**INTRODUCTION**

Proximal humeral fractures (PHF) are one of the most common traumatic lesions since they represent 4-5% of all fractures and 45% of the upper limb fractures. Although the majority of the fractures can be treated conservatively, for some fractures surgical treatment might be indicated with the aim of restoring function and reducing pain [1]. Despite most of the time surgery accomplishes this aim, a high rate complications have been largely reported [2]. Suprafascial and deep surgical site infections (SSI) after surgical treatment of a PHF is one of the most serious and feared complication. The incidence of these infections can vary from 9% to 8% depending of the studies, and their consequences can be devastating for joint function, patient quality of life and health care costs [3]. In case of a fracture, patients commonly undergo surgery after some days of immobilization with a bandage, often without the possibility of skin washing with axilla and arm. This may play a significant role in increasing the number and in changing the type of local skin bacteria hence affecting the infection rate [4]. Another factor potentially extremely important to influence post-operative risk infection, but again very little addressed, is the effect of preoperative cleaning [5]. Although the clinical relevance of this topic, very few articles have been carried out to investigate risk factors for the development of an acute microbial infection after surgery for PHF.

**AIMS**

In this scenario the aims of the present study were: 1) to provide a better understanding of the role of the delay to surgery on bacterial type and load at the level of the surgical site with particular emphasis on potentially pathogenic bacteria; 2) to figure out if pre-operative washing with a single skin preparation (povidone-iodine) or double skin preparation (chlorhexidine-gluconate solution plus povidone-iodine) can significantly reduce the bacterial load at the surgical site.

**MATERIALS AND METHODS**

### Patients

Thirty patients (mean age 68.32, range 42-90 years, 19 females and 11 males) affected by PHF were recruited at Emergency Department of Martini’s Ortho T. Hospital, Turin. The inclusion criteria were: a patient’s consent to the study protocol, b) displaced PHF with indication to a surgical treatment. Exclusion criteria were: open fractures and polytrauma cases. Once included in the study, the patients were intervened for conventional and digital data.

##### Study design

After the fracture was diagnosed, the patient underwent the emergency Department, the first skin cultures (day 0 swab) was taken from the area of the deltopectoral approach of each PHF patients. The patients were then treated with a Doxap or Valprox bandage for pain control and discharged in case of fractures- dilations of the shoulder or severe medical conditions. The patients were scheduled for surgical treatments and enter the hospital the planned day of surgery. The delay to surgery was determined by the availability of beds, concomitant medical diseases that needed to be studied or addressed before surgery, and/or the availability of preparatory computed tomography scan.

### Bacterial strain identification

From each swab serial 10-fold dilutions were performed in saline solution (0.9% NaCl). 100 ml of each dilution was spread on different media for aerobic and anaerobic bacteria so that the number of colony-forming units (cfu/mL) was estimated. In particular, the following media were used: Nutrient Agar (NA), Oxford Agar (OA), MacConkey Agar (MA), Mannitol Salt Agar (MSA), Merck Bicro (MB) for staphylococci; Schauer Agar plus 5% blood (BD) for anaerobic bacteria. Plates were incubated for 24-48 hours at 37°C under aerobic conditions for aerobic bacteria and for 7 to 14 days at 37°C under strictly anaerobic conditions within an anaerobic system (Gaspac EZ anaerobe system kit, BD) for obligate and facultative anaerobic bacteria. After incubation, the number of colony was recorded. All cultures with different morphologies, colonies, sizes and history of the patients were selected so that as many as the predominant bacterial types and isolates (CoNS) could be developed. For morphological analysis, Gram staining was performed and cellular morphology was determined by light microscopy. Stains of anaerobic bacteria and aerob the patients were interviewed for conventional and digital data.

### Statistical analysis

Our retrospective multicenter study [6] reported incidence and analyzed risk factors for infection after treatment for PHF: the factors that correlated with infection were length of surgery, prophylactic regime with chlorhexidine gluconate and prophylactic antibiotic. The length of surgery was found to significantly increase the rate of infection: in fact, the lowest incidence of infection was observed when the patients underwent surgery within 6 hours of trauma whereas acute infections were higher in patients that underwent surgery within 7 days of trauma. According to the study, it was highlighted that the delay of surgery influences the microbial colonization of the skin in the deltopectoral approach: an experimental rate of the bacterial load was observed after 5 days from trauma for all isolates (Figures 1-3), including Staphylococci and Propionibacterium acnes.

### RESULTS

**Figure 1.** Percentages of aerobic and anaerobic bacterial isolation frequency at the day of fracture (Day 0).

**Figure 2.** Percentages of coagulase-negative staphylococci isolation frequency at the day of fracture (Day 0).

**Figure 3.** Percentages of anaerobic bacterial isolation frequency at the day of fracture (Day 0).

The delay of surgery influenced the microbial colonization of the skin in the deltopectoral approach: an experimental increase of the bacterial load was observed for all isolates (Figure 4), including potentially pathogenic bacteria such as *Staphylococcus aureus*, *CoNS* and *Propionibacterium acnes*.

**Figure 4.** Effect of delay of surgery on bacterial load (cfu/mL). *Staphylococcus aureus*, coagulase-negative staphylococci (CoNS) and *Propionibacterium acnes*.

The single pre-operative washing with a single skin preparation (povidone-iodine) or double skin preparation (chlorhexidine-gluconate solution plus povidone-iodine) was significantly reduced the number of bacteria at the surgical site by using both single (povidone-iodine) or double (chlorhexidine-gluconate solution and povidone-iodine) skin preparation (Figure 5).

**Figure 5.** Effect of single or double pre-operative skin preparations on aerobic and anaerobic bacterial load (cfu/mL).

**DISCUSSION AND CONCLUSION**

Our prospective multicenter study [4] exposed incidence and analytical risk factors for infection after treatment for PHF: the factors that correlated with infection were length of surgery, prophylactic regime with chlorhexidine gluconate and prophylactic antibiotic. The length of surgery was found to significantly increase the rate of infection: in fact, the lowest incidence of infection was observed when the patients underwent surgery within 6 hours of trauma whereas acute infections were higher in patients that underwent surgery within 7 days of trauma. According to the study, it was highlighted that the delay of surgery influences the microbial colonization of the skin in the deltopectoral approach: an experimental rate of the bacterial load was observed after 5 days from trauma for all isolates (Figures 1-3), including *S. aureus*, *CoNS* and *P. acnes* (Figure 4), bacteria usually involved in orthopedic surgical site infections. The significant increase of the number and the change of the type of local skin bacteria could be due to the immobilization with a bandage, often without the possibility of skin washing, in patients that underwent surgery after more than 15 days from trauma. The anaerobic and *S. aureus* isolated from the skin surface (mainly from the fracture site) were the main bacteria isolated from the skin surface, and making skin preparations of the time of the procedure critical. The postoperative topographic agents for pre-operative skin cleaning are chlorhexidine gluconate solution and povidone-iodine. In this study we proved that the simple skin preparation to low bacterial contamination: Prevalence of 0.05 was considered significant.

### CITED BIBLIOGRAPHY


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