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Functional and Radiological Analysis of Management of Infected Non-Union of Long Bones of Lower Limbs

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Abstract:Introduction:*Infected non-union of fractures is one of the major problems in orthopaedic surgery. By definition, infected non-union is a Cierny IV osteomyelitis, meaning that the fracture is unstable before and after the debridement.In the treatment of an infected ununited fracture of a long bone it often is difficult to achieve union and eradicate the infection. The goal of treatment is a well-aligned, healed, painless and functional limb. Wound debridement, stable osteosynthesis and containment of the infection is the primary procedure for all cases of infective non-union.*

Materials and Methods: *The study was undertaken at Dept. of Orthopedics, S.V.Medical College, Tirupati for a period of one year from January 2018 to December 2018. All cases of infected non-union of femur and tibia were included in our study. This study was performed to evaluate the results of treatment of infected non-unions of tibia and femur.The method was chosen depended on the type of septic non-union that had occurred. Cases were followed up as outpatients in clinic. These patients were evaluated by taking a meticulous history and performing a detailed physical examination.*

Results:*Follow-up in the 39 patients who came for the interview ranged from six months to seventeen years (average 4.5 years). There were 21 tibial fractures, 18 femoral fractures in 37 men and two women with a mean age of 43.46 years (17-74 years). The median number of previous operations was two. Re-fracture was seen in one case after external fixator removal, union was achieved in this case by reapplication of the orthofix and bone grafting.*

Conclusion:*All the previous studies used Ilizarov as an external fixator , but we preferred Ilizarov in tibia. Most of the previous studies of infected non-union revealed excision of a segment of a bone followed by intercalary bone transport which is an extensive surgery may not be necessary in all the cases as we shown in our study as stabilization, adequate soft tissue cover and control of infection will make the natural process of healing to occur.*

Key Words: *External fixator, Ilizarov, Malunion, Non-union, Osteomyelitis*

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I. Introduction

Infected non-union of fractures is one of the major problems in orthopaedic surgery. By definition, infected non-union is a Cierny IV osteomyelitis, meaning that the fracture is unstable before and after the debridement[1].There are many available alternatives in the management of infected non-unions.These include extensive debridement and local soft tissue rotational flaps, packing the defects with antibiotic impregnated beads, Papineau type of open cancellous bone grafting, proximal tibio-fibular synostosis , cancellous allograft in fibrin sealant mixed with antibiotics , and /or free micro vascular soft tissue and bone transplants .None of the above mentioned techniques afford the surgeon the ability to correct deformities, eliminate prolonged pre and postoperative antibiotic therapy, regenerate new bone tissue without the use of bone grafts, progressively lengthen the extremity, and allow weight bearing during the treatment period simultaneously.

In the treatment of an infected ununited fracture of a long bone it often is difficult to achieve union and eradicate the infection. Infective non-union presents with a wide spectrum of disease, a number of different treatment modalities are appropriate depending on the age, type of non-union, status of infection and condition of the patient at the time of presentation. Reconstruction is particularly challenging in patients with deformity, soft tissue loss, and leg-length discrepancy.

The goal of treatment is a well-aligned, healed, painless and functional limb [2]. Wound debridement, stable osteosynthesis and containment of the infection is the primary procedure for all cases of infective non-union. This can be combined with an autogenouscorticocancellousbone grafts with an aim to achieve the bone continuity and union and split skin grafts or flap cover if needed. Thus stable fixation and control of infection not only maintains congruent limb movements but also prevents the need for amputation. Non-invasive methods are not recommended when osteomyelitis or a bone defect is present[3].Non-unions of the tibia associated with infection have always been a challenge to orthopaedic surgeons. External fixator application is the treatment of choice in these type of cases. Although external fixation is often considered a relatively ''new'' trend in modern traumatology and orthopedics, it has been used by physicians and surgeons for thousands of years. Hippocrates developed a crude external fixator around 377 BC [4]. The earliest of these devices consisted mostly of wooden splints used to treat closed fractures. They now have evolved into the use of a wide array of metals and composite materials. With the birth of external fixation came many complications, and for the novice, a somewhat difficult procedure to perform. Surgeons worldwide are now using external fixators to stabilize fractures and correct deformities. The modern external fixators (monorail, circular, hybrids) are still based on the ageless principles of external fixation and the methods employed to reduce fractures and correct deformities, particularly of the extremities.[5,6]

Though a general consensus is present regarding management of infected non-union by resection of the segment of the bone followed by intercalary bone transport but still union can be achieved by stabilization, thorough debridement and adequate soft tissue cover without the need of the extensive procedure.

II. Materials and Methods

The study was undertaken at Department of Orthopedics, S.V.Medical College / S.V.R.R.Govt. General Hospital, Tirupati. The period of study was from January 2018 to December 2018.

