

# Comparison of Outcomes of Membranous With Endochondral Bone Graft in Orbital Floor Reconstruction

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## Abstract

**Objective:** To compare membranous with endochondral bone graft in orbital floor reconstruction in terms of donor site hematoma and correction of postoperative diplopia. **Study Design:** Randomized clinical trial. **Place & duration of study:** Department of Oral & Maxillofacial Surgery, King Edward Medical University / Mayo Hospital Lahore. One year from 01-07-09 to 30-06-10. **Material and Method:** 58 patients clinically and radiographically having defect in the orbital floor due to trauma were included in the study. According to the treatment, patients were randomly divided into two groups by lottery method. Group A (29 patients) received the membranous bone graft from calvarium and Group B (29 patients) received the endochondral bone graft from anterior iliac crest. The variables to be analyzed were donor site hematoma and post-operative diplopia. **Results:**

Group A consisted of 29 patients (mean age 30.31 years  $\pm$  11.41) and Group B consisted of 29 patients (mean age 29.6 years  $\pm$  9.05). Donor site hematoma developed in 3 (10.3%) patients in Group A and in 9 (31.0%) patients in Group B. In Group A, postoperative diplopia persisted in 2 (6.9%) patients and in Group B, it persisted in 5 (17.2%) patients. Chi-Square test was used to compare the variables in both groups and the results were statistically significant for donor site hematoma (p value: 0.026) but insignificant for postoperative diplopia (p value: 0.113). **Conclusion:** Membranous bone graft is better than endochondral bone graft in terms of donor site hematoma. When it comes to the correction of postoperative diplopia, there is no difference between two types of bone graft. **Key Words:** Orbital floor reconstruction, Post-operative diplopia, Donor site hematoma.

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## INTRODUCTION

Fractures in and around the orbit are common. They vary from simple zygomatic fractures to complex craniofacial injury involving the orbital rim and several orbital walls. The important aspect of orbital injury is their intimate relationship with the globe, periorbital soft tissues, eyelids, sinuses, brain and the lacrimal apparatus. Some injuries may lead to loss of vision.<sup>1</sup> Orbital floor fractures are one of the most common components in patients with mid-face trauma.<sup>2</sup> The etiology is sports related 41.7%, traffic related 20.0%, violence related 10.0%, work related 13.3% and from other reasons 15%.<sup>3</sup> Various materials such as autogenous bone, cartilage and alloplastic implants have been used to reconstruct orbital floor.<sup>4</sup>

For the reconstruction of extensive craniofacial bony defects, autogenous bone is the material of choice because of its potential for revascularization and its osteoconductive and osteoinductive properties.<sup>5</sup> Alloplastic materials have also been gaining popularity for reconstruction of the internal orbit because of their ease of use and the fact that they involve no donor site morbidity. However alloplastic materials should be used with caution, because some of them can provoke unpredictable foreign body reactions.<sup>6</sup>

Bones are of two types embryologically; Membranous bones and Endochondral bones. Membranous bones are formed by intramembranous ossification in which embryonic mesenchymal cells differentiate directly

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into osteoblasts that synthesize a collagenous osteoid. The osteoid then becomes hard bone after undergoing mineralization by calcium phosphate. Endochondral bones are formed by endochondral ossification whereby cartilage growth occurs at an epiphyseal surface which is then replaced by osteoid that eventually becomes mineralized.<sup>7</sup>

The membranous bone graft is most commonly taken from calvarial bone and symphysis of mandible. Membranous bone harvested from outer table of calvaria is curved in two dimensions, therefore fit neatly into defect such as orbital floor and zygomatic prominence. Cranial bone graft produces less donor site morbidity compared with other sites, non-visible scar as the incision is placed within the hair-bearing skin. However, density of bone makes it very difficult to mould. The membranous bone has been shown to undergo less resorption, greater graft volume survival and is an ideal bone graft in orbital floor reconstruction.<sup>8</sup>

Of the endochondral bone grafts, rib and iliac crest are the most commonly used free grafts. These grafts have an advantage of easy harvest and can be shaped easily to fit many defect. However these bone grafts undergo more resorption. Iliac crest grafts provide an abundant supply of cancellous bone and inner or outer cortex may provide appropriate contour. The disadvantages include limited supply of cortical bone, postoperative pain and hematoma, acetabular injury, fascia lata clicking, and pain with paresthesias if injury to lateral femoral cutaneous nerve occurs.<sup>9, 10</sup>

Thus source of bone graft appears to be the most important factor when choosing a graft for reconstruction. The study is aimed to find out which of the two types of bone grafts; membranous or endochondral should be preferred for orbital floor reconstruction, thus reducing the complication.

## **PATIENTS & METHOD**

Approval from Hospital Ethical Committee was taken prior to conduct of study. 58 patients presented at Oral & Maxillofacial Surgery Department Mayo Hospital Lahore and meeting the inclusion criteria were included in this study. Patients having clinical and

radiographic defect also with diplopia and enophthalmos were included in the study. Patients medically unfit for surgery under general anesthesia or having ipsilateral or contralateral vision were not included in the study.

