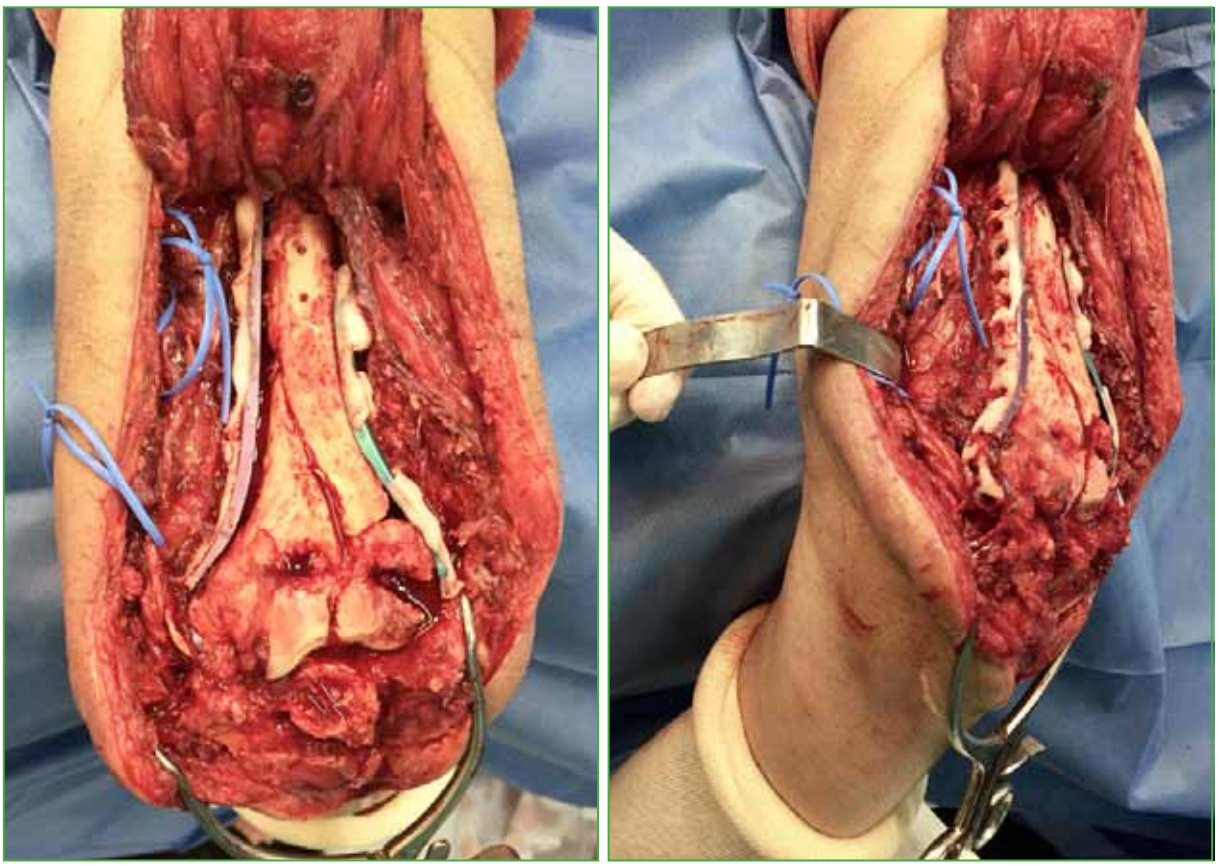

Figure 10. Intraoperative images showing the placement of a 180° double-plate construct coated with antibiotic-impregnated cement.

The postoperative was uneventful. The elbow was immobilized with a long-arm spica cast for 2 weeks, which was then replaced with a hinged splint which allowed for the patient to begin physical therapy (Figure 11). Radiographic bone healing was observed at week 12 (Figure 12). At the 6-month follow-up control, ESR and CRP values were normal. The Quick-DASH score was 4.5 (Figure 13).

DISCUSSION

Osteomyelitis associated with osteosynthesis failure represents a real challenge both for the patient and for the orthopedic surgeon, due to its high morbidity.

Implant removal, surgical debridement of the affected area, and external fixation as a temporary stabilization method coupled with antibiotic therapy administered by the systemic route constitute the basis for the initial management of infections associated with implant failure.[1,2] However, this combined management may prove inadequate to achieve complete control of the infection. For this reason, we opt for antibiotic-impregnated cement, which allows for maintaining a sustained release over an established time period. Said release is an advantage as it provides local concentrations higher than the minimum required inhibitory concentrations of antimicrobial agents while reducing the associated systemic toxicity.[1,2]

The antibiotic cement-coated plate constitutes an alternative for delivering and releasing local antibiotics (to beads, bead chains, spacers, etc.), but, unlike other methods, it enables fracture stabilization, prevents bacterial adhesion to the implant surface and its cement promotes the formation of a pseudo-synovial membrane that favors bone union.[3] Pelissier *et al*. showed that this cement-induced pseudo-membrane may produce growth factors and osteoinductive factors that favor osteoblastic lineage cell differentiation, which play a key role in implant osseointegration, and thus in fracture consolidation.[3]

Figure 11. Postoperative week 7 photographs showing active motion assisted with a hinged elbow splint.

