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Comparison among Histological Outcomes of Different Materials used for Reconstruction of the Orbit

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Abstract: ***Orbital wall fractures may lead to significant functional and aesthetic morbidity. Sometimes reconstruction is warranted to restore them. The material used for orbital wall reconstruction needs to be rigid and provide the best mechanical stability and least tissue reactions. Choosing implants could be based upon subjective opinions. Alloplastics had a higher chance of infection or other reactions. Autografts offer better compatibility with limitations of adaptation. Most used implant materials had perforations allowing better shaping and modifications. We investigated the effect of perforations on healing. We chose 12 rabbits and do defects in the floor with reconstruction by perforated and continuous titanium implant. A histological examination was done after 3 months. Macroscopic evaluation of wounds` healing shows no sign of inflammation or infection. The implant was well integrated within the tissues although it had not been fixed. Inflammation type, neovascularization, fibrosis amount and the presence of giant cells were investigated. In the case of the continuous implants, the healing was excellent, in the case of perforated orbital implants more signs of inflammation were evident. We conclude that the continuous implant could provide a better healing milieu.***

Keywords: orbital reconstruction; titanium implant; experimental; histology evaluation; healing

1. Introduction

Orbit had functional and aesthetic jobs. It houses the globe and other organs related to the subject's visual sense[1]. The function of the eye is essential for a healthy life. The orbit plays a significant role in maintaining the globe's functions[2]. Orbital injury would affect the globe at a certain level[3]. Midface injuries would cause long - term results that affect the vision of the patient[4]. Thus, the quality of the life in the long term could be severely affected. There is a wide range of injuries extending from simple scratches up to blindness. Repair of the orbit is very important to be considered as early as possible with every trauma[5]. Its volume and spatial configuration had a crucial impact on this sense. Its configuration permits a predictable fracture pattern that absorbs energy as much as possible to protect the more precious neurocranium and the globe itself[6]. The volume of the orbit in an adult age group is about 17cm^3[7]. Any change in this volume will result in consequential changes in the position of the globe. (hypoglubus, dystopia, enophthalmos, exophtamuls, …. etc) [8]. The shape of the orbit is quadripyramedial, and any wall when affected will have an effect on the structures intraorbital or in the extra orbital anatomical vicinity. Most of the orbital fractures are in the floor in the first place followed by the medial wall and rarely on the lateral and roof of the orbit[9].

The requirement of the orbital reconstruction is to provide stability of the multiple fractured pieces to ensure uneventful healing; provide a separation medium to preclude orbital content herniation and provide smooth continuous contour to any defect that changes the volume of the orbit. The orbit could be injured due to multiple causes such as trauma, interpersonal violence, RTA or invaded and damaged by different pathological conditions [9]

The biomaterials used for orbital reconstruction had many forms that govern their properties and manipulation[10]. They could be perforated as in the case of titanium mesh or as solid material as in the case of titanium plates or polymeric materials.

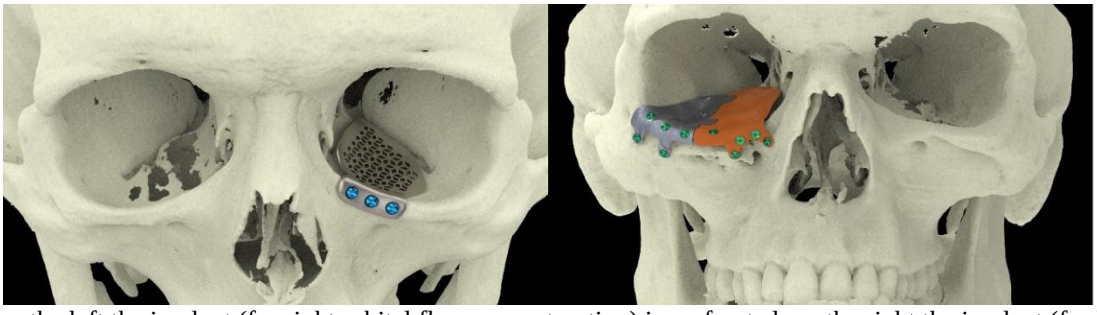

Figure 1: on the left the implant (for right orbital floor reconstruction) is perforated, on the right the implant (for left orbital floor reconstruction) is multi pieces solid continuous

The perforations make the implant easier to adapt and are claimed to enhance tissue integration [11][12]. The continuous implant had less total surface area to mass ratio in contrast to the perforated variety which lead to more tissue exposure to the implant and multiply the area which could lead to a more intense response to any infection, although the claim of tissue fluid escape seems to have little influence of the postoperative period.