After taking complete history, thorough clinical and systemic examination was carried out. To evaluate the extent of defect following investigations were performed, X-ray water view or PNS view, Coronal & axial sections of Computed tomography (CT) scan, three dimensional reconstruction and volumetric assessment according to situation.

After explaining the outcome of surgical procedures to every patient included in this study an informed consent was taken before the surgical procedure. According to the treatment, patients were randomly divided into two groups by lottery method: Group A, patients received membranous bone graft from calvarium and Group B, patients received endochondral bone graft from anterior iliac crest.

Donor site hematoma was assessed by development of tense swelling at donor site which may or may not be purplish red in colour in first 72 hours postoperatively. Postoperative diplopia was present if patient has double vision on any of the following gazes; superior, inferior, medial, lateral, supromedial, infromedial, suprolateral and infrolateral on diplopia test 3 weeks postoperatively. All the observations were entered on preformed proforma.

## **DATA ANALYSIS**

Data was entered & analyzed by using SPSS version 10.0. Mean and standard deviation were calculated for quantitative variables like age. Qualitative data like gender, donor site hematoma and postoperative diplopia were presented as frequency and percentages. Chi-square test was used to compare the donor site hematoma and postoperative diplopia. P value < 0.05 was considered significant.

## **RESULTS**

In our study male gender predominates over female. 48/58 (82.75%) patients were male and 10/58 (17.24%) patients were female. In group A, out of 29 there were

23 male and 06 female patients. While in group B, there were 25 male and 04 female patients (Table 1). The age ranged from 12 to 54 years with mean age of 30 years  $\pm$ 10.21. Male had the mean age of 30.20 years  $\pm$  10.26 while female had the mean age of 29.90 years  $\pm$  10.53. In group A, the mean age was 30.31 years  $\pm$  11.41 with range from 12 years to 53 years. Male had the mean age of 29.26 years  $\pm$  11.72 and female with the mean age of 34.33 years  $\pm$  10.01. In group B, the mean age was 29.6 years  $\pm$  9.05 with range from 14 to 54 years. Male had the mean age of 30.64 years  $\pm$  8.95 and female with the mean age of 23.75 years  $\pm$  8.26 (Table 2).

Donor site hematoma (DSH) was checked in first 72 postoperative hours first at 4 hours interval for 24 hours then at 6 hours interval for next 48 hours. Out of 58 patients; 12 developed DSH (Table 13). In group A, out of 29 patients; 3 patients developed DSH. In group B, out of 29 patients; 9 patients developed DSH (Table 3).

Immediate post operatively diplopia was checked following the completion of procedure. Out of 58 patients; 48 patients showed satisfactory results. In group A, 26 patients out of 29 showed satisfactory results. In group B, 22 patients out of 29 showed satisfactory results.

At follow up visit, 3 weeks postoperatively, out of 58 patients; 51 showed satisfactory results. In group A, 27 patients out of 29 patients showed satisfactory results. In group B, 24 patients out of 29 showed satisfactory results (Table 4).

**Table-1**  
**Distribution of patients by gender**

Bone Graft	Gender	Frequency	Percent
Membranous	Male	23	79.3
	Female	6	20.7
	Total	29	100.0
Endochondral	Male	25	86.2
	Female	4	13.8
	Total	29	100.0

**Table-2**  
**Distribution of age by gender**

Sex	Bone graft	Age	n	Minimum	Maximum	Mean with Std. Deviation
Male	Membranous	Age	23	12.00	53.00	29.2609 $\pm$ 11.7249
	Endochondral	Age	25	17.00	54.00	30.6400 $\pm$ 8.9577
Female	Membranous	Age	6	18.00	45.00	34.3333 $\pm$ 10.0133
	Endochondral	Age	4	14.00	34.00	23.7500 $\pm$ 8.2614

**Table-3**  
**Distribution of patients by donor site hematoma**

Bone Graft		Frequency	Percent
Membranous	Absent	26	89.7
	Present	3	10.3
	Total	29	100.0
Endochondral	Absent	20	69.0
	Present	9	31.0
	Total	29	100.0

p-value (1-sided): 0.026

**Table-4**  
**Distribution of patients by postoperative diplopia**

Bone Graft		Frequency	Percent
Membranous	Absent	27	93.1
	Present	2	6.9
	Total	29	100.0
Endochondral	Absent	24	82.8
	Present	5	17.2
	Total	29	100.0

p-value (1- sided): 0.113

## DISCUSSION

Most of the studies about the treatment of orbital floor fractures remained controversial and have not been designed adequately to provide meaningful comparison. Also statistics available related to orbital floor fractures have mostly been surveyed in developed countries and much of the demographic information on maxillofacial injuries that appears in English language journal comes from USA, England, Netherlands and Scandinavian countries. However, with in light of limited work in the literature and this study, relatively satisfactory results regarding donor

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site hematoma can be achieved with orbital floor reconstruction with membranous bone graft.

