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Surveillance of infection in fractures of extremities treated with internal fixation

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Abstract
Infection is a major problem in orthopaedics quite often leading to implant failure. The aim of the study is to determine the outcome of infection after internal fixation of fractures and the risk for non-union in infected fractures. We evaluated 34 patients with 34 fractures that were infected after internal fixation to be followed up in this study from August 2017 to December 2018. At final follow up the surveillance showed satisfactory results in 31 (91.2%) cases and the rest 03 (8.8%) had an unfavourable outcome in terms of Non Union and persistent infection. Of the 34 patients enrolled in the study, 22 had sound bony union at the time of presentation. Of the 12 fractures which had not progressed to union, 9 eventually united. Only 3 patients showed no clinical or radiological signs of union at the end of the study. Of the 3 patients who did not achieve union by the end of the study only 1 continued to be infected. Infection persisted in 2 patients in spite of achieving good union. Statistical analysis showed association of the surgery-infection interval and the type of microorganism identified. Late infections had a higher chance of failure in culture. Infection when intervened and adequately treated does not quite appear to interfere with the process of union.

Keywords: Implant failure, micro-organisms, bacteremia, stable fixation

Introduction
Infection is a major problem in orthopaedics quite often leading to implant failure. It is a challenging task to treat orthopaedic implant infections that may lead to implant exchange and, in severe cases, may results in amputation and mortality [1]. Infections in surgical site are the third most commonest in cause of infection in surgical patients [2]. Infection is when pus is present in the wound or there is discharge that yields growth of pathogenic micro-organisms on culture. In implant surgery when device is not exposed, infection is taken as a superficial but when the implant is exposed, it is deep infection [3]. Some factors such as advanced age, concomitant infection elsewhere in the body, use of systemic steroids, smoking, alcohol, and transfusion of certain blood products also increases the risk of infection [2]. Staphylococcus aureus is the most frequent pathogen implicated in post-surgical infections [4]. The risk of infection after internal fixation is between 0.4% and up to 16.1% according to the type of fracture. Sources of infectious bacteria include the environment of the operating room, surgical equipment, clothing worn by medical and paramedical staff, resident bacteria on the patient's skin and bacteria already residing in the patient's body [1]. Early postoperative infection (<3 weeks) is generally characterized by erythema, local hyperthermia, protracted wound healing and a secreting wet wound. Delayed (3–10 weeks) or chronic (≥10 weeks) infections are typically due to low-virulence microorganisms such as coagulase negative staphylococci [5]. Our aim of the study is to determine the outcome of infection after internal fixation of fractures and the risk for non-union in infected fractures.

Materials & Methods
This is a prospective study involving surveillance of patients presenting with signs and symptoms of infection during the follow up period of fracture fixation of extremities treated at a tertiary level care hospital attached to a postgraduate level teaching institution during the period from August 2017 to December 2018. This study was carried out at the department of Orthopaedics, SSG Hospital & Medical College, Vadodara.

Adult patients presenting with local infection after internal fixation of fractures either at O.P.D. or admitted in wards and consenting to participate in the study defined by inclusion and exclusion criteria were enrolled in this study. We identified 35 patients having infection after fracture fixation of the extremities. Of these, 1 was excluded as the patient did not fulfil the study criteria. Hence, we had 34 patients with 34 fractures that were infected after internal fixation to be followed up in this study. This study being a surveillance, all 34 patients included were closely observed for a period of 6 months from the date of presentation, while they were being treated. No study specific alteration was done in the management which was decided on individual merits by the treating surgeon. All subjects were evaluated with respect to the demographic data history of fracture being treated, presenting symptoms and signs, current management and outcome as outlined in the Performa. Culture and sensitivity test was obtained in all cases. All patients at the initial presentation were put on empirical injectable antibiotics against gram positive cocci (injection cefotaxime). Antibiotic therapy was revised as per culture sensitivity reports. In patients with negative culture an aminoglycoside (Gentamycin) and Nitroimidazoles (Mertonidazole) were added to the ongoing therapy. Injectable antibiotics were continued for the minimum period of 2 weeks after-which a decision was taken to switch over to oral therapy depending on the resolution of infection. Antibiotics coverage was prescribed for the minimum period of 6 weeks for all cases. Repeat cultures, if required were taken from time to time. We evaluated every patient for a minimum of six months at every six weekly interval. At every follow-up patient was assessed clinically for pain, swelling, signs of infection, wound status etc and radiologically for union status, alignment, implant status and infection. We considered outcome favourable when plain radiographs showed bridging bone across the fracture in both orthogonal views (i.e. fracture continued to be united) and the patient could bear full weight (or do activities requiring grip/pinch/ hold for more than 60 seconds when involving upper limb) without pain. We considered outcome as favourable when fracture union was achieved whether or not infection persisted. Failure to unite/ implant loosening/ implant breakage and failure to return normal activities involving daily living using the involved limb was considered as unfavourable outcome.

