



Arthroplasty of the small Joints of the hand

Essay

Submitted for Partial Fulfillment of Master Degree
in *Orthopedic Surgery*

By

Mahmoud Khaled Ghonem

M.B., B.Ch.

Faculty of Medicine –Ain Shams University

Under Supervisors

Prof. Dr. Mahmoud El-Sebaei

Professor of Orthopedic Surgery

Faculty of Medicine - Ain Shams University

Dr. Ahmed Naeem Attia

Assistant Professor of Orthopedic Surgery

Faculty of Medicine - Ain Shams University

**Faculty of Medicine
Ain shams University
2016**



*First and foremost thanks to "Allah" the most beneficial
and the most merciful*

*It is a great pleasure to express my profound gratitude
and deep thanks to **Prof. Dr. Mahmoud El-Sebaei**,
Professor of Orthopedic Surgery, Faculty of Medicine - Ain
Shams University for his supervision, generous cooperation and
great help to end this work.*

*I wish to express my sincere thanks to
Dr. Ahmed Naeem Attia, Assistant Professor of Orthopedic
Surgery, Faculty of Medicine - Ain Shams University, for his
careful supervision on this work, his valuable cooperation and
encouragement.*

*Finally, my deepest thanks to my family for all their great help
and support.*

Contents

Subjects	Page
List of abbreviations.....	II
List of Figures	III
List of Tables	IV
Abstract	IX
Keywords	X
• Chapter (1): Introduction	1
• Chapter (2): Anatomy & Biomechanics	6
♦ A- Metacarpophalangeal (MCP) joint.....	6
♦ B- The proximal interphalangeal (PIP) joint.....	16
♦ C- First Carpometacarpal Joint (CMCJ).....	18
• Chapter (3): Indications & Contraindications	24
♦ A-Indications.....	24
♦ B-Contraindications.....	30
• Chapter (4): Surgical techniques, Complications and Various types of implants	32
♦ A-Surgical techniques.....	32
♦ B-Complications of arthroplasty.....	48
♦ C- Various types of implants.....	75
• Chapter (5): Rehabilitation	99
• Summary	104
• References	107
• Arabic Summary	

List of Abbreviations

<u>Abb.</u>	<u>Complete sentence</u>
CMC	Carpometacarpal.
CoCrMo	Cobalt-chromium-molybdenum.
DIP	Distal interphalangeal.
DJOA	Digital joint operative arthroplasty.
HDPE	High-density polyethylene.
ICR	Instantaneous centre of rotation.
IP	Interphalangeal.
MCP	Metacarpophalangeal.
OA	Osteoarthritis.
PEEK	Polyetheretherketone.
PIP	Proximal interphalangeal.
RA	Rheumatoid arthritis.
STT	Scaphotrapezotrapezoidal.
TMC	Trapeziometacarpal.
UHMWPE	Ultra-high molecular weight polyethylene.

List of Figures

<u>No.</u>	<u>Figure</u>	<u>Page</u>
<u>2-1</u>	Normal metacarpophalangeal joint anatomy	7
<u>2-2</u>	Axis of rotation of the metacarpophalangeal joint.	12
<u>2-3</u>	PIP anatomy	17
<u>2-4</u>	Thumb movement	18
<u>2-5</u>	Osseous anatomy of first carpometacarpal (MC) joint.	20
<u>2-6</u>	Volar view diagram (left) shows volar beak (VB) ligament originating from distal trapezial tubercle and inserting onto ulnar base of first metacarpal (MC).	21
<u>3-1</u>	Implant silastic arthroplasty for PIP osteoarthritis.	28
<u>3-2</u>	Radiographic appearance of osteoarthritis of the thumb	28
<u>3-3</u>	Eaton staging of 1 st CMC O.A	30
<u>4-1</u>	The cut made at the base of the proximal phalanx using the appropriate alignment jig.	33
<u>4-2</u>	Brooches are used to shape the medullary canal to fit the shape of the stem of the implant.	33
<u>4-3</u>	The metacarpophalangeal joint is in place. The joint is then flexed and extended and its stability checked.	34
<u>4-4</u>	The pre-operative appearance of the arthritic metacarpophalangeal (MCP) joint.	35
<u>4-5</u>	Intraoperative view of metacarpal component	38