Criteria for inclusion: All cases of infected non-union of femur and tibia were included in our study. This study was performed to evaluate the results of treatment of infected non-unions of tibia and femur. Our cases were included in the study taking into account the method of treatment used for their management, regardless of age, gender or other epidemiologic variables. These patients had been due to septic non-union of tibia and femur and had already undergone several unsuccessful operations to eradicate infection and induction of union before admission.Patients with infected non-union of tibia and femur presenting more than six months after injury with active draining sinus were considered as "draining" and those with quiescent infection without any active discharge were considered as "non-draining" cases. The period of study was chosen such that on final assessment a minimum follow-up of two years would be available following the completion of treatment for the analysis of the results clinically and radiologically.

The method was chosen depended on the type of septic non-union that had occurred. Cases were followed up as outpatients in clinic. These patients were evaluated by taking a meticulous history and performing a detailed physical examination. Imaging methods (plain radiography, CT and bone scans when necessary), peripheral haematological indices and serum biochemical and inflammatory markers were checked in all patients. Our main tool for follow-up was physical examination and plain radiography. Our definition for non-union was a minimum elapsed time of 6 months since surgery without progressive signs of healing (clinical and radiographic) for 3 months .Our variables in this study, apart from epidemiologic data, were type of non-union, the method of treatment , union and its duration, eradication of infection and the number of operations before our intervention.

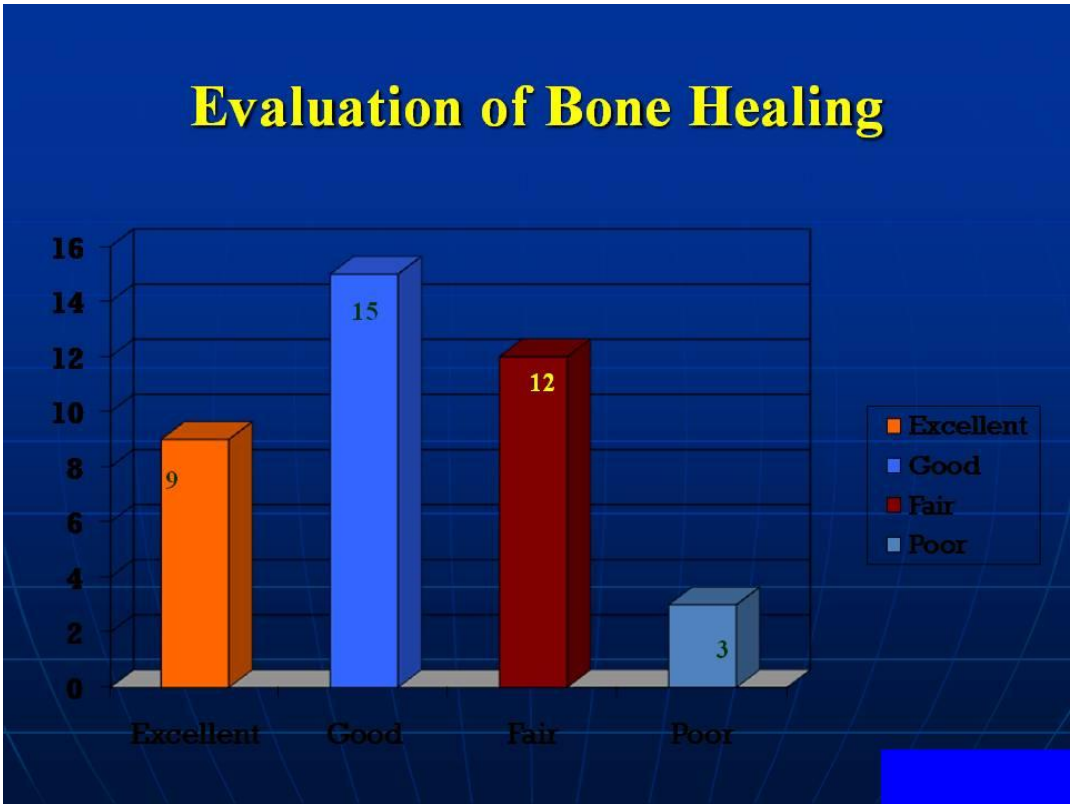
Exclusion criteria: All the cases of infected non-union without a minimum follow-up of two years are excluded in our study.

