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Controversies in orbital reconstruction

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Abstract
The goal of orbital reconstruction is to repair wound injuries, anatomically correct the eye location, prevent enophthalmos and restore ocular function. Many surgeons recommend materials for the reconstruction of (trauma) defects which can be bent into an anatomical shape and which possess the properties of radio pacificity and long-term stability. However the ideal material for orbital reconstruction remains controversial apart from these desired properties. Autologous bone is often referred to as the' gold standard,' probably due to its mechanical properties, the potential for revascularisation and its adaptation to the orbital tissue with minimal acute and chronic immune reactivity. The aim of this analysis is to provide a comprehensive overview of the benefits and disadvantages of materials used to repair traumatic orbital defects and to provide a realistic set of guidelines based on evidence and complexity.

Keywords: Orbit, trauma, blowout fractures, classification of facial fractures, orbital fractures, orbital reconstruction, biomaterials

Introduction
Orbital defects are among the most commonly facial fractures experienced due to the midface area's exposed position and thin bony walls. Orbital fractures can occur alone or in conjunction with other midfacial fractures, including zygomatic complex fractures, naso-orbito-ethmoidal fractures, and frontal bone / orbital roof fractures. The management of orbital fracture treatment remains controversial, and a particular subject of debate is the indication for surgery [1].

Modified classification of orbital wall defect size-

Table 1: According to L. Dubois1, S. A. Steenen1, P. J. J. Gooris1, R. R. M. Bos2, A. G. Becking1[2]

Category I	Low complexity	Isolated defect of the orbital floor or the medial wall, 1–2 cm2, within zones 1 and 2	Note -
Category II	Medium	Defect of the orbital floor and/or of the medial wall, >2 cm2, within zones 1 and 2	
Category III	High	Defect of the orbital floor and/or of the medial wall, >2 cm2, within zones 1 and 2	
Category IV	High	Defect of the entire orbital floor and the medial wall, extending into the posterior third (zone 3)	Bony ledge preserved at the medial margin of the infraorbital fissure, Missing bony ledge medial to the infraorbital fissure

Table 2: Ideal orbital reconstruction material characteristics According to L. Dubois1, S. A. Steenen1, P. J. J. Gooris1, R. R. M. Bos2, A. G. Becking1 [2]

Stability and fixation	Strong enough to support the orbital content and related forces Ability to be stable and retain its shape once manipulated No deformation (sagging of material into maxillary sinus) under pressure load Stable over time Possibility of being fixed to surrounding structures
Contouring and handling	Restores adequate volume to treat enophthalmos, diplopia, and motility disorders Easy to shape to fit the orbital defect and regional anatomy/ malleability Adequate in three-wall fractures No sharp edges and smooth surface
Biological behaviour	Biocompatibility: no infection/extrusion/migration/foreign body reaction Chemically inert, non-allergenic, non-carcinogenic Durable with minimal resorption Osteoinductive/osteoconductive
Drainage	Spaces within the implant to allow drainage of orbital fluids
Donor site morbidity	Does not increase surgical complication rate/donor site morbidity (pain, swelling, etc.)
Radiopacity	Radiopaque to enable radiographic evaluation without artefacts
Availability and cost-effectiveness	Readily available in sufficient quantities Acceptable costs

Burnstine criteria for orbital fracture surgery timing

Table 3: L. Duboisa,, S. A. Steenena, P. J. J. Goorisa, M. P. Mouritsb, A. G. Becking [1]

Time frame days Within 24 h (immediate) (early) Indications	1–14 days	>14 (late)
Diplopia with CT evidence of an entrapped muscle or peri-orbital tissue associated with a non-resolving oculocardiac reflex: bradycardia, heart block, nausea, vomiting, or syncope‘ White-eyed blowout fracture’, young patient (<18 years), history of peri-ocular trauma, little ecchymosis or oedema (white eye), marked extraocular motility vertical restriction, and CT examination revealing an orbital floor fracture with entrapped muscle or peri-muscular soft tissue Early enophthalmos/hypoglobus causing facial asymmetry	Symptomatic diplopia with positive forced duction, evidence of an entrapped muscle or peri-muscular soft tissue on CT examination, and minimal clinical improvement over time Large floor fracture causing latent enophthalmos Significant hypo-ophthalmos Progressive infraorbital hypaesthesia	Minimal diplopia (not in primary or downgaze), good ocular motility, and no significant enophthalmos or hypoophthalmos

