PROSTHESES OF THE HAND

Essay

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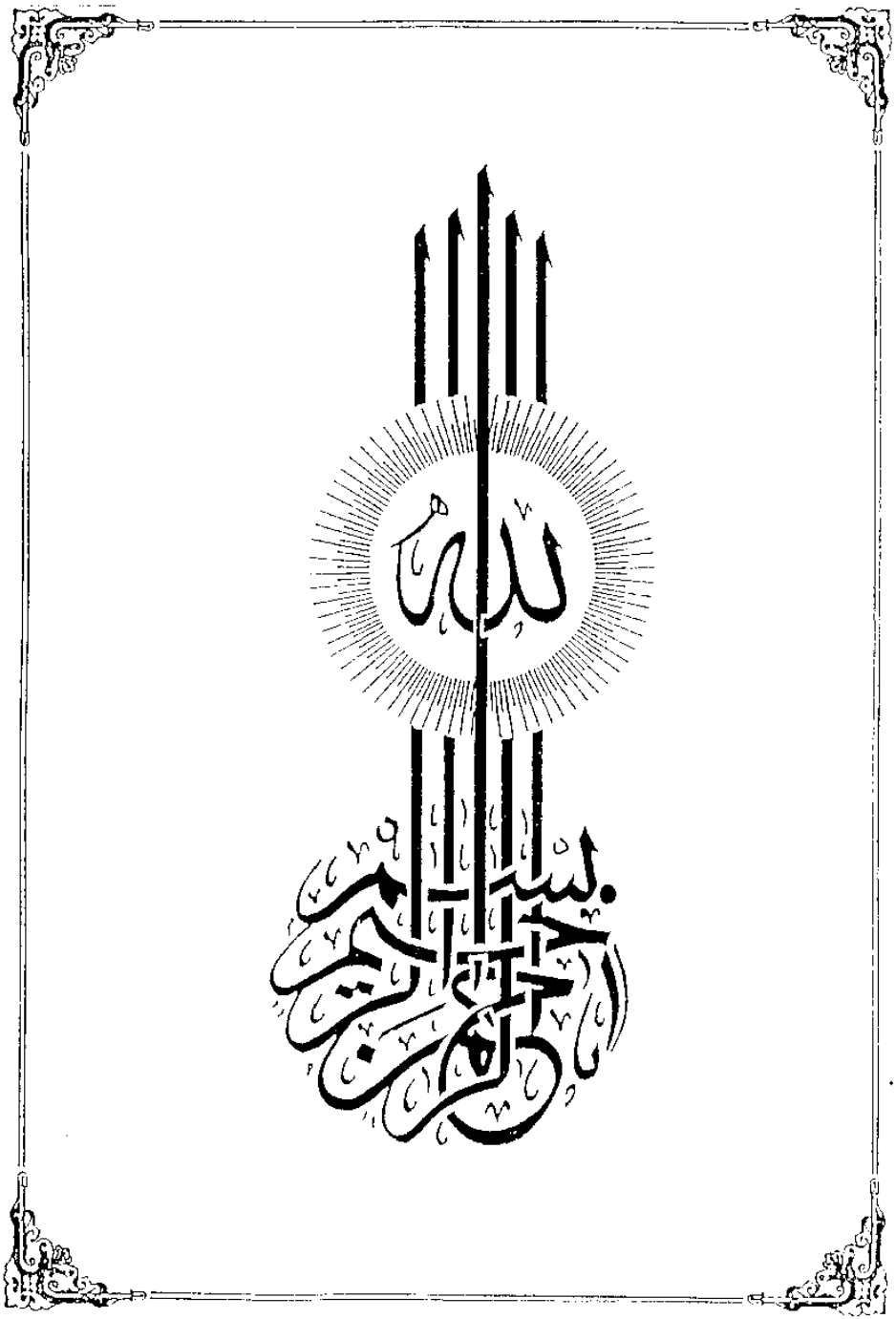

List of Abbreviations

DIP : Distal Interphalangeal.

MP : Metacarpophalangeal.

PIP: Proximal Interphalangeal.

TMC: Trapeziometacarpal.