Observations & Results

In this study we identified 35 patients having infection after fracture fixation, which suggested an infection rate of 5.7% at Medical college & S.S.G. Hospital, Vadodara, Gujarat during the period August 2017 to December 2018. Of these 35 patients, 1 was excluded as the patient did not fulfil the study criteria. Hence, we had 34 patients aged 20 to 70 years, with 34 fractures that were infected after internal fixation to be followed up in this study. The maximum number of patients were males (30) doing labour work for earning (24), in the age group <40 years (21). There were 31 closed and 3 open fractures (2 OG I, 1 OG II). There were 12 simple (A Type), 03 Intermediate (B type), 19 Complex (C type) fractures as per the OTA Classification. Radius-Ulna (26.2%) and Tibia (23.4%) were the most frequently infected fixations. All fractures had definitive ORIF within 16 days of injury (Average 6.36 days). 15 patients underwent open reduction (44.2%), 10 underwent closed reduction (29.4%) and 9 were treated with MIPO technique (26.4%). Plating (N=25) outnumbered IM Nailing (N=9) in distribution. Maximum surgeries were conducted by post-graduate residents (47.1%) and in decreasing order by junior consultant (38.2%) and senior consultants (14.7%). Seven patients presented within 10 weeks of primary surgery whereas the rest presented later than that, to as long as 6 years. Discharge from the previous surgical wound, sinus, local redness/tenderness and swelling were the most common symptoms of presentations. Seven patients (20.58%) had clear signs of infection on x-ray. 22 patients (64.8%) had visible signs of union on x-ray at the time of presentation. The blood investigations reflected that most of the infected implants that presented to us were chronic in nature. ESR was raised in 29 cases (85.3%), WBC count had returned back to normal and Acute phase protein level had come down to levels below detection by qualitative analysis in 21 patients (61.8%). All 32 patients presenting with discharge underwent culture reports and for the remaining 2 patients a tissue culture was sent intra-operatively. No growth was detected in maximum (n=20) number of patients (58.8%). Staph. aureus was detected in 10 (29.6%) of which 3 (9%) were methicillin-resistant. 2 (5.8%) each of pseudomonas and Enterobacteriaceae constituted the rest of the reports. Eight patients were treated conservatively by antibiotics and a short duration of splinting and the rest 26 were treated surgically. Surgical procedures included Debridement (6), Implant Extraction (12) and Revision fixation (8). Of the 26 cases operated 4 patients had loosening of implants, where as in most of the case implants were found intact. Patients admitted for infection after fracture fixation required an average hospital stay of 16.7 days (range 6-60 days).

Table 1: Outcome (Union Status) assessment at final follow up.

Outcome assessment	No. of patients	Percentage	Status of infection	
			Infected	Un infected
Favourable (United)	31	91.2 %	2	29
Unfavourable(Not United)	03	8.8 %	1	2
Total	34	100 %	3	31

The surveillance showed satisfactory results in 31 (91.2%) cases and the rest 03 (8.8%) had an unfavourable outcome in terms of Non Union and persistent infection. Of the 34 patients enrolled in the study, 22 had sound bony union at the time of presentation. Of the 12 fractures which had not progressed to union, 9 eventually united. Only 3 patients showed no clinical or radiological signs of union at the end of the study. Of the 3 patients who did not achieve union by the end of the study only 1 continued to be infected. Infection persisted in 2 patients in spite of achieving good union. These 3 patients with persistent infection at the end of the study had no growth on culture tests, hence a specific antibiotic protocol could not be instituted.

