Alloplastic Implants in Reconstruction of Cranio - Maxillofacial Bone Defects

Essay

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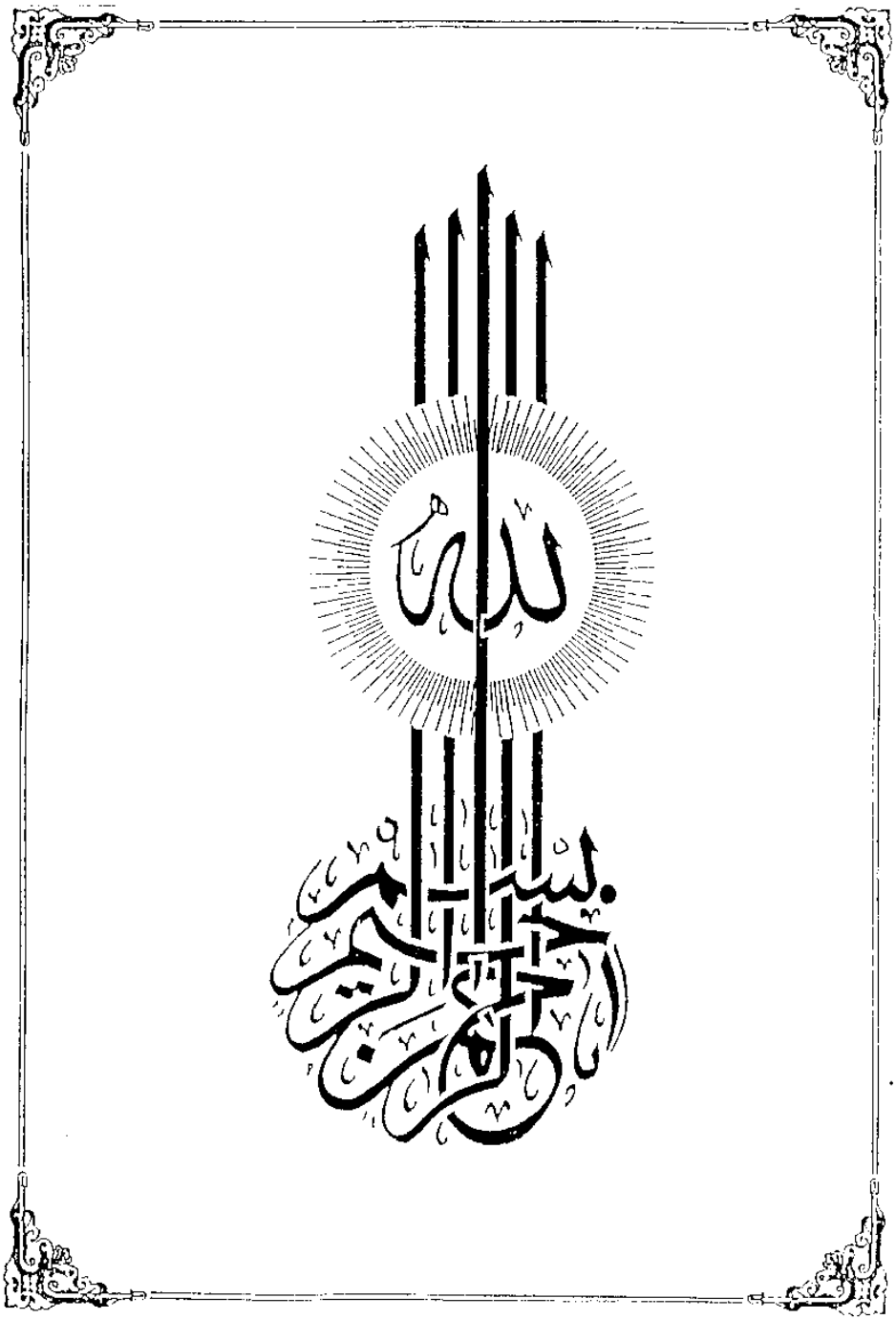
To the soul of Professor Doctor

MOHAMED ZAKI SALEM



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INTRODUCTION

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In the history of man's effort to reconstruct tissue loss and deformities, is attempts to use implant materials have probably paralleled those of utogenous tissues. Reliable clinical success in the use of implant materials id not emerge, however, until the twentieth century with the advent of iocompatible metals followed by polymers and ceramics. During the past wo decades, there has been an evolution in collaboration by scientists, ngineers and clinical investigators in the use of biomaterials, resulting in an ncreased understanding of the requirements and potential of implant naterials. The development of newer techniques to transfer autogenous tissues such as osteomyocutaneous flaps and free vascular bone grafts did not replace the need for implant materials. As the understanding of the properties and behaviour of alloplastic implants increases, it is likely that the spectrum of their use in plastic surgery will continue to increase, (**Holmes, 1990**).

