

## COMPARISON OF OUTCOME OF BONE AUTOGRAFT AND ALLOGRAFT IN UNION OF LONG BONE FRACTURES

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**Abstract. Background and Purpose:** There are few studies addressing the rate of application of bone allograft and its use; hence, the present study aimed to compare the clinical outcomes of using bone allograft and autograft in patients with long bone fracture.

**Method:** In this clinical trial study, all patients who underwent bone graft surgery with the diagnosed long bone fractures of upper and lower limbs at Shahid Beheshti Hospital were included in the research. Patients were divided into two groups, autograft and allograft, according to type of treatment. They were evaluated for their union, complications, and range of motion. **Results:** In the present study, 124 people were studied. Among them, 100 patients were eligible and included in the study. The allograft and autograft groups did not have any statistical significant differences in terms of age, sex, location, causes of fracture, and surgical methods. Results of the present research on patients in terms of fracture site indicated that there was no significant relationship between the two groups in rate of union ( $P = 0.18$ ). Allograft and autograft had no difference in terms of complications. Studied range of motion indicated that patients were not different in terms of their ranges of motion. **Conclusion:** Based on findings of the present study, allograft could be a suitable substitute for the autograft. The two graft methods were similar in terms of complications, union, and ranges of motion.

**Key words:** allograft, autograft, long bones, fracture, union

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## INTRODUCTION

**B**one graft means the removal of bone from a limb and transferring it to another limb for bone repair and health. Bone or bone-like materials are used in the limb graft. Bone graft, which is directly transplanted from the skeleton of a person into the person's own bone or into another person, is called autologous bone graft [1]. Compared with other tissues and organs, the skeletal system has a high potential for reconstruction. Bone fracture repair is along with a cascade of cellular events and biochemical factors that ultimately result in the reconstruction of the complete and functional structure of damaged skeletal system. Disruption of the repair process occurs in about 5-10% of fractures and causes the nonunion or delayed union [2]. The limb graft is now essential and inevitable. In this regard, the bone graft has a special place. In the United States, there were reported 6.2 million cases of fracture in 1999 [3]; and about 875,000 cases of bone graft were performed in 2001 [4]. Despite the fact that the autograft is the best choice from a variety of possible grafts, from various points of view, some conditions such as performing two simultaneous surgical procedures in one person, limited rate of graft, the probability of bleeding and increasing the likelihood of infection have attracted the attention to its proper substitution, namely allografts, so that the frequency of allograft use increased from 15,000 to 145,000 cases in the United States every year over a ten-year period from 1985 to 1995 [5, 6]. Bone grafts are used to accelerate the healing process in delayed healing, two-piece suture, osteotomies, arthrodesis and multiple fractures, and substitute of some pieces that are removed with the tumor. There are wide range of methods for accelerating the bone repair and filling bone defects. Autogenous bone grafts are rich in bone formation cells and have substances which induce bone formation in the site and also provide scaffolds at the fracture site where blood vessels and osteoblast cells penetrate and work. Autogenous bone graft is a golden standard for bone replacement because there is minimum possibility of immunological problems and there is a complete histopathological compliance. This type of bone graft plays all three roles, osteogenesis, osteoconductive and osteoinductive roles that repair bones. Autograft often contains osteogenic cells and a bone matrix protein and provides sufficient growth conditions for the skeletal system [7, 8]. As mentioned, the allograft can be used due to the limitations of the autograft. Allograft, which is made of cadaver, has osteoconductive and osteoinductive roles among the three roles of repair, but its main advantage is the possibility of preparation in different shapes and sizes, and it can

well cover bone defects [8, 9]. The removal of bone grafts requires additional surgery at the site (usually iliac corsets, distal femur and proximal, and distal tibia) and the additional surgery can lead to additional complications including infection, chronic illness and prolongation of operation. However, there is still controversy about the potential role of allograft in transmitting infectious diseases. Therefore, the present study aimed to compare results of bone allograft and autograft in patients with long bone fracture.

