Chapter I

INTRODUCTION

Isoelasticity implies the optimum approximation of the physical characteristics of an implant to those of bone. The familiar term (isoelastic) by definition means, "equal in elasticity" and the connotation derived from isoelastic implant is that an implant of the same stiffness would not be adequate for sufficient stress transfer to bone. An ideal isoelasticity, however, can never be achieved since bone is anisotropic and the alloplastic materials used in implants shows isotropic properties. In addition, there is no adaptation of the structure to the forces acting on the bone as in the case of viable bone. Moreover, the variety of individual forms and strengths of the human bone can never be limited by an artificial implant ***(Morscher and Dich, 1982)***

The optimal fixation of an implant depends on its material and design. The elasticity of material and consequently the deformation of an implant depends on the elastic modulus of the material. Modulus of elasticity measures the rigidity or stiffness of the material. A high modulus of elasticity indicates the material is stiff and low modulus of elasticity indicates that the material is pliable. Modulus of elasticity refers to the material not on the actual implant. Theoretically, a low modulus of elasticity (more elastic) may be advantageous because it would reduce the stress in the component and increase the loading of cement and bone; Likewise, a high modulus of elasticity (less elastic) may be considered advantageous because it would reduce the stress in the cement around the component and decrease the risk of cement failure, but it could be disadvantageous because the bone become unloaded so that, disuse osteoprosis or stress shielding, could develop resulting in producing loosening of the component ***(Harkess, 1991).***

Any bone, as femur in its normal state carries its external loads, all by itself. When provided with an intramedullary stem, it shares the load-carrying capacity with the implant. As consequence, the bone is subjected to reduced stress, hence, stress shielded. Accordance to Wolf's low, the reduction of stress relative to remodel and to adapt itself by reducing its mass either by becoming more porous (internal remodeling) or by getting thinner (external remodeling) ***(Huiskes et al., 1992).***

In any discussion of stress shielding and bone remodeling, it is helpful to consider several concepts related to stiffness or elasticity. In simplistic terms, an implant of equal stiffness to the bone could stress shield the bone by as much as 50%. This implies that (iso) or equal implant stiffness would not be adequate for sufficient stress transfer to bone ***(Bobyn et al., 1992).***

Metal endoprosthesis are about 20 times stiffer than bone in proportion of their moduli of elasticity, therefore, if they have been implanted without bone cement, they are never at rest at the interface between the bone and endoprosthesis. Further, the uneven distribution of forces which result leads to atrophy of bone sectors that are not under load i.e. stress shielded ***(Hassellach and Bamrlli, 1990).*** Stress shielding has received much attention as an important cause of implant failure. It is responsible for improper transfer of mechanical stress which causes remodelling of periprosthetic bone ***(Ang et al., 1997)***

Recently, the concept of isoelasticity is that the implant and bone should be deform as one unite ***(Kinnard et al., 1994).***

The contents of this essay are a discussion of the following items in details:

1. Mechanical properties of used materials in the orthopaedic implants.
2. Varieties of implantable materials.
3. Basic biomechanical properties of bone
4. Basic principles of design of implants.
5. The examples of isoelastic implants.
   a- RM. Isoelastic cementless total hip prosthesis.
   b- The isoelastic prosthesis of the shoulder.
   c- RM isoelastic total elbow prosthesis.
   d- The isoelastic cementless finger prosthesis.