<u>No.</u>	<u>Figure</u>	<u>Page</u>
	and trapezial cup cemented in place prior to reduction.	
<u>4-6</u>	Postoperative thumb radiographs showing Braun-Cutter thumb implant (SBI, Morrisville, PA) in place and clearly illustrating cement mantle around components.	38
<u>4-7</u>	Photograph taken at follow-up visit 3 weeks after surgery demonstrates functional thumb adduction to small finger metacarpophalangeal volar crease.	39
<u>4-8</u>	Chamay approach to the proximal interphalangeal joint.	41
<u>4-9</u>	A curved incision is made on the dorsum of the proximal interphalangeal joint. The tendon is split. The central slip is reflected along with the periosteum of the middle phalanx to the mid lateral lines	43
<u>4-10</u>	The proximal interphalangeal joint implant impacted into place. The two bone sutures introduced prior to the introduction of the implant into the base of the middle phalanx are seen. These are used to reattach central slip before longitudinal closure.	46
<u>4-11</u>	The pre-operative and post-surgical radiographs of the proximal interphalangeal joint surface replacement showing the implant in place. The joint is congruent. The stems of each implant are centrally located within the respective bone.	46
<u>4-12</u>	Pre-operative and post-operative radiographs of proximal interphalangeal joint replacement.	47
<u>4-13</u>	Norwich regime for early mobilization for	47

<u>No.</u>	<u>Figure</u>	<u>Page</u>
	extensor tendons injures with wrist extension 45o, MCP flexion 50o -70o, IP's in neutral position.	
<u>4-14</u>	Presumed fracture of a PIP silicone implant based on subluxation and deformity of the joint.	49
<u>4-15</u>	Sclerosis around PIP silicone implant	51
<u>4-16</u>	Lateral approach for insertion of a PIP silicone implant	52
<u>4-17</u>	Pyrocarbon implant. (A) The implant. (B) The implant placed in situ	54
<u>4-18</u>	Dorsal dislocation of a pyrocarbon PIP implant.	54
<u>4-19</u>	Loosening of a pyrocarbon PIP implant in a patient with a long history of “squeaking.”	54
<u>4-20</u>	73-year-old woman with infection after first carpometacarpal arthroplasty.	71
<u>4-21</u>	51-year-old woman with dorsoradial subluxation of first metacarpal after ligament reconstruction and tendon interposition.	72
<u>4-22</u>	Complications after implant arthroplasty.	73
<u>4-23</u>	Brannon Klein design of hinged prostheses.	75
<u>4-24</u>	Steffee design of hinged prostheses.	76
<u>4-25</u>	St George- Buchholtz design of hinged prostheses.	77
<u>4-26</u>	Minami Alumina design of hinged prostheses.	78
<u>4-27</u>	Strickland design of hinged prostheses.	78
<u>4-28</u>	Weightman design of hinged prostheses.	79
<u>4-29</u>	Mathys design of hinged prostheses.	80

<u>No.</u>	<u>Figure</u>	<u>Page</u>
<u>4-30</u>	WEKO design of hinged prostheses.	81
<u>4-31</u>	DJOA design of hinged prostheses.	82
<u>4-32</u>	Swanson design with grommets of flexible one-piece prostheses.	83
<u>4-33</u>	Neibauer design of flexible one-piece prostheses.	87
<u>4-34</u>	Sutter – Avanta design of flexible one-piece prostheses.	89
<u>4-35</u>	Neuflex design of flexible one-piece prostheses.	90
<u>4-36</u>	Helap Flap design of flexible one-piece prostheses.	91
<u>4-37</u>	Lundborg design of flexible one-piece prostheses.	92
<u>4-38</u>	Pyrolytic Carbon design of surface replacement prostheses.	93
<u>4-39</u>	Avanta SR design of surface replacement prostheses.	95
<u>4-40</u>	Moje design of surface replacement prostheses.	96
<u>4-41</u>	Elogenics design of surface replacement prostheses.	96
<u>4-42</u>	Total metacarpophalangeal replacement design of surface replacement prostheses.	97
<u>4-43</u>	Andigo design of surface replacement prostheses.	98
<u>4-44</u>	Digitale design of surface replacement prostheses.	98

List of Figures

<u>No.</u>	<u>Figure</u>	<u>Page</u>
<u>5-1</u>	Typical dynamic outrigger.	<u>101</u>

List of Tables

<u>No.</u>	<u>Table</u>	<u>Page</u>
<u>2-1</u>	Hand grip strength for normal and diseased hands.	10
<u>2-2</u>	Muscles that support the first carpometacarpal joint.	23
<u>3-1</u>	Eaton Staging of first carpometacarpal joint osteoarthritis.	30
<u>4-1</u>	Outcome after surface replacement arthroplasty proximal interphalangeal joint (metal and pyrocarbon)	67

Abstract

The indications for joint replacement are pain and joint deformity. Osteoarthritis and traumatic arthritis may lead to joint arthroplasty, but the joint is in better condition in comparison with a joint affected by rheumatoid arthritis. A higher number of patients are expected to have implant replacement due to rheumatoid arthritis rather than osteoarthritis or traumatic arthritis.