III. Results

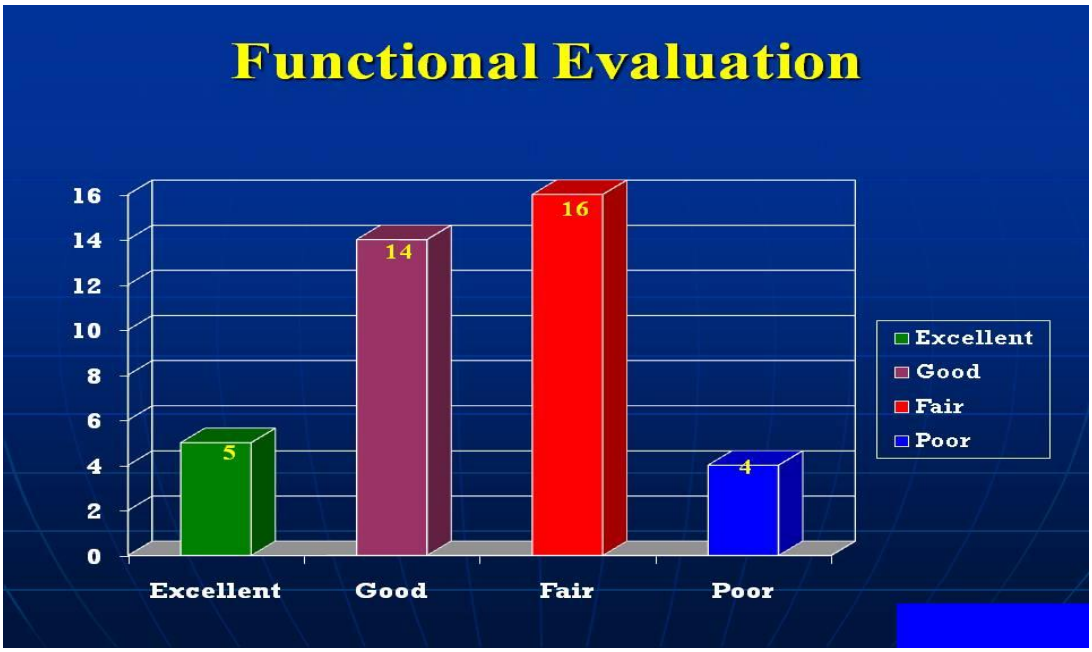
Follow-up in the 39 patients who came for the interview ranged from six months to seventeen years (average 4.5 years). There were 21 tibial fractures, 18 femoral fractures in 37 men and two women with a mean age of 43.46 years (17-74 years). The median number of previous operations was two. Refracture was seen in one case after external fixator removal, union was achieved in this case by reapplication of the orthofix and bone grafting.

There were episodes of pin or wire track infection in the 27 patients, 22 patients required treatment in hospital including parenteral antibiotics, antiseptic dressings and change of the offending wires. Others were managed as out patients by culture and sensitivity, appropriate antibiotics and dressings. There were no episodes of wire breakage. The median time in the frame was 6.5months (5-20months). As many as 20 of our patients had stiffness of the relevant joint (knee or ankle). Most patients had multiple previous surgeries with resultant soft tissue scarring. Loss of motion averaged 45% at the knee and 60% at the ankle as compared with the opposite side. The median duration of follow-up after the frame removal was 4.5 years (1-17years).According to

ASAMI protocol, the bone result was excellent in 9 patients (23%), good in 15 patients (38.46%), fair in 12 (30.76%) and poor in 3 (7.6%).



Of the 37 male patients, ten returned to their previous work (27.02%), 18 required a change from their previous work (48.64%) but were gainfully employed while nine did not return to any work at all (24.32%). Both the female patients were able to perform some household activities. Seventeen patients had a noticeable limp. Nineteen patients had stiffness of either at the knee or the ankle. Eight patients had significant pain, which resulted in reduced activity or disturbed sleep. According to these criteria, the functional results were excellent in five patients (12.82%), good in 14 (35.89%), fair in 16 (41.02%) and poor in four (10.2%).



The average amount of shortening is 3.33cm. The average number of operations after the establishment of infected nonunion was 3 *(1 – 14 surgeries).* The average time for external fixator removal was 6.5 months (3-15 months)**.**The final outcome of closed and compound fractures in our study are also assessed by ASAMI protocol. The radiological healing in the fifteen cases of closed fractures showed four excellent results, good result in six cases, fair in four cases and poor result in one case; whereas in compound fractures, four cases had excellent result, good results in nine , fair in eight cases and three poor results.The functional healing in the closed fractures of the study shows two excellent results, eight good results, four poor results and one poor result. In compound fractures, three excellent results, six good results, twelve fair and three poor results.