## MATERIALS AND METHODS

In the present clinical trial study, all patients, who underwent bone graft surgery due to the diagnosed upper and lower limb bone fractures in Shahid Beheshti Hospital, were included in the research. After confirming the research by the Research Council and the University's Ethics Committee, it was recorded with the code IRCT20160508027797N3. The research inclusion criteria included the patients' satisfaction with participation in the study; lack of genetic disorders and other skeletal deformities in organs with effects on research results; lack of systemic disease such as diabetes; no bone disease such as bone cyst; no brain trauma, metabolic disease, and diaphyseal closed fractures of long bones without any general or specific bone underlying disease. The exclusion criteria included the non-timely referral to orthopedic clinics for therapy follow up.

Patients were randomly divided into two groups, autograft and allograft, according to the type of treatment. The two groups were matched according to age and sex. After treatment, open reduction and internal fixation were done with appropriate bone graft including autograft from the patient's own cancellous iliac wing during the operation. Cancellous allograft chips (Kish Company) were utilized. All patients were operated by a surgical team; radiological interpretation was performed in all cases by a surgeon and a radiologist. The amount of embedded graft was calculated according to the need and amount of defect, and it was then placed in site after fracture stabilization. Patients were examined and compared in terms of union rate using clinical examinations including measuring the patients' ranges of joint motion and pain using the visual analog scale (VAS) and repeated radiographs during 6 months. They were also evaluated in terms of complications such as infection and deformity of graft site and probable vascular and neuropathic damages. Data was analyzed by SPSS V.22. Chi-square and T tests were used; and p-value of less than 0.05 was considered as the significance level.

## RESULTS

In the present study, 124 patients were studied. Among them, 100 participants were eligible and were thus included in the study. The participants' mean age was  $37.62 \pm 13.66$  years (the minimum age was 15 and the maximum age was 78). Table 1 presents basic characteristics of patients with long bone fractures.

Based on the analysis, allograft and autograft groups did not have any statistical significant difference in terms of age, sex, location and cause of fracture and surgical methods (Table 1).

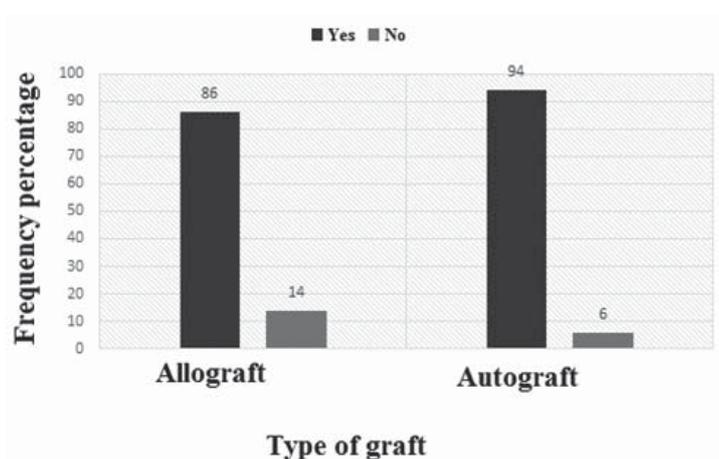
The results of the study showed no significant difference between the two groups in terms of rate of union in the fracture site ( $p = 0.18$ ).

In the present study, patients were examined in terms of complications in both groups. According to results of the following table, allograft and autograft were not significantly different in terms of complications. Morbidity was not observed in any group.

The existence of hematoma in the bone graft site with a frequency of 5 cases (10%) was the most important complication of autograft group. Furthermore, 2 patients (4%) in the autograft group had pain at the autograft site.

