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ORIGINAL ARTICLE

OUTCOMES OF CHIPPING & BONE GRAFTING IN COMPLEX NON-UNION OF LONG BONES

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ABSTRACT

Background: Non-union of fractures is the body's inability to heal the fracture. The objective of this study was to determine the outcome of chipping with bone grafting in complex non-union of bones.

Materials & Methods: This descriptive study was conducted in the department of Orthopedics, Khyber Teaching Hospital, Peshawar from June 2022 to January 2024. 103 patients admitted through OPD or emergency were included in the study. Data for the sample was defined by counts & percentages.

Results: At 6 months of follow up, 97(94.17%) patients achieved complete union & 6(5.82%) patients failed to achieve union & required further interventions. Five patients had Limb Length discrepancy of >2cm & 5 patients had knee stiffness in cases of Femoral non-union.

Conclusion: Chipping along with autologous bone graft is a very effective method in complex non-union of long bones. It is an easy & encouraging method for patients having non-union of long bones.

KEY WORDS: Nonunion; Bones; Deformity; Long bone; Grafting.

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INTRODUCTION

Non-union of fractures is the body's inability to heal the fracture. FDA defines the fracture that persists for minimum of 9 months without signs of healing for three months.[1] Non-union is divided into four types; Hypertrophic non-union, Oligotrophic non-union, Septic non-union & Atrophic non-union.[2] Non-union tend to occur in approx. 2% of all fractures & 20% of all diaphyseal fractures.[3] In UK the incidence of non-union is estimated as 20 per 100,000 population & males of working age group are the most common.[4] The prevalence of tibial shaft non-union is 10-12% & that of femur is approx. 8%.[5]

The non-union occurrence depends on several factors e.g., anatomic site (tibia its more common), fracture type (open fracture, comminuted fracture, high energy trauma & bone loss), patient habits (chronic smoker, alcohol abuse), chronic NSAIDs user or infection.[4,6] To aid in the healing of bones in fractures at the non-union site, a variety of substances are used in addition to mechanical stabilization of bone. These include bone grafting (Autograft & Allograft), bone substitutes (beta-tricalcium phosphate & hydroxyapatite), bone marrow aspirate from endosteal reaming, bone marrow concentrate & bone morphogenic proteins (BMP).[7,8] Autogenous bone graft is considered as most valuable option in non-union & has been in use for decades. Approx. 2 million bone grafting procedure are performed worldwide each year.[9,10] Bone grafting has osteoconductive, osteoinductive & even osteogenesis properties as well. Iliac crest is the most widely accepted source of bone graft having both cortical and cancellous bone. Both anterior & posterior iliac crests are an intrusive source of bone graft (approx. 30cc).[11,12]

Chipping is also one of the methods used in non-union of long bones. In this procedure both ends of the bone fragments are chipped in to small pieces. After chipping both ends of bone are approximated & shortening is done if required. This technique can be further aided with external fixators or Ilizarov for

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correction of LLD or deformities correction i.e., angulation or rotation as well.[13] Watanabe et al.[14] from Tokyo, Japan in their study found that 21 femoral non-union patients were managed with chipping & external fixator. All patients were completely recovered after one or two sessions of chipping. Aoki et al.[16] from Aichi, Japan in their case report found that 87 years old patient having bilateral femoral pain & radiolucent fracture lines in diaphysis had a complete union following IMN along with chipping. Matsushita et al.[13] in their study found union of five out of six cases with chipping technique without using bone graft.

Unawareness about the outcomes of chipping with bone grafting in complex non-union of bones was our research problem. Our research will help surgeons in the management of complex non-union of long bones. The objective of this study was to determine the outcome of chipping with bone grafting in complex non-union of bones.

MATERIALS & METHODS

This descriptive study was conducted in the department of Orthopedics, Khyber Teaching Hospital, Peshawar from June 2022 to January 2024. After taking approval from hospital ethical committee & informed consent from patients or attendants' study was conducted. All adult patients having age >15years & non-union of long bones, confirmed clinically by no signs of healing i.e., pain and movement at the fracture site for nine months and radiologically no signs of healing for 3 months i.e., radiolucent line at the fracture site were included in the study. The exclusion criteria comprised patients unfit for surgery, patients with pathological fractures or having gap non-union of >4cm. 103 patients admitted through OPD or emergency were included in the study.

All patients having complex non-union were operated with chipping and bone grafting with autologous cancellous graft. Appropriate fracture fixation technique was used including revision of implants & fixation. All patients were followed for at least 6 months postoperatively. In follow up visit's patients were evaluated for clinical markers of bone healing along with radiological signs of union. Data was analyzed using IBM-SPSS-V.25. Sex (men/women), age groups (≤ 40 years & >40 years) & types of bone involved in non-union were our qualitative variables & are described as MeanS.D. Categorical variables e.g., non-union of long bones & postoperative complications e.g., LLD, knee stiffness, contracture will be defined by counts and percentages.

