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by Tri Wahyu Martanto

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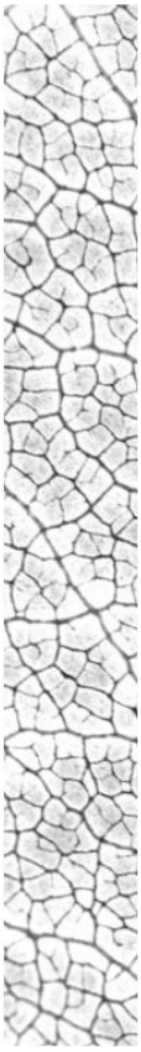

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The evaluation of chip freeze-dried cancellous bone allograft of local products usage as a scaffold in completing small defects on long bone

Tri Wahyu Martanto [1], Ronald Vinantius Munthe [1], Heri Suroto [1], Sulis Bayusentono [1], Aries Rakhmat Hidayat [1], Ferdiansyah [1*]

[1] Department of Orthopedic and Traumatology, Faculty of Medicine, Universitas Airlangga - Dr. Soetomo Regional Public Hospital, Surabaya 60131, INDONESIA
*Corresponding author: ferdiansyah@fk.unair.ac.id

Abstract

Background: Bone graft as a therapeutic modality for bone defects reconstruction has been widely applied. Bone autograft is the optimum comparative standard for each substitute material, but can still cause complications and limited availability. Bone allograft has long been used as a natural substitute material for bone autograft. Chip freeze-dried bone allograft is one of the allograft's types available in various shapes and sizes, so it has the capability of filling the gaps of bone defects precisely. **Purpose:** This study aims to evaluate the achievement of chip freeze-dried bone allograft in completing small bone defects compared to bone autograft. **Method:** The researchers recapitulated the data of 10 patients with bone autograft, and chip freeze-dried bone allograft and evaluated the outcome of applying bone repair by utilizing Hammer classification on bone defects healing. The collected data were then examined statistically with the Mann-Whitney Test. **Results:** In the autograft group, 70% of radiological evaluations were mostly obtained from grade 2 Hammer classifications. While, in the allograft group, the highest results were obtained in grade 3 Hammer classifications, those were 40%. Statistical tests indicated that there was no significant difference in bone healing between the bone autograft and the bone allograft groups (p=0.579). **Conclusion:** Bone, in both groups (bone autograft and chip freeze-dried cancellous bone allograft), has the same results in terms of the healing process.

Keywords: bone allograft, bone autograft, small defect, long bone

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INTRODUCTION

In general, fracture bones can heal themselves naturally; however, that ability can be disrupted in a state of severe trauma along with bone and soft tissue defects. Bone defects occur due to bone fragments extrusion during trauma or after debridement in open fracture cases, where the damaged bone is removed (Nayagam, Warwick, & Solomon, 2010. Nather, Yusof, & Hilmy, 2010. Utomo, et al. 2019; Singh, & Issac, 2018).

Therapeutic modalities for reconstruction bone defects have been widely applied, and it can save fracture limbs more. Local bone transportation by the Ilizarov method is one of the therapeutic modalities that has been broadly used. This method has a fairly high success rate with a low deformity rate; however, it also has a significant risk of complications. Another disadvantage is that this technique requires repeated intervention (Buckwalter, Einhorn, Simon, 2000. Miller, 2008. Delloye, et al. 2007. Bullens, P. H. J. 2011). Other modalities that can be employed are bone graft consisting of autograft (bone taken from the patient's body), allograft (bone taken from another person of the same species) and xenograft (bone obtained from animal's body or different species). Bone autograft is the optimum comparative standard for each substitute material. However, limited availability and donor site morbidity are the barrier of utilizing this material (Nather, Yusof, & Hilmy, 2010, Delloye, et al. 2007. Buckwalter, Einhorn, Simon, 2000).

Bone allograft itself has long been used as a natural substitute material for bone autograft, which has limited availability. Bone allografts can initiate a healing response from the recipient base surface to produce new bone on the host-graft surface and in the allograft pores. Besides, the recipient base surface vascularization and mechanical stability are also

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Table 1. Radiographs of Fracture Healing Classification According to Hammer Classification

Grade	Radiological assessment		
	Callus formation	Fracture line	Stage of Union
1	Homogeneous bone structures	Obliterate	Achieved
2	Massive, Bone trabeculae crossing fracture lines	Barely discernible	Achieved
3	Apparent, Bridging the fracture lines	Discernible	Uncertain
4	Trace, Did not bridge the fracture lines	Different	Not achieved
5	No callus formation	Different	Not achieved

Table 2. Radiological Assessments of Healing Bone Defects According to Hammer Classification

	Hammer Classification					Total
	Definitely Union	Likely Union	Moderate	Likely Non-Union	Non-Union	
Autograft	2 (20%)	7 (70%)	1 (10%)	0	0	10 (100%)
Allograft	3 (30%)	3 (30%)	4 (40%)	0	0	10 (100%)
Total	5	10	5	0	0	20

Table 3. Statistical Test Results

	N	Mean	Deviation Standard	P
AutoGraft	10	1.90	0.568	0.579
AlloGraft	10	2.10	0.876	

important. In optimum integration of the graft, the recipient base surface should comprise sufficient pre-osteogenic and osteogenic cells or should enhance other cell sources such as autograft bone marrow. The base surface should be prepared to drain blood through the bone. Host-graft contact should be stable to enable the blood vessels growing into the graft (Greenwald, et al. 2001. Bullens, 2011. Buckwalter, Einhorn, Simon, 2000. Greenwaldet al. 2001).