**Table 1.** Comparison of basic characteristics between the two groups

Variable	Allograft Number (percent)	Autograft Number (percent)	P value
Gender			
Male	33 (0.66)	24 (0.48)	0.10
Female	17 (0.34)	26 (0.52)	
Age group (year)			
Under 30	22 (0.44)	14 (0.28)	0.21
31-50	22 (0.44)	26 (0.52)	
≤ 51	6 (0.12)	10 (0.20)	
Fracture site			
Ulnar	1 (0.2)	3 (0.6)	0.50
Tibia	3 (0.6)	8 (0.16)	
Femur shaft	31 (0.62)	26 (0.52)	
Femur	4 (0.8)	2 (0.4)	
Shaft of humerus	6 (0.12)	7 (0.14)	
Subtrochanteric	5 (0.10)	4 (0.8)	
Cause of fracture			
Crash	45 (0.90)	39 (0.78)	0.32
Fall	2 (0.4)	4 (0.8)	
Fall from height	3 (0.6)	7 (0.14)	
Surgical procedure			
Plating	39 (0.78)	40 (0.80)	0.80
Intramedullary nail	11 (0.22)	10 (0.20)	



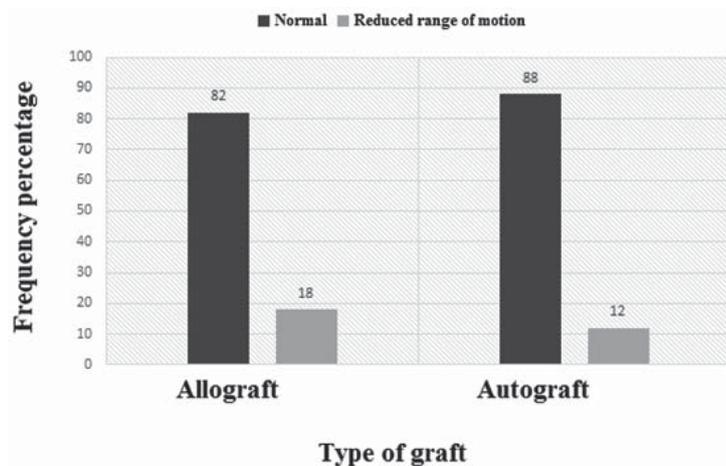
**Fig. 1.** Comparison of rate of union in allograft and autograft

**Table 2.** Comparison of allograft and autograft in terms of complications

Variable	Allograft Number (percent)	Autograft Number (percent)	P value
Infection			
Yes	6 (0.12)	4 (0.8)	0.74
No	44 (0.88)	46 (0.92)	
Swelling			
Yes	47 (0.94)	44 (0.88)	0.48
No	3 (0.6)	6 (0.12)	
Pain			
Yes	11 (0.22)	10 (0.20)	0.80
No	39 (0.78)	40 (0.80)	
Lameness			
Yes	4 (0.8)	6 (0.12)	0.50
No	46 (0.92)	44 (0.88)	
Neurovascular injury			
Yes	2 (0.4)	1 (0.2)	0.55
No	48 (0.96)	49 (0.98)	

As presented in the above table, patients were not different in allograft and autograft groups in terms of complications.

According to the examination of patients' ranges of motion with long bone fracture treated with allograft and autograft, it was found that patients were not different in terms of range of motion (Fig. 2).



**Fig. 2.** Comparison of range of motion in allograft and autograft groups

## DISCUSSION AND CONCLUSION

The present study aimed to compare results of bone autograft and allograft in bone fracture union. Various analyses and evaluation of sub-purposes indicated that the bone autograft had no difference with allograft in terms of complications, union, and range of motion. Based on the research results, the allograft can be used instead of autograft. Since the non-union

and lack of local bone are serious problems in the treatment of trauma patients with long bone fractures, the use of bone grafts is essential for higher stabilization and biological repair [10]. The rate and speed of union and return to everyday activity are important in treating patients with bone fractures. The autograft and allograft are now applicable in fractures; and autograft selection has difficulty due to complications and limitation of bone density. Since the selection of appropriate bone grafts can be the key to success in treatment, comparing two types of graft in terms of complications, morbidity, pain, ranges of motion, and union rates were strengths of the present study. Moreover, there are very few studies in Iran and abroad addressing these issues. Therefore, it can be claimed that comparison of results of autograft and allograft in the long bone fracture union in a region in the north of Iran was among the first studies in this field, which is strength of the present study.

In the present study, the rate of union in patients with autograft was slightly higher than allograft (94% to 86%), but the insignificance of this difference indicated that allograft was not significantly different from autograft in terms of union rate. According to this finding, allograft can be replaced by autograft in many cases because the rate of union is the most important feature in the selection of graft in spite of risk of complications [11] and it ultimately leads to patient recovery and return to normal activity.