Three categories of implants are used in arthroplasty, hinged implants, flexible one-piece implants & surface replacement implants.

Arthroplasty has been successful in preserving motion and alleviating pain for the distal interphalangeal (DIP), PIP, and MCP joints.

Keywords

- Hand biomechanics
- Rhumatoid hand
- Small joints osteoarthritis
- Small joints arthroplasty
- Arthroplasty complications
- Types of implants
- Hand rehabilitation.

Chapter one: Introduction

Our hand is not only for grasping and feeling. It is also a means of communication and is of major importance for body language and social contact. Therefore pain, swelling, and deformity of hand, with impaired mobility and sensitivity, represent an important medical and social disability.

The metacarpophalangeal (MCP) joint is the articulation between the metacarpal and phalange bones of the hand. The MCP joint is critical for finger positioning and hand function.⁴ The TMC joint is a biconcave convex double saddle joint with a permissively loose capsule.

It differs from other saddle joints by having a characteristic movement which is opposition due to laxity of the capsule of the TMC joint which permit flexion, extension, abduction and adduction in combination with some rotatory motion. The MCP, PIP, CMC joints are frequently affected by arthritis, which leads to great pain and disability. Joint replacement implants are commonly used to replace the diseased joint, but they have had varying success.

Arthritis of the hand encompasses a variety of disorders. They can be classified as inflammatory (e.g. rheumatoid arthritis) or non-inflammatory (e.g. osteoarthritis and traumatic arthritis). Rheumatoid arthritis

is the predominant type of arthritis affecting the human hand joints, ⁵ while osteoarthritis in the small joints of the hand is less common than in other joints such as the hip and knee.

Rheumatoid arthritis is a symmetric polyarthritis characterized by synovitis, loss of articular cartilage, and bone erosion. The bone in a rheumatoid joint has reduced bone density, reduced strength, and stiffness compared with a normal or osteoarthritic bone.⁶ there is a selectivity of synovial inflammation for the small joints of the body.

Due to the joint anatomy and biomechanical factors in the pathology of the disease in the early stage of rheumatoid arthritis, there is a predominance of the disease on the radial side of the MCP joint; this asymmetry appears to tend towards symmetry over time.^{7, 8}

Osteoarthritis is a non-inflammatory disease that involves articular cartilage deterioration and new bone formation at the joint edges, and usually affects one joint at a time. Osteoarthritis of the metacarpophalangeal joint is very rare, and specifically affects the index and middle fingers.^{9, 10}

Traumatic arthritis is a form of arthritis caused by penetrating or repeated trauma, or by forced inappropriate motion of a joint or ligament. Posttraumatic arthritis patients are often young, and the limitations imposed by the disease affect their careers and hobbies.¹¹

The indications for joint replacement are pain and joint deformity. Osteoarthritis and traumatic arthritis may lead to joint arthroplasty, but the joint is in better condition in comparison with a joint affected by rheumatoid arthritis. A higher number of patients are expected to have implant replacement due to rheumatoid arthritis rather than osteoarthritis or traumatic arthritis.

A number of strategies have been used in developing joint replacements for the MCP. The most common over the last 40 years has been the Swanson silicone implant¹². Essentially acting as a flexible spacer between the proximal phalange and the metacarpal, the Swanson implant is a single piece of silicone with stems on either side.

Alternatively, ultra-high molecular weight polyethylene (UHMWPE) implants have been used with one surface of UHMWPE sliding against an opposing surface of metal – usually steel or cobalt chromium; similar to what has traditionally been used in hip or knee implants. Such systems will press-fit the components into the bone and attempt to replicate the natural action of the joint ¹⁴. Over time, the UHMWPE components will tend to experience wear. Aside from decreasing overall performance, wear debris released into the body can initiate an immune response from the body, causing inflammation, bone resorption (osteolysis) and loosening of the implant ¹⁵.

Similar in action to UHMWPE/metal implants, pyrolytic carbon, or pyrocarbon, implants have been