Fig 1: Clinical pictures & x-rays of the patient with favourable outcome.

Fig 1: Clinical pictures & x-rays of the patient with unfavourable outcome.

Table 2: Micro-organisms v/s Surgery-infection interval.

Micro-organisms	Surgery-infection interval		P value
	Early (<10 weeks)	Late (>10 weeks)	
Staphylococcus	1	6	0.0387
MRSA	0	3	
Pseudomonas	2	0	
Enterobacteriaceae	1	1	
No organisms	3	17	

Statistical analysis showed association of the surgery-infection interval and the type of microorganism identified. Late infections had a higher chance of failure in culture.

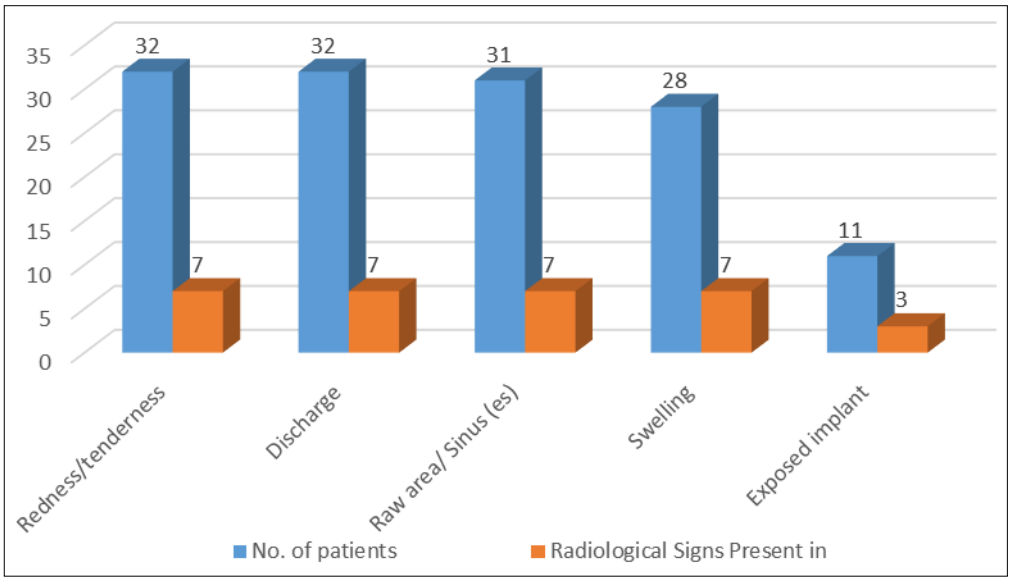

Chart 1: Radiological Signs of Infection v/s Clinical sign of Infection.

Clinical signs were far more common than radiological signs (x-ray) in identifying implant infection. A meagre number (7) of patients had signs of infection on plain radiographs at the time of presentation justifying a known fact that infection cannot be diagnosed purely on x-ray. All patients showing signs of infection on x-ray had definite clinical signs of infection. Of the 7 patients with x-ray suggestive of infection 2 had unfavourable outcome suggesting that x-ray signs predict a poorer prognosis.

Implants were retained in 14 patients and revised in 8. The

remaining 12 patients were either treated non-operatively or by debridement only. Definitely removal of implants eradicated infection. Infection persisted in a small group of patients (3) and all of them still had hardware in place at the time of follow up.

Discussion

Infections have always been shadowing surgeries in the history of modern medicine. Every surgeon has faced the wrath of infection at some or the other time in their practice. However more commonly such incidents are moved to the chest of undisclosed treasure by many a surgeon. Instead of shying away from such occurrences it will be more productive if such cases are studied and analysed to the betterment of the future practice.

