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ORIGINAL ARTICLE

Outcome of Chipping Method in Complex Non-Union of Long Bones

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ABSTRACT

Objective: To determine the outcome of chipping method in the treatment of long bones complex non-union with autologous bone graft.

Patients and Methods: This interventional study was conducted in orthopedics and trauma department Khyber teaching hospital, Peshawar. Duration of this study was January 2015 to January 2016. The consecutive nonprobability technique was used to collect the samples and twenty-one patients were managed with chipping method for complex non-union of long bones. All the patients were treated by appropriate fracture fixation, including revision of implants. and followed for at least 06 months postoperatively.

Results: A total of 21 patients were included in the study among which 14(66.67%) were males and 7(33.33 %) were females. Mean age of the patients was 44 years (Range 20 to 80 years). Among them 13 patients had femoral shaft fracture non-union,5 patients had tibial shaft fracture non-union, 2 patients had humerus fracture non-union and one had radius/ulna fracture non-unions. Mean duration from trauma to non-union was 15 months (Range 6 months to two years). All the patients were treated with this method, using an autologous bone graft from the iliac crest and followed for at least six months postoperatively. Twenty patients obtained bony union successfully. One patient failed to get a union, requiring the second operation, three patients got ipsilateral knee stiffness and three patients got limb length discrepancy less than 2cm.

Conclusion: Chipping method with autologous bone grafting is easy to perform and is an encouraging approach for enhancing bone healing in long bones complex non-union.

Keywords: Autologous bone graft, Chipping method, Non-union.

Author`s Contribution
[1] Conception, synthesis, planning of research and manuscript writing
[2] Interpretation and discussion
[3] Data analysis, interpretation and manuscript writing, [4, 5] Active participation in data collection

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Introduction

Nonunion is a failure of bone union following a fracture of bone that needs further treatment before healing can occur.[1] The exact length of time needed to determine whether a fracture is nonunion is not well defined, nevertheless, previous studies reported that fracture that doesn't heal completely in 9 months is considered as nonunion.[2,3] Nonunion is a common complication following long-bone fracture, with a prevalence ranging

from 2.5–46%.[3-6] Risk of nonunion increases in the presence of open fractures, extensive soft tissue injury and vascular injuries.[7,8] Nonunion of fractures of long bones represent a significant clinical challenge and is associated with high complication rates.[6,9] Challenges associated are to obtain union, restore alignment and leg length along with good range of motion joint above and joint below the non-union or delayed union site.[9-12] Conventionally, treatment of nonunion of bone has involved acquiring mechanical stability through internal fixation, with or without the use of bone graft in an attempt to improve healing.[1,13] Judet and Patel's decortication technique is also one of the good techniques for managing nonunion of long bones but difficult to reproduce in the same way as described in the original report.[14,15] Autologous bone graft is considered to be the gold standard for supplementing bone defects and for enhancing bone healing in non-unions and delayed unions.[1] Bed preparation is necessary for bone grafting and the method needs to be described in detail as no detail description is existing.

Chipping method is a new technique for the management of complex non-union of long bones. The literature review identified two studies which used chipping technique.[16,17] Matsushita and Watanabe used chipping and lengthening technique in 6 patients for the management of non-union of long bones[16], while Hattori et al. presented a case report in which they used chipping and lengthening technique to treat proximal tibial pseudoarthrosis.[17] Both studies reported good results with chipping methods.[16,17] Current study was designed to further evaluate the effectiveness of chipping method in the treatment of long bones complex non-union with autologous bone graft.

Patients and Methods

This interventional study was conducted in orthopedics and trauma department Khyber teaching hospital, Peshawar from January 2015 to January 2016. Consecutive nonprobability sampling technique was used. A total of 21 patients were managed with chipping method for complex non-union of long bones and followed for at least 06 months postoperatively. Total 13 femur,5 tibia,2 humerus and one radius/ulna having aseptic non-unions and previously treated with implants were included in the study. Gap non-union of more than 4 cm gap and medically unfit patients were excluded. All the patients were treated by appropriate fracture fixation, including revision of implants. The radiographic evaluation included standard anteroposterior and lateral preoperative x-rays of the non-union site including joint above and joint below. Intraoperatively, the non-union site was exposed without periosteal stripping to preserve the blood supply. The previously implanted plate or nail was removed if needed, fibrous tissue was removed from the non-union site and both ends of the fracture fragments were chipped into small pieces, using small sharp osteotome and a small hammer, producing pathways into the bone marrow. The osteotome was inserted into the bone parallel to the bone axis but not parallel to the fracture line. The autologous cancellous bone graft was taken from the iliac crest and grafted into the gap and chipped ends of both segments appropriate fixation was performed. The extent of bone chipping was adjusted according to the size of the fractured bone. Chipping was done very carefully, avoiding detachment of small bone pieces from soft tissue. If the intramedullary nail was used for appropriate fixation of the non-union, chipping was done from anterior, lateral and posterior sides of the ends of both fragments.