List Of Figures

Page

Fig.1 : Concept of flexible implant arthroplasty..... 19
Fig.2 : Concept of encapsulation.....20
Fig.3 : Gliding Phenomenon. 22
Fig.4 : Larsen classification of MP joint arthritis.....28
Fig.5 : Swanson Silicone MP joints prosthesis.....31
Fig.6 : X-ray for silicone MP joints prostheses.....32
Fig.7 : Buckling phenomenon of Swanson MP joints Prosth.....36
Fig.8 : Swanson grommets for MP joints. 37
Fig.9 : Niebauer Silicone MP joints prosthesis.....41
Fig.10: Sutter MP joint prosthesis. 42
Fig.11: Results of MP joints Prostheses.....44
Fig.12: Complications of MP joints prostheses.....45
Fig.13: Schultz MP joint prosthesis. 47
Fig.14: Steffee MP joint prosthesis.....50
Fig.15: Helal MP joint prosthesis.....54
Fig.16: Osseointegrated MP joint prosthesis. 57
Fig.17: Non Cemented pyloric carbon MP joint prosthesis.....60
Fig.18&19: Steffee MP joint of the thumb prosthesis.....66&67
Fig.20: Swanson Silicone PIP joints prostheses.....71
Fig.21:Cemented PIP joints prostheses.....75&76
Fig.22: Complications of cemented PIP joints prostheses. 77
Fig.23: Exposure for DIP joints prosthesis.....80
Fig.24: Swanson Silicone trapezial prosth.....85
Fig.25: Complications of Swanson silicone trapezial prosthesis. 87
Fig.26: Silicone elstomer universal small joint spacer for trapezium.90
Fig.27,28,&29A : Convex condylar trapezial prosthesis.....96&97
Fig.29B: Concave condylar trapezial prosth.....98
Fig.30: Eaton silicone trapezial prosthesis.....101
Fig.31: Neibauer silicone dacron trapezial prosthesis..... 104
Fig.32: Kessler prosthesis for the base 1st. metacarpal bone..... .. 107
Fig.33: X-ray for kessler prosthesis..... 107

Fig.34: Types of TMC joint prostheses.....112
Fig.35: Braun total TMC joint prosthesis..... .115
Fig.36: Steffee totl TMC joint prosth. 118
Fig.37A&B: De la Caffienier total TMC joint prosthesis.....120
Fig.38: Mayo total TMC joint prosthesis..... . 122
Fig.39A,B&C: Lunate prosthesis.....127&128
Fig.40A,B&C.: Scaphoid prosthesis.....133&134

CONTENTS

page

- ***Introduction.*** *1*
- ***Historical Review.*** *3*
- ***Biomaterials.*** *8*
- ***Criteria For Prostheses of the Hand*** *10*
  - Implants criteria 10
  - Indications 10
  - Contraindications 12
  - Complications 13
  - Salvage surgery 16

- ***Types :*** *25*

- Metacarpophalangeal joints prostheses 26
- Proximal interphalangeal joints prostheses 68
- Distal interphalangeal joints prostheses 78
- Trapezium bone prostheses 81
- First metacarpal bone base prostheses 105
- Trapeziometacarpal total joint prostheses 108
- Lunate and Scaphoid bones prostheses 123

- ***Summary*** *139*
- ***References*** *143*
- ***Arabic Summary***

INTRODUCTION

Prostheses of the hand include both exoprostheses and endoprostheses.

Exoprostheses are used in cases of partial or complete congenital deficency or amputation of the hand. The needs for these prostheses can be divided into two basic requirements, one is the desire for the best possible aesthetic replacement and the other is the restoration of specific hand functions, particularly grasping, holding and carrying, There are two types of exoprostheses of the hand, the passive and the functional prostheses. The problem still is that the best possible cosmetic result can be obtained only with passive hand prostheses with little or no function while the best possible function is available only with devices whose appearance has little to do with the human hand but reminds the patient of a lobster claw or a robot ***(Wilson et al. 1983).***

Endoprosthetic arthroplasty in the hand is indicated in the presence of pain, stiffness and/or deformity. In general, rheumatic conditions are the most common causes for arthrosis requiring arthroplasty, but occasionally in degenerative and traumatic conditions, surgery is also indicated ***(Bechenbaugh & Linscheid, 1992).***

The ideal goal of reconstruction procedures is to provide pain relief, mobility and strength with reasonable stability. Proper evaluation of the specific problems presented, including the severity of the disease and the patient's age and functional requirements is essential in selecting the best treatment from the wide range of available procedures ***(Swanson and Swanson, 1988).***

The aim of this work is to discuss endoprostheses of the hand as regard biomaterials, indications, contraindications, complications, and types.

HISTORICAL REVIEW

The first recorded effort at treating the disease by simple resection of soft tissue and diseased bone was carried out by Ambroise Pare in the 16th century with the hope of avoiding amputation for incurable joint infection. This surgery was the birth of all future articular reconstructive surgery and of the specialty of orthopaedic surgery in the18th century. With the advent of anesthesia, surgical excision became more complete and refined and the principle of restarting function to a damaged joint by resection followed by postoperative rehabilitation and therapy of the parts in an attempt to develop a pseudoarthrosis was further developed.

Arthroplasty or reconstruction of joints, was the logical sequence of the resection procedures. The problem was to interpose a buffered material between the articular surfaces to prevent bone healing. Adipose tissue was first used but soon discarded because it was found to be quickly absorped Prior to 1900, surgeons in America, England and Europe inserted materials such as wood, gold, silver, tin, and magnesium; synthetics such as cellulite, and rubber sheets were also used. The use of fascia for joint reconstruction became popular because it eliminated the unpredictable effects of using heteroplastic or synthetic materials in living tissues ***(Mann, 1979).***

The orthopaedic surgeons of the early 20th century further refined resection arthroplasty techniques. They used synthetic materials such as glass, and bakelite and then in 1938, began to use the non ferrous alloy and vitallium.