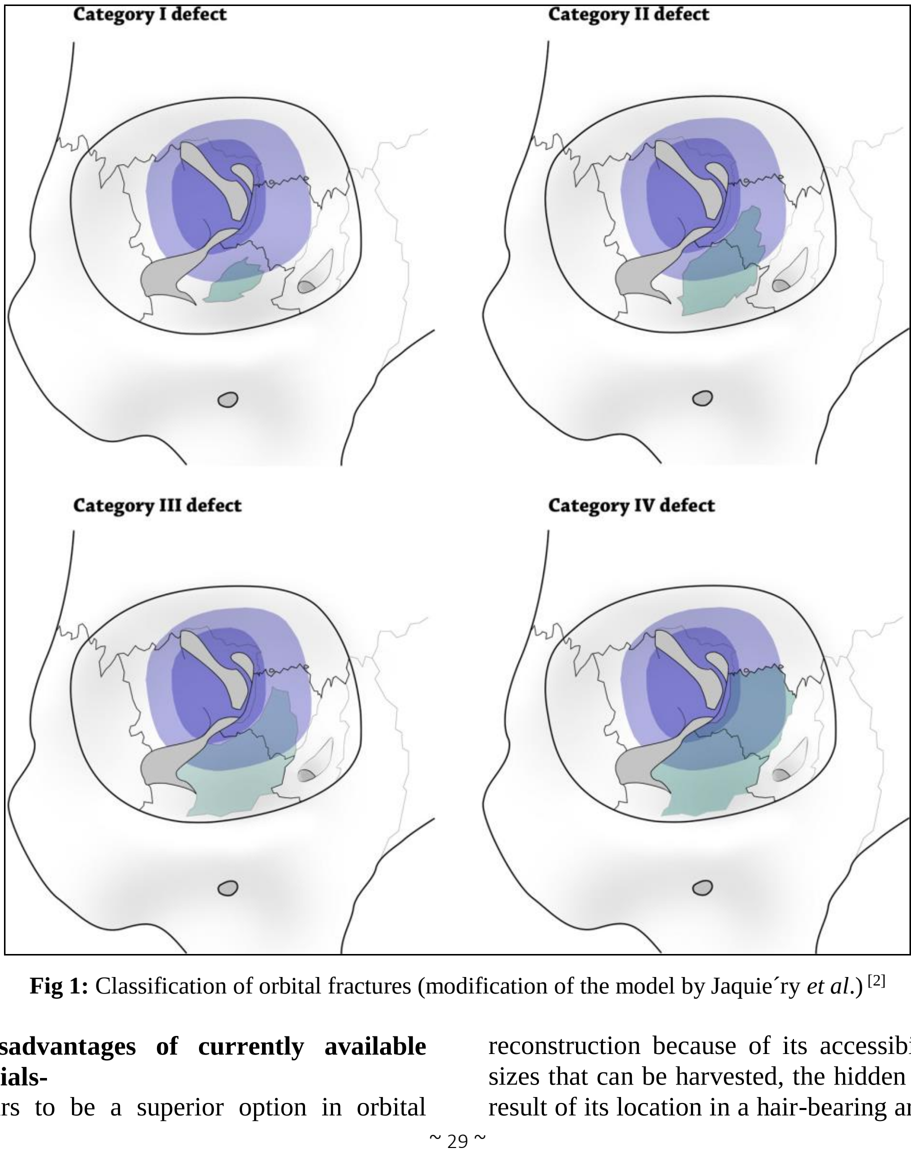

Fig 1: Classification of orbital fractures (modification of the model by Jaquie´ry *et al*.) [2]