The allograft use increased significantly as its function to cover bone defects in the cases of bone loss trauma or bone tumor resection (Nather, Yusof, & Hilmy, 2010. Delloye, et al. 2007. Matejovsky, Matejovsky, Konfranek, 2006)., Freeze-drying is one of the methods for creating the allograft. Allograft which is processed through freeze-dried technique, is biomechanically weaker than other methods such as deep-frozen allograft. Allograft has an ability to complete the gaps of bone defects and not to form the bone structure that sustains the body burden (Nayagam, Warwick, & Solomon, 2010. Nather, Yusof, & Hilmy, 2010. Canale, & Beaty, 2008. Borjian, Nazem, & Yassine, 2006. Lavernia, et al. 2004).).

Under those circumstances, it is necessary to evaluate the achievement of chip freeze-dried bone allograft in completing small bone defects. This study evaluates the patients who received chip freeze-dried bone allograft obtained from Tissue Bank of Dr. Soetomo Regional Public Hospital, Surabaya.

METHOD

In this study, two sample groups were unpaired and obtained from the patients who were operated using chip freeze-dried bone allograft and bone autograft with ten samples of each group. The samples were taken randomly based on the criteria of patients with bone defects following osteomyelitis, osteotomy, and bone defect trauma.

The main data of this study were patients who had been operated using chip freeze-dried cancellous bone allograft and bone autograft. Medical record tracing was conducted after the data recapitulation was obtained, then the researchers evaluated the patient's outcome. Patients' healing results radiologically after giving the auto bone graft, and chip freeze-dried cancellous allograft would be assessed according to Hammer Classification, by assessing the callus and fracture lines.

The radiological assessment interpretations of **Table 1** were; grade 1 fracture healing was union, grade 2 fracture healing was union, grade 3 fracture healing was intermediate, grade 4 fracture healing was non-union, and grade 5 fracture healing was also non-union. After collecting and analyzing the data, the statistical test was performed by following the Mann-Whitney Test.

RESULTS

The results of radiological assessment based on Hammer classification on bone defects healing could be seen in **Table 2**. Based on **Table 2**, the highest value of radiological evaluation in the autograft group was on grade 2 Hammer classification. On the other hand, in the allograft group, the highest value was obtained on grade 3 Hammer classification.

This study compared the process of bone healing in both two groups by evaluating it with Hammer Score. The Mann Whitney test was preferable since the data were ordinal. Statistical tests indicated that there was no significant difference in bone healing between the bone autograft and the bone allograft groups (p=0.579).

DISCUSSION

The results of postoperative radiological evaluation utilizing Hammer Classification indicated that there was no significant difference between bone healing using bone autograft and chip freeze-dried cancellous bone allograft. Based on statistical tests, it was found that the bone healing process between the bone autograft and

the bone allograft groups showed no significant difference (p=0.579).

There were some differences from several studies that had been conducted before. The previous retrospective studies in 2013 involving 182 patients indicated that in the bone healing process from both groups, there was a significant difference where the auto bone graft group was better (Flierl, et al. 2013).). Another supporting study was conducted in 2006, which employed a cancellous allograft for distal radius comminuted fractures. The result indicated that utilizing a cancellous allograft and auto bone graft had no significant difference in terms of healing (Rajan, et al. 2006).).

Union was the end-point of fracture healing. The bone healing process could be achieved if there were no mechanical problems from fracture fragment fixation and biological problems from the tissue around the fracture fragment. Fractures with small bone defects could interfere with the bone healing process even though there were no mechanical or biological problems at all. The gap (cleft) between bone fragment could cause delayed healing or even non-union because of the large strain ratio between fracture fragments. Bone graft had a function as a gap filler that facilitated bone formation in the fractures with small bone defects. (Widiyanti, 2016).). When the bone graft reached the bone surface, the distance between bone fragments became smaller. Stable fixation and the small gap between bone fragments would reduce the strain ratio in the fracture gap so that bone could heal precisely.

Auto bone graft and chip freeze-dried cancellous bone allograft had different characteristics. Autograft had three characteristics of osteoinductive, osteoconductive, and osteogenesis, whereas allograft only had osteoconductive and osteoinductive characteristics (Nather, Yusof, & Hilmy, 2010).). Progenitor cells occurred in the osteoinduction process, where osteoblasts would form a new bone. Allograft osteoconduction characteristics would act as a scaffold for the skeletal of bone-forming. Both of these processes worked together in providing optimal components and environments for the bone's natural healing process (Nayagam, Warwick, & Solomon, 2010).

CONCLUSION

The results of postoperative radiological assessment from 10 samples in each group utilizing Hammer Classification indicates no significant difference in bone healing process between the group receiving bone autograft and the group receiving chip freeze-dried cancellous bone allograft. Bone, in both groups (bone autograft and chip freeze-dried cancellous bone allograft), has the same results in terms of the healing process.

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