Prior to the development of the flexible implants, excessive and prolonged postoperative fixation with pins and external support was frequently required. A new era of research in joint reconstruction and replacement has been opened by the advent of medical grade synthetic polymers (***Mann, 1979).***

In other word, the industrial development of synthetic materials that can be used in the human body has opened up extraordinary possibilities for joint reconstruction ***(Swanson & Swanson, 1986).***

Through the 1940s and 50s, attempts to achieve pain free stable, implant arthroplasty with metacarpal cups and with soft tissue interposition met with limited success ***(Beckenbaugh & Linscheid, 1993).***

The availability of medical - grade silicone rubber gave a great boost to the development of joint prostheses in the late 1950s and early 1960s. This material offered the advantage of having a modules compatible with bone. This allows the bone supporting the implant to better tolerate the forces generated around the implant.

Since that time, the development of joint implants has taken two diverse courses of designs; a fixed stemmed design and nonfixed design ***(Kessler, 1986).***

In 1959 Brannon and Klien first described a prosthetic device for the replacement of a destroyed finger joint. They inserted titanium hinged prostheses with single stem into the fingers of 21 military patients. They reported problems of sinking and loosening of the stem in the medullary canals ***(Brannon & Klein, 1959).***

Flatt in 1961, described a double-stem metal hinged prosthesis that allow satisfactory motion for the metacarpophalangeal and the proximal interphalangeal joints. Due to the rigidity of the prosthetic stem and the relative porosity of the bone, these prostheses tended to loosen, migrate and occasionally penetrate through the cortex of the bone ***(Flatt, 1961).***

Stimulated by the successful results of silicone implants in other areas of the body, investigators began to use these flexible materials for implants in the hinged joints of the fingers. In 1962, Brody and White described the reconstruction of the proximal interphalangeal joints by using a hard silicone rubber rod. This implant was a firm silicone rod transversely positioned to function as a roller, allowing the bone shafts to slide around it.

(Urbaniak,1974).

In 1963 a silicone sponge and silicone roller were used as interpositional material to enhance resection arthroplasty.These resulted in efforts to devise flexible implants for reconstructive surgery of the upper extremity. In 1963 Calnan and Reis, described a finger joint prosthesis of polypropylene stems and hinge with a silicone-elastomer capsule. In 1966 Swanson described a flexible silicone rubber implant for use in deformed arthritic finger joints. He subsequently reported the successful clinical results of the intramedullary-stemmed one piece designed silicone implant in nearly 4,000 finger joints ***(Mann, 1979).***

None of the above implants were designed to obtain bonding of the implant to the intramedullary cavities of the finger bones, Niebauer, in 1969, presented his clinical experience with the silicone - dacron metacarpophalangeal joint prostheses. The dacron sleeving on the prosthetic stem accomplishes fixation of the prostheses in the medullary canals by tissue ingrowth ***(Niebauer et al., 1969)***

Then, Urbaniak, McCollum, and Goldner have reported results on nearly 400 finger joints with the silicone-dacron metacarpophalangeal and proximal interphalangeal joint prostheses ***(Urbaniak & McCollum, 1973).***

Encouraged by the success of silicone implants in the finger joints, investigators were stimulated to develop silicone prostheses for implant arthroplasties for arthritic joints involving the trapezium, lunate, and scaphoid. Swanson has been the leader in the design and clinical testing of these implants ***(Swanson, 1972).***

Successful clinical results with the silicone-dacron trapezium of the Niebauer-cutter design over many years have been promising. Kessler in 1971, reported successful results with the use of a stem pessary design of a silicone implant at the thumb base ***(Urbaniak,1974).***

Early success with cemented endoprostheses in the lower extremity led Steffee et al., Braun, and others to develop similar designs for finger joints. Follow up studies in the 1970s and 80s have demonstrated problems with loosening at the cement- bone interface. While the silicone spacer implant is still the most popular arthroplasty in the hand, both cemented endoprostheses and silicone spacer implants are being used ***(Gelberman & Dimick, 1987).***

BIOMATERIALS OF END0PROSTHESES OF THE HAND

1. Silicone :

Until the introduction of the silicones there was no material that appeared to satisfy the criteria of an accepted implant. The silicones are a combination of organic and inorganic materials consisting of a chain of silicone and oxygen atoms to which organic groups are attached ***(Swanson, 1968).***

They are heat stable, non adhesive, and have good flex and force damping properties. They tear easily, however, if their surfaces are lacerated, the medical grade silicones do not generally produce host-tissue reaction.The implants are formed in a mold at 25 F degree, under 325Ibs/square inch pressure. They are crued at an elevated temperature and are fabricated in a controlled atmosphere. Early implants were tested for 50 million repititions without evidence of breakdown. They are considered biologically inert and mechanically well tolerated, being softer than bone.

In 1974 a high performance silicone elastomer implant was introduced. It offered up to 400% greater tear resistance, allowing wire fixation with less fear of tearing. The intramedullary stem of the implant is