Fig: Chipping in 38 years old male having femur non-union

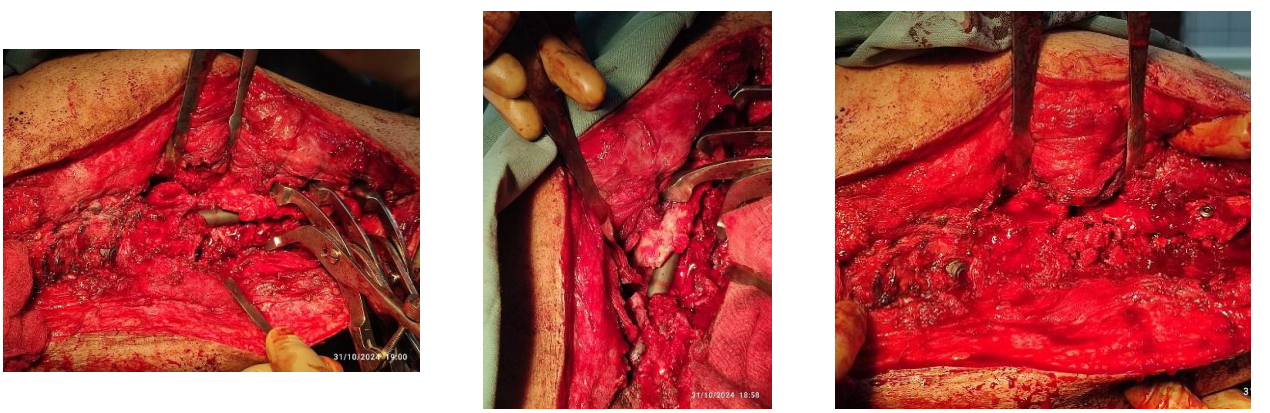

Fig: PFN along with chipping and bone graft in complex non-union of femur

RESULTS

Out of 103 patients, 89 (86.4%) were males & 14 (13.6%) were females. There were 60 (58%) patients >40 years old & 43 (42%) patients ≤ 40 years old. Mean age was 42.5 years. 60 patients had tibial non-union, 28 femoral non-union, 7 humerus non-union, 3 radius/ulna non-union, 3 had isolated radius & 2 had isolated ulna non-union. At 6 months of follow up, 97(94.17%) patients achieved complete union & 6(5.82%) patients failed to achieve union & required further interventions. Five patients had Limb Length discrepancy of >2cm & 5 patients had knee stiffness in cases of Femoral non-union.

Table 1: Outcomes of chipping method (n=103)

	Groups	Number (%age)	
Outcome	Union	97(94.17%)	
	Non-union	6(5.82%)	
	Complications	Knee stiffness	5(4.85%)
		LLD >2cm	5(4.85%)

Table 2: Various implants used in chipping method

Implants Used	Types of Bones involved				
	Femur	Tibia	Humerus	Radius	Ulna
Ilizarov	20	53	2	1	0
PFLP/ DFLP	6	2	0	0	0
ILN	2	5	0	0	0
DCP	0	0	1	5	5
Locking plate	0	0	4	0	0
Total	28	60	7	6	5

DISCUSSION

Non-union of long bones is a quite challenging & serious complication of fractures. The complications associated with non-union i.e., bone defect, shortening, deformity & infection further complicate the management.[15] The non-union incidence is 5-10% in long bone fractures. Fractures which fail to show healing radiologically after 3 to 5 months are treated by surgical intervention.[16] Atrophic non-unions are particularly difficult to treat as compared to hypertrophic types, due to lack of vascularization & significantly decreased number of activated mesenchymal cells.[17,18] Chipping with bones grafting is one of the effective methods in the treatment of complex non-union of long bones. In this method the surgeon chips the ends of non-union of both bones & an autologous cancellous bone graft taken form iliac crest is placed in between. It is hypothesized that in this technique stem cells having osteogenic capacity migrate from bone marrow which exist in extracellular matrix, participate in healing process. Cytokines such as Fibroblast growth factor (FGF) & Bone morphogenic protein (BMP) are also released from bone marrow.[13,19]

In our study it was found that at 6 months of follow up, 94% patients had union at fracture site both clinically and radiologically while 6 patients had no union & needed further intervention. Five patients developed knee stiffness & five patients had LL-D>2cm. The knee stiffness was present in patients operated through Ilizarov & its one reason was poor compliance of patients to physiotherapy.

In literature there were few studies available on management of non-union by chipping & bone graft method. Chipping method is indicated in atrophic or oligotrophic aseptic non-union with gap less than 4cm. Similar to our study, Watanabe et al.[14] from Tokyo, Japan in their study found that 21 femoral non-union patients were managed with chipping & external fixator. They found complete healing after one or two sessions of chipping. Matsushita et al.[13] in their study found union of five out of six cases with chipping technique without using bone graft.

CONCLUSION

Chipping along with autologous bone graft is a very effective method in complex non-union of long bones. It is an easy & encouraging method for patients having non-union of long bones.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	MI, MA
Acquisition, Analysis or Interpretation of Data:	MI, MA, MU, AK, SU, SA
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All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.