Vining et al. (2012) compared the allograft and autograft in children with leg surgery in 2012 and found that the use of allograft was very safe, cost effective, and efficient. They reported that the non-union was 0.5 percent in patients with allograft [12]. In the present study, the total non-union was 6% in the allograft. The emergence of non-union depends on several factors. Causes, which make a difference in the non-union in a study by Vining and the present study, include the patient age because Vining et al. studied the children population; and their union rates and speed were higher due to their lower age. Generally, bone graft in orthopedics is generally performed for the treatment of non-union, delayed union, and filling bone cavities. The bone autograft is now the best choice for bone repair, but its complications have limited its use [13]. Results of the present study provide a new perspective on the choice of type of graft in the field of bone fractures because the allograft can be used instead of autograft due to its non-difference from autograft in different indices. However, further investigation is necessary to generalize this finding to a larger population and a definite

opinion to be formed. Based on experimental studies on animal models, which can be generalized to humans, the formation of blood vessels in the bone allograft begins after bone union from the patient's bone joint to the host and progresses over several years, and becomes stabilized over time [14]. Peyvandi et al. used allograft for treating open femoral fractures and presented results as case reports. They stated that the use of large bone allografts is used in bone reconstruction surgery and can be effective [15]. Samartzis et al. conducted a study for comparing allograft and autograft in neck disks. They found that the non-union was less seen in patients with allograft; and the difference of allograft and autograft was not significant [16]. The result was consistent with results of the present study. Grier et al. also reported that the use of allograft plus platelet-rich plasma (PRP) could lead to better repair and reduced complications in treatment of sole deformity [17]. The rate of union was 86% in the allograft in the present study; 85% in a study by Xu et al.; 94.7% in a study by Kong et al.; and 92% in a research by Sedighi et al. [1, 18, 19]. In general, the fracture union was 85%-90% in studies on allografts; and it was 98% in a study by Grier et al. due to the allograft combination with platelet-rich plasma [17].

Based on results of the present study, the allograft was not significantly different from autograft in terms of infection and swelling, pain, and lameness in patients after surgery. The low rate of complications is an important feature in choosing the right graft [20]. Despite the fact that autograft is currently an ideal graft and is able to bind chemically to the bone surface without fiber tissue interference, has the ability to stimulate bone growth on its surface, to differentiate original bone formation cells from the surrounding tissue and form new bones by osteoblastic cells in graft [21], the use of suitable substitutes is taken into account because of limited amount of bone density and the risk of post-operative infection and transmission of diseases. Major complications of autograft, which are mainly due to the proximity of vascular and nervous system, include false aneurysm of pelvic vessels, arteriovenous fistula, loss of large amounts of blood, pelvic instability as the back pain, unattached anterior superior iliac spine (ASIS), urinary tract damage, hernia and neuropathy [22]. In general, none of these side effects occurred in the present study.

Milder complications include neurovascular injury, permanent unpleasant feelings, localized complications of wound such as infection and hematoma formation [23]. In the present study, 10% of patients had hematoma in autograft and 4% had pain. A strength of the present study was that we evaluated the amount

of lameness in both groups after surgery. The findings indicated that 40% of patients with allograft and 60% with autograft reported leg lameness. It can be concluded that the two types of graft are not different.

The ranges of motion in patients with allograft and autograft were also investigated in the present study. The results indicated that patients with allograft were similar with autograft in ranges of motion of joints. In terms of reviewed ranges of motion in patients with fractures, allograft seems to be a better choice because two simultaneous surgical procedures on a person and the probability of bleeding prolong the hospitalization time and consequently increase the patient's inactive time. All of them attracted the special attention to a proper alternative, the allograft. It should be noted that final clinical outcome of treated patients with grafts depends on the non-union site and spent time of the initial trauma and the ways of stabilizing the fracture and non-union [24].

Based on findings of the present study, the allograft can be an appropriate alternative for autograft. Both graft methods were similar in terms of complications, union rate, and ranges of motion of joints.

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