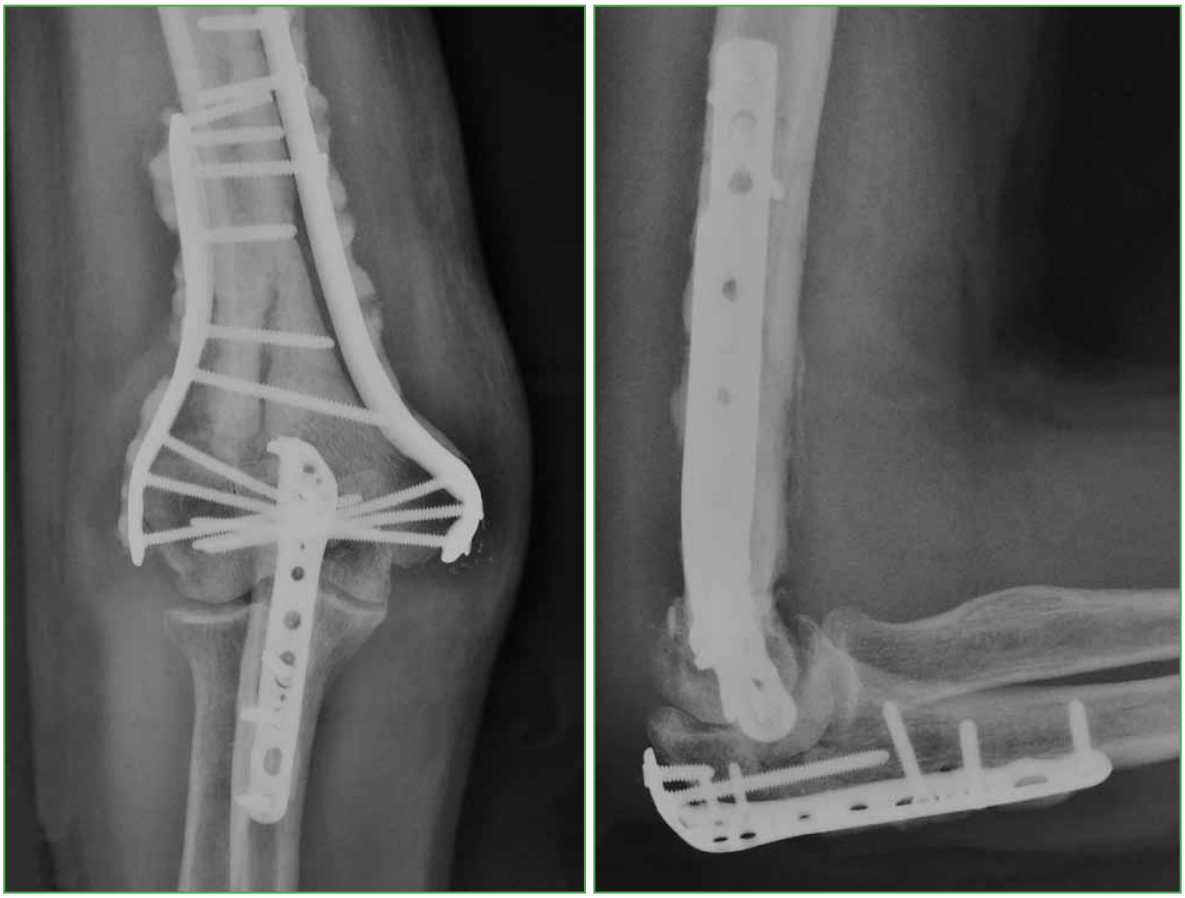

Figure 12. Radiographs from the 9-week follow-up control showing fracture union.

Figure 13. Range of motion at 6-month postoperative control.

Multiple elements have been studied as delivery vehicles for the local release of antibiotics. Polycaprolactone, collagen sponges, calcium hydroxyapatite, and fibrin implants have failed to show significant differences in terms of elution gradient when compared to polymethylmethacrylate (PMMA).[4-6]

The choice of antibiotics to be used with PMMA cement depend on the following factors: 1) action spectrum; 2) heat stability; and 3) elution characteristics.[7]

A synergistic effect has been identified in the combination of antibiotics such as vancomycin and tobramycin. Adams *et al*. studied this interaction and reported increased local concentrations of 103% and 68%, respectively.[7] This very same concept was confirmed by Penner *et al*., who showed that combining vancomycin and tobramycin in the same batch of PMMA cement instead of using either individually had an additive effect on the elution rates of both antibiotics.[8]

The recommended amounts of 3.6 g tobramycin and 1 g vancomycin per 40 g of PMMA cement have been proven to be safe in terms of nephrotoxicity, and it should be considered that the entire dose is not administered as only a limited amount of cement is used to coat the plate.[8,9]

PMMA-based bone cement can absorb up to as much as 2% water by weight. This fluid absorption and exchange allow for some of the drug molecules to be released from the PMMA matrix, mainly those near the surface of the cement.[10-12]

Although multiple studies are supporting the use of nails coated with antibiotic-impregnated cement for osteomyelitis in long bones shaft fractures,[13,16] the use of plates coated with antibiotic-impregnated cement in the treatment of osteomyelitis remains controversial and there is a limited number of published reported cases.[17,18]

CONCLUSION

The use of plates coated with antibiotic-impregnated cement in the treatment of osteomyelitis associated with osteosynthesis failure is a viable alternative to intramedullary nailing in regions where the latter fails to provide adequate mechanical stability.

Conflict of interests: Authors claim they do not have any conflict of interest.

S. Argüelles ORCID: http://orcid.org/0000-0002-9002-5687
M. P. Rodríguez ORCID: http://orcid.org/0000-0002-2616-0251
E. Pereira ORCID: http://orcid.org/0000-0001-7307-7824

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