The extensive literature on the replacement of osseous tissue recommends the use of bone and bone substitutes for filling the defects caused by trauma, excision of neoplasms, infection, congenital deformities and surgical intervention. Replacement of osseous structure is aiming to preserve morphologic contour, restore mechanical strength and function, to eleminate dead space so as to reduce post-operative infection, and to enhance the retention of prosthetic devices. So the surgical correction of bone defects is one of the most challenging aspects in plastic surgery, (**Bahn, 1966**).

Alloplastic implant materials are by definition, biomaterials used to augment or replace a tissue, organ, or a function of the body. Such materials must be biocompatible and must not elicit toxic, immunogenic or carcinogenic reaction. Alloplastic implants may be categorised into three groups:

(1) **Metals** as stainless steel, titanium, cobalt-chromium alloys.

(2) **Polymers** as silicones, proplast, teflon and polymethyl-methacrylate.

(3) **Ceramics** as tricalcium phosphate and hydroxyapatite.

In contrast to alloplastic implants, autogenous bone grafts result in secondary donor site morbidity, their accurate contouring may be technically difficult. They are of limited quantity and can undergo significant graft resoportion, hence impede the normal process of healing. (**Holmes, 1990**).

Before discussing these alloplastic implants, there are some definitions that should be clear, to help us in understanding the subject.

Implantation: is the use of a biomaterial to augment or replace a tissue, organ or function of the body, (**Holmes, 1990**).

Transplantation: is the surgical transfer of a living tissue, organ or system. The cells of the transplant must survive and function in a normal manner for the procedure to be judged clinically and immunologically successful, (**Bay, 1983**).

With the exception of breast implants, most implant materials for plastic surgery are used in the face. However, advances in the cranio-facial surgery have increased the opportunities for reconstructing the facial skeleton, (**Antell and Smith, 1991**).

AIM OF THE WORK

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The aim of this study is to review the alloplastic implants used in reconstruction of cranio-maxillofacial bone defects and to study their types composition and biological behaviour, also to spotlight on the advantages of these biomaterials in comparison to autogenous bone grafts.

REVIEW OF LITERATURE

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Biology of Bone Graft Regeneration

The reconstructive surgeon has to understand and enhance the mechanisms of tissue repair and bone regeneration. The principal tissue in successful bone reconstruction are the vascularity and fibroblastic cellularity of the recepient bed, as well as the osteogenic quality and quantity of the transplanted bone. Fibroblasts are capable of producing different types of collagen that may form the organic matrix of either dermis, fascia, bone or basement membrane. They can withstand the trauma of surgery, but must maintain a specific environment to carry out their primary function of collagen synthesis and cellular replication. In bone grafted wounds, fibroblasts need the presence of either fibrin or collagen as a scaffold for migration into the graft. Collagen synthesis is stimulated by a slightly acidic environment and may be initiated in hypoxic tissue with tensions as low as 10 torr. However, the fibroblast requires molecular oxygen tensions of at least 20 torr to complete a mature extruded collagen molecule, which can form a matrix for fibroblast migration and replication, as well as for capillary support, (**Hunt & Pai, 1972**). The rate of collagen synthesis was shown to be proportional to the availability of oxygen, ascorbate and ferrous ion, (**Niinikoski et al., 1972**).

The vascularity of the recepient tissue and the angiogenesis that occurs in response to bone grafts are of equal importance to the function of the fibroblasts in the recepient tissue bed and the activity of mesenchymal cells. These new vessels always arrise as capillary buds from existing

vessels. The existing vascularity of the recepient tissue bed is important for two reasons. First, the metabolism and consequently the survival of transplanted osteoprogenitor cells depends entirely on nutritional oxygen diffusion alone until revascularization occurs. A pre-existing rich capillary density enhances such diffusion during the early critical days. Second, a dense vascular network afford more numerous sites from which capillary buds may begin angiogenesis and vascularize the graft. In a recepient tissue bed which has received a bone graft, macrophages, fibroblasts and endothelial cells form a unit of inter-dependant cells which support, stimulate and nourish each other. The stimulus to angiogenesis arises from macrophages, platlets and tissue hypoxia, (**Branemark, 1965**). Each of them has been shown to initiate new vessel formation and exist in the surgically created bone grafted wound. The production of lactate ion by macrophage digestion of nonviable tissue, forms the acidity which together with hypoxia initiate collagen synthesis. However, the fibroblast can not respond to this stimulus without the vasculature, which supply factors needed for collagen synthesis such as oxygen, aminoacids, ascorbate, ferrous ion, glucose, ... etc. The local vessels in a similar fashion can not sprout new capillaries into an area without external support for these new and fragile vessels, (**Ollier, 1967**). The solution of this apparent dilemma resides in the fibroblasts in the recepient tissue at the graft margin. These "lead" fibroblasts are close enough to the wound environment to respond to the stimuli towards collagen synthesis. The initial collagen laid down by the "lead" fibroblasts at the graft periphery, begins an interdependant cycle which will eventially result in vascularization of the graft. With survival of transplanted graft cells, and an