Infection can prolong hospital stay and increase morbidity and mortality [6]. A surveillance needs to be done before chalking out a road map for control of infection. Our study focussed on surveillance of infection after fracture fixation of extremities to determine their outcome, to obtain a benchmark rate and use of this information to enhance the quality of patient care. We had a cluster of 34 patients satisfying our criteria to be included in this study. Previous studies [7] in line with our aims and objectives also had a similar sample size, ranging from 30 to 70 with near-identical distribution and variables. More dedicated studies had a longer span of study duration [8] or had a wider inclusive criteria [3]. The overall rate of implant infection as calculated in this study was 5.7 %. Even though CDC definition [9] limits implant related infection to the first year after surgery, we did not use this criteria as we have had experience of patients presenting late with implant infection [7]. Similar studies [3] conducted in the same geographical area with un-identical inclusion criteria showed a wide variation in incidence of implant infection (2.6-22.58 %). Male gender considered to be the bread earner in our society sustain trauma more frequently than female counterparts and so the higher rate of infection as well in them. Literature [7] reports an advanced age as a risk factor for development of surgical site infection. We deliberately avoided including open fractures that required external fixators as we wanted to focus on infection after clean surgeries. Infections were more commonly identified in distal part of extremities than proximal. This could be possibly due to these areas being less covered and protected. The possibility of decreasing perfusion gradient of blood in distal parts can't be negated. Contrast to our expectations none of the patients had any pre-existing systemic and local disease that could predispose the patient to develop infection. Most of the patients with trauma undergo an urgent surgery. Long pre-operative hospital stay leads to colonisation with anti-microbial resistant micro-organisms and affects patients susceptibility to infection by lowering host immunity or by providing increased opportunities for bacterial colonisation [10]. Open surgeries combined with plate fixation appear to have a higher possibility of getting infected. Subcutaneous plating in proximal and distal tibia are also prone to get exposed and infected. Late (>10 weeks) infections after surgeries are more frequent than early (<10 weeks) infections. Emergency surgeries were usually performed by junior doctors, more often with complications and had dirtier cases [10]. Retaining hardware beyond fracture union seems to be a reason for infection. Timely implant removal which hitherto was done more on demand by patient than by advice of surgeon, should be stressed upon to avoid future bacteremias that might flare up a controlled local infection.

Defining what constitutes infection in relation to orthopaedic implants has always been difficult [9]. Although prosthetic joint infections have clearly been classified and defined in literature, there is paucity of information on what exactly defines an orthopaedic related infection. Culture of organisms from the local area is diagnostic of infection. Our routine clinical experience has been that not all obviously infected wounds yield a positive culture. Hence, we relied more on clinical features to diagnose infection. Culture reports, probably the most awaited investigation after infection, did not show any remarkable observation. Whereas 20 patients showed no growth, 10 showed growth of Staphylococcous Aureus. In a study [11] it was concluded that it is important to identify the infecting organisms in ensuring success of treatment. Meyer *et al*. [12] found no correlation between the types of infecting organisms and outcome of treatment. However a negative culture report was not commented up on. Staphylococcous aureus has been the most commonly identified bacteria in cultures of infected implants in literature [11]. Statistical analysis showed association of the surgery-infection interval with the type of micro-organisms identified. Late infections had a higher chance of failure in culture. It requires a strategic planning with the micro-biologists to narrow this grey area of identifying the microbes in all cases of obvious infection.

Eight patients were treated conservatively by antibiotics and a short duration of splinting and the rest 26 were treated surgically. Surgical procedures included debridement, implant extraction and revision fixation. In most cases implant were found to be intact. Implant removal promoted resolution of infection. Nazri M.Y. *et al*. [11] concluded that a stable fixation in a fracture which is still not united should be retained and need not be removed even in the presence of infection because the infection did not prevent subsequent bone union.

As in other studies, [11] a united fracture with implants in situ and infection were not excluded from our study as we focussed more on surveillance rather than on outcome. Our study suggests that it is possible to achieve union and mange infection whether or not hardware is removed. However risk of recurrent infection flares is lowered to a minimum by removing the implants. Our study was the beginning of a long journey to control, if not eliminate the risk of infection after fixation of fractures. At the same time this study has several limitations. We expanded the definition of implant related infection to accommodate our clinical practice. The sample size was much smaller than expected. No control group or matching healthy group was compared to validate the results. Also not all patients with implant infection might have approached us for further treatment thereby masking some results. Culture reports did not always support the clinical presentation. All patients whom we labelled as resolved from infection could develop a recurrence in future due to possibility of suppressed infection.

Conclusion

In our study, although no statistical conclusion can be derived from this information, infection when intervened and adequately treated does not quite appear to interfere with the process of union. A stable fixation will still progress to union if infection is cleared.

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