In our experimental study, we want to explore the effect of this feature (implant perforations) on the performance of the implant and its biocompatibility.

2. Material and Methods

12 rabbits of the wild rabbit (Oryctolagus cuniculus spp.) had been used in our study.

The study was approved by the KHCMS (Kurdistan Higher Council of Medical Specialties). The rabbits were kept in the animal house of the college of medicine during the study period. For surgical procedures, they were anaesthetized by an intramuscular combination of xylazine and ketamine (2% xylazine 5m/kg and 10% ketamine 2.5mg/kg). Two forms of titanium grade II implant was provided by OSTEOOTECH (UK company):

- Continuous implant form
- Perforated implant form

After 3 months, the rabbits were slayed using the same anaesthetic agents with the addition of a lethal dosage of phenobarbital.

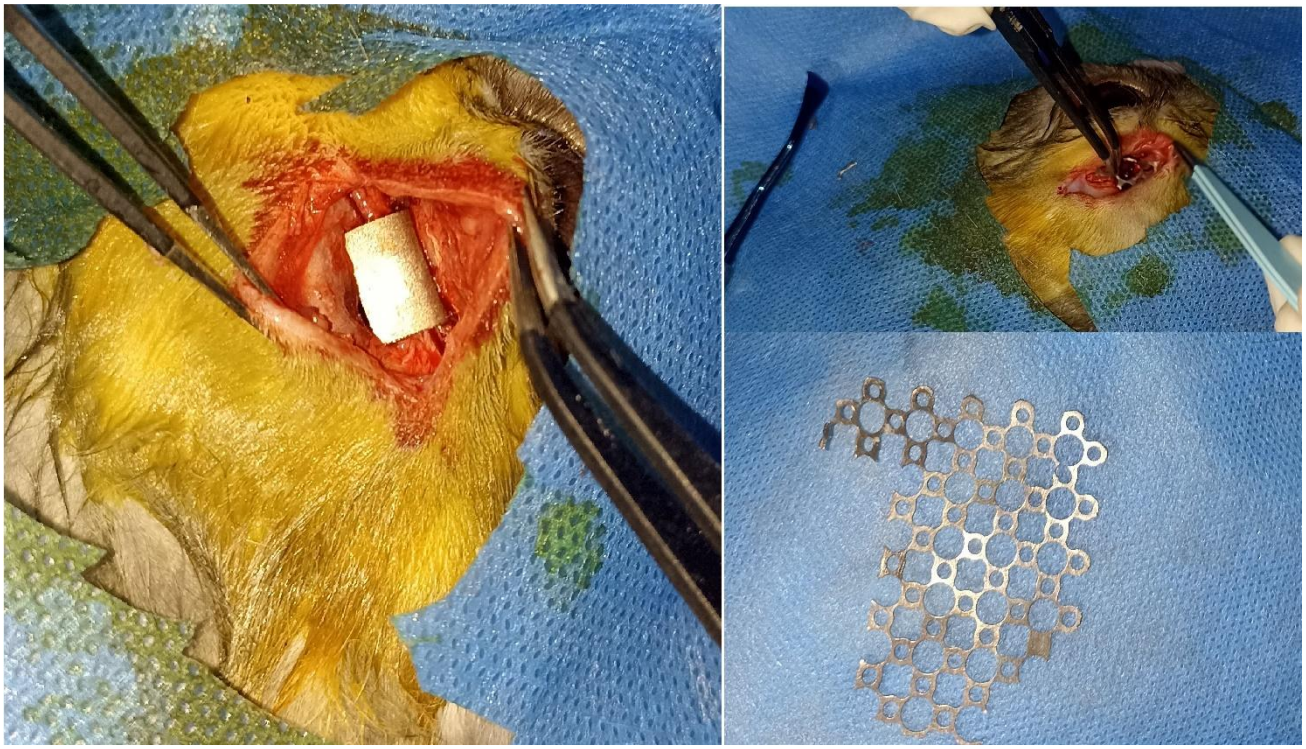

Figure 2: On the left is the continuous form and on the right is the perforated form

Surgical procedure; implant placement:
After the anaesthetic drug established its action, hair was cut using an electric trimmer. The skin incision was about 2cm below the lid margin. Alternative sharp and blunt dissection had been done to reach the bone, and a defect of 1*1cm had been created. The implant had been placed after good adaptation. The closure was done using PTFE 4 - 0 suture. Healing was excellent without breakage or dehiscence in any of our models. Suture removed after 2 weeks.