Advantages and disadvantages of currently available reconstruction materials-

Calvarial bone appears to be a superior option in orbital reconstruction because of its accessibility, the various graft sizes that can be harvested, the hidden nature of the scar as a result of its location in a hair-bearing area, and the occurrence of little or no postoperative pain. Donor site morbidity remains a general drawback for autologous bone harvesting. In full-thickness calvarial harvesting, care has to be taken not to tear the dura, since this injury carries the risk of iatrogenic subarachnoid haemorrhage or even intracerebral haemorrhage. Additional disadvantages of autologous bone are the difficulty that can occur in contouring the bone to the perfect shape.

Titanium has been used extensively in craniofacial surgery and dentistry in the form of implants, plates, and screws. With its high biocompatibility and physico- mechanical properties, it could be an ideal implant for covering large anatomical defects (categories III–V) and globe malposition if implant-stabilizing surrounding bone or a distal landmark (a 'bony ledge') is absent. An attractive feature of titanium is its ability to be both incorporated into the surrounding tissues and to osseointegrate. However, titanium is costly and may have irregular edges if not cut properly, which may impinge soft tissue. Furthermore, fibrous tissue will incorporate the mesh-holes, which can make implant replacement technically complex.

Biological ceramics- Hydroxyapatite (HA), which is chemically and crystallographically similar to bone mineral, has been available for craniofacial surgery since the 1990s. However, in orbital surgery, it has been found to be inferior to porous PE sheets with regard to the postoperative outcomes of enophthalmos. Bioactive glasses (BAGs) are synthetic blocks or granules that bond chemically to bone. The disadvantages of BAGs include their rather brittle nature and the lack of ease in moulding, shaping, and fixing them. Nonetheless, these materials have been demonstrated to be osteoinductive and osteoconductive as implants, and to cause minimal foreign body reaction, infection, extrusion, displacement, and resorption. The benefits of preformed bioglass implants need further research.

Availability and cost-effectiveness- Availability is a relative parameter related to economic and local circumstances and hospital interest and availability. Stocks of alloplasts can be limited in some parts of the world. Under these circumstances, the harvesting of bone grafts may be preferable, and in the case of orbital reconstruction, several options are available for the donor site. However, alloplasts reduce both the operation time and hospitalization because of the lack of donor site morbidity. Pre-bent or preformed alloplastic materials are even more advantageous and have shortened the operating time compared to other alloplasts [2].

Treatment algorithm for orbital wall fractures

1. Small-sized, low-complexity defects (class I): Most materials are suitable; biological behaviour is most important and resorbables may be used in these cases.
2. Medium-sized, medium-complexity defects (class II): Apart from the biological behaviour of an implant, the experience of the surgeon with specific types of orbital implants will benefit the outcome. Various materials can be used, from autologous materials to alloplasts (e.g. PE or titanium).
3. Large-sized, high-complexity defects (classes III–VI): Stability and contour become more significant, and pre-bent or patient-specific titanium mesh is the preferred reconstruction material [2].

Clinical recommendations

The debate on the clinical recommendations for orbital reconstruction material will likely continue because of the absence of RCTs and best practice clinical studies. The predominant factor regarding the most suitable material characteristic may be the defect size and to a lesser extent the defect location. Availability is also an important variable and is dependent on geographic and economic backgrounds. Nonetheless, based on the literature and material characteristics of the different types of orbital implants, it is possible to derive clinical recommendations for materials in specific cases [2].

Discussion

The indication for surgery in solitary medial wall fractures is even more controversial. No specific prospective studies have been published on this subject. Generally accepted indications are a positive forced duction test or persistent diplopia, with CT evidence of an entrapped muscle.

Conclusion

currently available studies were analysed in this systematic review and it was found that the data are insufficient to provide a robust basis for guidelines recommending the best reconstruction method(s) for each type of orbital fracture. Furthermore, in the near future, it will hopefully be possible to identify those defects for which the use of certain biomaterial properties will increase the predictability of the orbital reconstruction.

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