Reconstruction of the orbital floor with bioresorbable materials is a controversial subject. None of the materials has yet proven to be successful without any complications in clinical work. One of the main issues is the maintenance of the initial three dimensional shape of the implant. To achieve this, the implant need to resist coiling and deformation, and to be strong enough to tolerate the pressure exerted by the orbital content without being passively moulded. It should also be biocompatible. The ideal material should have biological and physiological properties that replicate those of the tissue it replaces. The material should be permanently accepted by the host, unless the implant material degrades completely within the acceptable time limit. The result of two different types of material used for orbital floor reconstruction, one membranous bone graft and second endochondral bone graft, were assessed in our study. In our study male gender predominates over the female. It is consistent with previous studies. In a study carried by Zhu et al in 2001 male gender predominated.<sup>11</sup> In another study carried by Sakakibara et al in 2009 male gender predominated.<sup>9</sup> Jaquierey et al in 2007 carried a study on 72 patients and out of these 65 were male.<sup>12</sup> In our study most of the patients fell in the third and fourth decade of life. It is consistent with the literature. In a study carried by Sakakibara et al in 2009 mean age of the patients was 26 years.<sup>9</sup> In another study carried by Kosaka et al in 2004 most of the patients were in third and fourth decades of life.<sup>13</sup>

Patients who experience true diplopia naturally are troubled by this symptom and nearly always present this as their chief complaint. Basically diplopia may be monocular or binocular. The three most common hypotheses for binocular double vision and impaired eye movement are different eye ball level of both eyes, contusion injury to the extraocular muscles or soft tissue and incarceration of these structures to the fracture line.<sup>14, 15</sup> Our patients, in most of the cases, had double vision and limitation of movements in upward gaze. This can be explained by mechanisms mentioned in previous paragraph. CT scan has been reported to be sensitive for orbital fat, orbital muscles and hematoma.<sup>16, 17</sup>

In the present study all these structures were clearly visualized by CT scan. On the intact orbital floor the

orbital fat faced the straight bony floor. Therefore the flat inferior rectus muscle was well visualized leaning on the orbital floor. On the fractured side the orbital fat protrude as a round mass into the maxillary sinus. The inferior rectus muscle was considerably rounded compared to flat shaped muscle at the uninjured site, giving an impression of being edematous. When preoperative CT taken from the same fracture was compared with postoperative CT no trap door fracture or muscle incarceration was documented and neither was seen. In our study, results regarding donor site hematoma were better with membranous bone graft as compared to endochondral bone graft. Both frequency and statistical analysis by chi-square test proved to be significant. This is consistent with previous studies. Cheney et al in 1995 carried a study on 35 patients using membranous bone graft and only 8% of them developed donor site hematoma.<sup>18</sup> In a study carried by Zhu et al in 2001 on 34 patients using membranous bone graft none of the patients developed donor site hematoma.<sup>11</sup> In a study carried by Niedhart et al in 2003 using endochondral bone graft 34.3% patients developed donor site hematoma.<sup>19</sup> Seiler et al in 2000 carried a study on endochondral bone graft from iliac crest and found that donor site hematoma is 10%.<sup>20</sup> There is a study which contradicts our results regarding donor site hematoma using endochondral bone graft as well. Takashi et al in 2000 performed a study on 94 patients regarding the development of donor site hematoma after iliac crest graft and found that only 1.1% patients suffered with it.<sup>21</sup>

According to our study apparently it looks that patients treated with membranous bone graft have shown more satisfactory results in terms of postoperative diplopia than the patients treated with endochondral bone graft. But when we analyzed our results statistically using chi-square test there appeared to be no difference between two types of bone grafts in correction of postoperative diplopia. Some studies favor and some contradict our results. Following studies favor our result; Siddique et al in 2002 performed a study on comparison of membranous with endochondral bone graft on 22 patients and found no difference between the two types of bone graft in correction of postoperative diplopia.<sup>22</sup> In a study carried by Kontio et al in 2006 on 24 patients treated with endochondral bone graft no postoperative diplopia is seen.<sup>10</sup> Following studies contradict our results; Zhu et

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al in 2001 carried a study using membranous bone graft for orbital floor reconstruction on 34 patients and found that diplopia is corrected in all patients.<sup>11</sup> Sakakibara et al in 2009 carried a study on 101 patients using endochondral bone graft and found that diplopia is persistent postoperatively in 15 patients.<sup>9</sup>

## CONCLUSION

The following conclusion can be drawn from the results obtained in our study: Membranous bone graft is better than endochondral bone graft in terms of donor site hematoma. When it comes to the correction of postoperative diplopia there is no difference between two types of bone grafts.

## CONFLICT OF INTEREST

None declared by authors.

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