Surgical procedure; implant retrieval:
No ocular movement mechanical restriction was evident, we did a forced - duction test. Examination of previous surgical and implant sites revealed very well healing.

The same previous steps had been followed and the wound was larger. About 0.5 away from the implant, a cut by bonecutterhad been done and soft tissue was cut by scissors. During implant removal before specimen processing and wax embedding the retrieval of the perforated implant form was difficult due to the presence of abundant fibrosis, but in the case of the continuous form of the implant, this step was easily done and tissues shelled out of the implant. Each animal was killed at the end of the procedure.

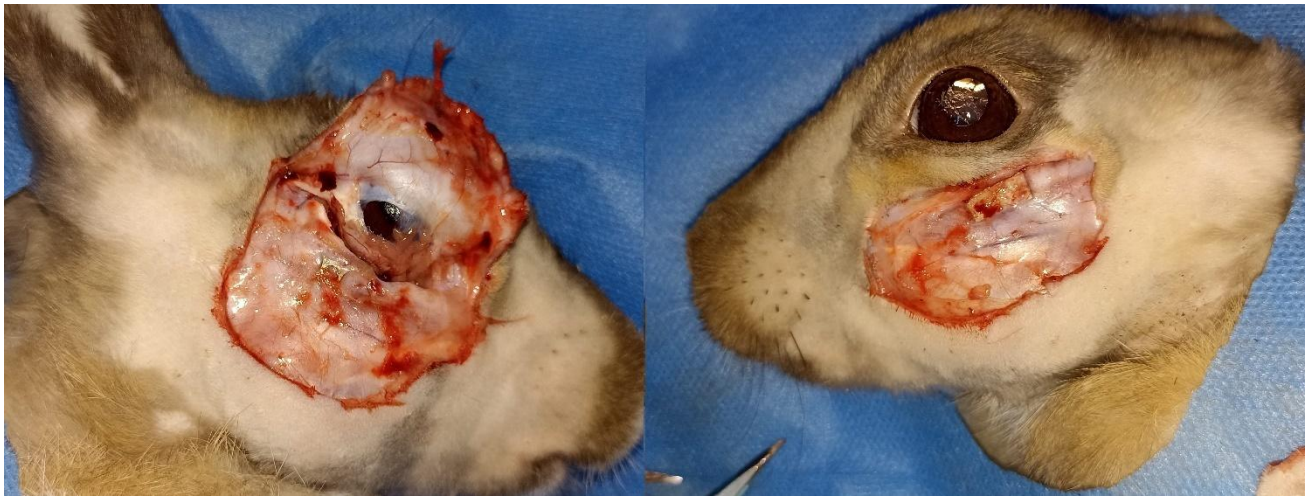

Figure 3: After exposure to the implant site

Statistic

We used SPPSS software (IBM Corp. Released 2021. IBM SPSS Statistics for Windows) to get the results. We depend upon Chi - square and fisher's exact test to compare results qualitatively. Significance was assigned to any probability less than 0.05

3. Results

Infection and exposed implants had not been witnessed in any sample. Healing was excellent and we attribute part of this healing to the type of used suture.

Microscopically there was a significantly more intense response at the site of the perforated implant associated with giant cell reaction Amount of fibrosis was significant among two groups (p=0.015), as there was Plump fibroblastic proliferation associated with perforated implants. Numerous osteoclast reaction was seen in both samples, as this was osteogenesis in both (p= 0.04). Giant cells and inflammatory cells infiltration difference was significant (p=0.02)

Foci of necrosis had also a significant difference (0.024)