Results

A total of 21 patients were included, among these 14 (66.67%) were males and 7 (33.33 %) were females with an average age of 44 years (range 20 to 80 years). In total 13 patients had femoral shaft fracture non-union, 5 patients had tibial shaft fracture non-union, 2 patients had humerus fracture non-union and one had radius/ulna fracture non-union. Mean duration from trauma to non-union was 15 months (Range 6 months to two years). All the patients were treated with chipping method. Mean follow up time was 09 months (range 06-12 months). K-Nail was used for 5 patients who had femoral fracture while plates were used for 9 patients having different fracture sites (4 femoral fractures, 2 tibial fractures, 2 humeral fractures, and 1 radial/ulnar fractures) (Table 1). Distal femoral locking plate was used in chipping method for 6 patients having femoral fractures while locking plate was used for 6 patients having different fracture sites (3 femoral fractures, 2 tibial fractures, and 1 humeral fracture) (Table 2). Bony union was obtained successfully

in 20 patients and one patient required second surgery for union due to type 2 diabetes mellitus and past smoking history.

Table 1: Use of multiple treatment modalities in different types of bones

Treatment modalities	Types of Bones				Total
	Femur	Tibia	Humerus	Radius/ Ulna	
K-Nail	5	0	0	0	5
Interlocking nailing (ILN)	2	1	0	0	3
Plates	4	2	2	1	9
Dynamic hip screw (DHS)	2	0	0	0	2
External-fixation	0	2	0	0	2
Total	13	5	2	1	21

Table 2: Outcome of chipping method (n=21)

Outcome	Number (percentage)
Successful bone union	20 (95)
Second surgery for union required	01 (05)
Knee stiffness	03 (14)
Limb length discrepancy	03 (14)

Table 3: Use of different types of implants in chipping method

Implants used	Types of Bones			
	Femur	Tibia	Humerus	Radius/Ulna
Inter locking nailing	2	0	0	0
Locking plate	3	2	1	0
Conventional plate	1	0	1	1
Proximal femoral locking plate	2	0	0	0
Distal femoral locking plate	6	0	0	0
Ilizarov external-fixator	0	1	0	0
Condylar blade plate	1	0	0	0

Total 3 (14.3%) patients got knee stiffness and 3 (14.3%) patients got limb length discrepancy less than 2cm (Table 3).No donor site morbidity or infection was detected. Mean duration from surgery to successful union was 13 weeks (range12-16 weeks) in femur and humerus, 16 weeks (12-20 weeks) in tibia and 14 weeks in radius/ulna.

Discussion

The objective of current study was to determine the outcome of chipping method in the treatment of long bones complex non-union with autologous bone graft. In chipping method, the surgeons chip the ends of both fragments of the non-union, producing pathways into the bone marrow. Autologous cancellous bone graft is taken from iliac crest and grafted in the non-union site and the prepared apertures of the chipped bone. This technique allows the bone marrow stem cells to be mobilized and the bone morphogenic proteins in the bone matrix to induce osteoinduction thus enhancing bone healing in non-union.[1,18] The chipping method appears similar to Judet and Patel's decortication technique, however in Judet and Patel's decortication technique, only surface of the bone is chipped off,[14,15] whereas in the chipping technique the entire thickness of bone is chipped, making intramedullary channels. In this technique, it is hypothesized that stem cells with ostegenic capacity migrate from bone marrow and bone morphogenic proteins, existing in the bone extracellular matrix, introduce into the fracture site and participate in the healing process.[18] Matsushita and Watanabe used chipping and lengthening technique in delayed union and non-union with shortening or bone loss.[16] They used external fixator for lengthening without using autologous bone graft. In the current study, autologous bone grafting and internal or ilizarov external fixation are used along with the chipping of non-union. Results of the current study showed that out of total 21 patients, bony union was obtained successfully in 20 patients while only one patient required a second surgery for the union. One patient in which chipping method was not successful had type 2 diabetes mellitus and also had past smoking history. Similar results were also reported by previous studies, which used chipping technique.[16,17]

Matsushita and Watanabe reported that five out of six nonunion with shortening or bone loss were successfully united by using chipping method.[16] Chipping technique is usually indicated in atrophic or oligotrophic aseptic nonunion with gap less than 4 cm because it gives good results and very less complications in these biologically less active non-unions.

It is very easy to perform and provides enhanced bone healing. Bone morphogenetic protein-7 has very good

results in terms of bone healing in non-union[19,20] but autologous bone grafting is still gold standard, useful and frequently used tool.[10,12] Bone autograft is the only graft material that has osteogenic, osteoinductive, and osteoconductive properties, which makes it an ideal graft material.[7,13] The iliac crest is the most common donor site for obtaining autogenous bone.[21] Though the majority of studies reported good results with autologous bone graft but it is associated with donor-site morbidity.[1,16] Major complications have been reported in approximately 10% of iliac crest harvest procedures,[8,22], however, no such donor site morbidity or infection was detected in current study.

In current study, 14.3% patients (n=3) got knee stiffness after surgery, while the previous study which used ilizarov fixator for the management of complex non-union of long bones reported knee stiffness was observed in 6% patients.[11] The high prevalence of knee stiffness in the current study can be explained by the fact that all these 3 patients who got knee stiffness were having poor compliance towards physiotherapy. Despite these complications, chipping method with autologous bone grafting is easy to perform and is an encouraging approach for enhancing bone healing in long bones complex non-union.

Conclusion

Chipping method with autologous bone grafting is easy to perform and is an encouraging approach for enhancing bone healing in long bones complex non-union.

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