Complications:

Pin tract sepsis is the most common complication we encountered and it is almost seen in most of our patients and in almost half of these patients change of pin was done. Cancellous bone grafting was required at the docking site in one patient and excision of interposed soft tissue, with freshening of the bone ends after bone transport. There was one refracture at the non-union site for which application of orthofix and bone grafting was done which subsequently united in a period of six months. Four patients developed significant equinus deformity for which percutaneous tendo-achillestenotomy was done in one case and three needed open elongation of tendo-achilles. One patient underwent adductor tenotomy for the adductor spasm. One case went for ankle arthrodesis because of significant arthritic changes in the ankle joint and twocases went for triple arthrodesis because of severe pain in the foot and ankle. Debridement and sequestrectomy was needed in eleven patients.One patient developed supracondylar fracture of the femur due to disuse osteoporosis when the patient is still under our treatment and we were able to treat it conservatively in a Bohler-Braun splint with traction.

IV. Discussion

Long standing infected non-union is difficult to treat and is a challenging problem for the orthopaedicians.Conventional methods of non-union treatment are successful in cases of non-infected non-unions, in which bone vascular supply and soft tissue integrity are not compromised.[7] Repeated surgical procedures, osteomyelitis, non-union, bone loss, disuse osteoporosis, muscle dystrophy, impaired arterial circulation, and decreased venous and lymphatic drainage ensue when bone fractures do not consolidate.[8,9]It usually leads to residual deformity, persistent infection, contracture and at worst - a useless limb[10]. Certain severe complications like infection, non-union with or without bone defect and deformity are common. It is due to severe destruction of soft tissue and comminution of underlying bone and elimination of local humoral and cellular defense mechanisms and destruction of periosteal layer and endosteal vasculature[11,12]. Septic non-union is one of these complications that make conventional management methods ineffective and requires several operations and long term treatment.It is often difficult to achieve union arıd eradicate an infection at the same site[13]. A diagnosis of non-union can be made when at least six months have elapsed after the time of the fracture and when there is evidence that the fracture will not unite. An infection at that point tends to be chronic, because it is associated with an organism that is resistant to most antibiotics[14] and because many patients who have an infection at the site of a non-union have additional scarring after unsuccessful operative attempts to eradicate the infection or treat the non-union. The infection is more likely to be eradicated if all of the necrotic bone is resected completely. However, such extensive resection makes the bridging of the bone ends more difficult to achieve. Furthermore, a non-union that is associated with an infection is almost always also associated with deformity, leg-length discrepancy, joint stiffness, disuse osteoporosis, and soft-tissue atrophy. Sometimes there is neurovascular damage as well.

In our study, the treatment of individual case is different and for tibia we usually prefer Ilizarov as the external fixator and for the femur orthofix is used with few exceptions. We educate and explain the patient regarding the duration of the treatment, approximate cost of the treatment, subsequent procedures, and complications as the patient compliance is the prime factor in these types of cases. All our patients were operated on several times before they underwent treatment. Bone healing and functional results as assessed by ASAMI criteria were not well correlated[15].In our series, the functional results seemed to be inferior to the bone results. An excellent bone result, even in a patient who had a severe infection does not guarantee a good functional result. The cooperation of the physical therapist and a patient is very important, since the patient must exercise the limb and joints. The infection appeared to have been successfully eradicated in all our patients. Amputation was done in five patients. There were no signs of inflammation in the patient with refracture either. However, since we could not with certainty exclude the possible future reactivation of inflammation, the absence of inflammatory signs for a minimum of 2 years was considered a success. This rule applied to all our patients. In our patients, the outcome of bone consolidation was better than the functional results. Also, an excellent result of the bone defect treatment accompanied by the resolution of inflammation does not guarantee a good functional result. The functional result depends primarily on the existing damage of nerves, muscles, vessels, joints, and, to a lesser extent, bones.

We agree with Green et al in that the largest number of complications is associated with wire tract infection whereas the second biggest difficulty was wire loosening associated with infection or wire osteolysis. Recent advances in microvascular anastomosis technology have permitted vascularised osseous transfers for dealing with missing bone tissue. In the lower limb such grafts whether the fibula or iliac crest take years to hypertrophy and often fracture one or more times before remodelling is complete. Also microvascular bone transfers often fail to unite to the recipient osseous tissue at one or both ends[16].

Wood et al[17] showed that the only 40% of the patients with osseous sepsis went on to unite microvascular osseous transplants.

V. Conclusion

Infected non-union is always a perplexing problem for the orthopaedic surgeons.Prevalence of infectionis more common in unstable situation.Infected non-union is a post-traumatic bony wound and not equivalent to hematogenous osteomyelitis. Thorough wound debridement, adequate soft tissue cover, respecting the biology and attainment of the stability will control the infection and enhances the union. The outcome of bone consolidation was better than the functional results.All the previous studies used Ilizarov as an external fixator, but we preferred Ilizarov in tibia. Most of the previous studies of infected non-union revealed excision of a segment of a bone followed by intercalary bone transport which is an extensive surgery may not be necessary in all the cases as we shown in our study as stabilization, adequate soft tissue cover and control of infection will make the natural process of healing to occur.

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