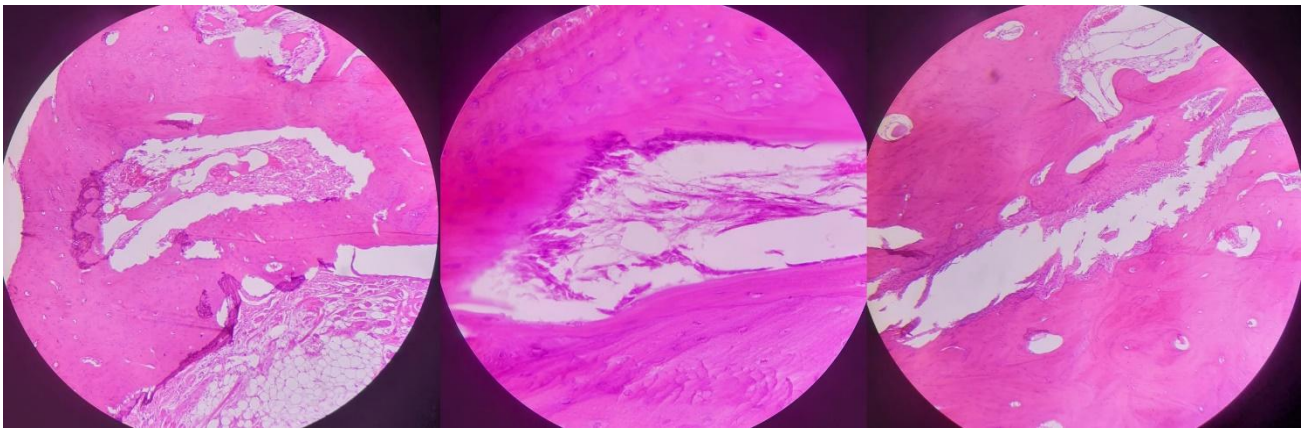

Figure 4: Histological findings of the continuous implant

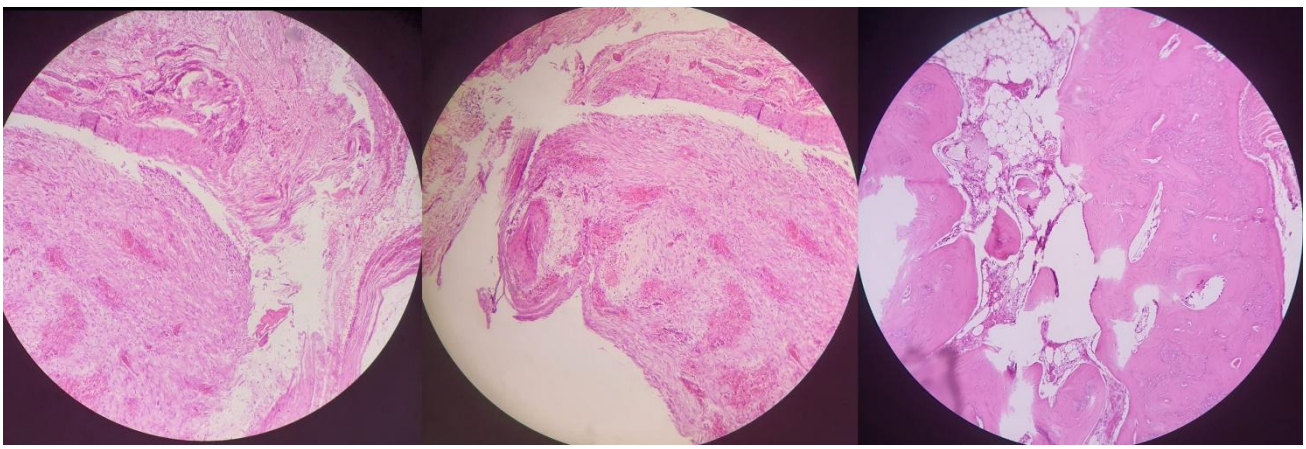

Figure 5: Histological findings of the perforated implant

4. Discussion

Orbital reconstruction materials had a married variety in shape and structure [13]. Autologous material had many disadvantages such as secondary site surgery and lack of many properties that fit in this specific anatomical site (limited area, need a material that doesn't resorp, high rigidity to mass ration, …. etc)

To address these drawbacks alloplastic material had been introduced, but the debate upon implant type selection had been resolved yet. [14].

Titanium had wide acceptance as implantable material [15]. Its form had a huge impact on biocompatibility and tissue reaction [2]. Tissue response could lead to more complications that necessitate further surgeries [16]

Despite the autologous material's good features, many drawbacks are present and with the addition of second site morbidity the surgeon should think about other alternatives [17]

A W Sugaret al reported the successful use of titanium mesh and stated: " This material is especially useful in the orbital floor and medial wall blow - out fractures, and is a valuable additional material for use in maxillofacial reconstruction " although he stated that the presence of perforations and pattern of perforations could affect the surgery and would necessitate implant reo=moval[18]. He indicates that although perforation would be blessed as tissue integration is higher but could be acurse due to more difficult removal and a higher chance of infection.

Hui Bae Harold Lee, report a significant effect of the perforated implant on the soft tissue intraorbital and extraorbital. [19] they stated that continuity of the implant without any perforation is a prerequisite to the safety of its usage

We had found that continuity of the implant would reduce the more pronounced tissue reactions and improved results could be achieved with this type of implant. The debate continues and needs to be resolve

We suggest reducing the perforation of the implant and it is better included in the areas where the implant needed to be bent or folded as it will facilitate this step

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