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Postoperative Therapy for Metacarpophalangeal Arthroplasty

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1. Introduction

Since the earliest metacarpophalangeal (MCP) arthroplasties in the 1950s, numerous resurfacing and excisional arthroplasties, and a greater choice of surgical tools and techniques to implant the prostheses have become available. Of the excisional arthroplasties, one-piece and two-piece hinge designs, constrained by screws or unconstrained, cemented and non-cemented, have been designed (1) Surgeons now perform these procedures as day surgery, and leave as much original bone as possible in the likelihood of replacing the prosthesis as the patient ages.

At the time of surgery, synovectomy and soft-tissue balancing procedures are often performed to increase lateral joint stability or enhance the biomechanical advantage of the tendons around the operated joint. These procedures may necessitate post-operative immobilisation, specific joint positioning and strict motion protocols to achieve the best soft tissue range of motion and stability around the prosthesis (2-6).

The efficacy of postoperative therapy regimens also requires research, as they affect patient outcome, and are time-consuming and expensive. The aim of this review is to determine which postoperative regimen are most effective in achieving freedom from pain and function, and if any particular regimen is best suited to a specific prosthesis or soft-tissue balancing procedure at the time of surgery.

2. Method

For inclusion in this review, studies had to evaluate the efficacy of a post-arthroplasty regimen for patients who had metacarpophalangeal or joint arthroplasty. Preferred study designs were meta-analyses, systematic reviews, and randomised controlled trials, but all published literature except expert opinion was accepted. Patients may have received any type of implant and soft-tissue procedure, due to rheumatoid arthritis, osteoarthritis or trauma.

Electronic databases searched were the Cochrane Musculoskeletal Disease Group Register, The Cochrane Library of Systematic review, Google Scholar, and Scopus. Manual searches included of the Journal of Hand Therapy, Hand Therapy and the Journal of Arthroplasty. Search terms in all combinations included 'joint replacement, hand, wrist metacarpophalangeal, arthroplasty, rehabilitation, post-operative, occupational therapy, physical therapy'. The search included papers from 1990 onward, aiming to find research about currently used prostheses and not prostheses of older designs and materials.

Studies were appraised as described by the Cochrane Collaboration (7) for sources of methodological bias that could decrease the internal validity of a study. The types of methodological bias were in patient selection, equality of treatment, attrition of patients, and detection of all relevant outcomes. If the study could not be fully appraised from the publication, information was sought by writing to the authors.

3. Results

Sixteen studies described post-operative therapy for MCP joint replacement in enough detail to understand the treatment schedule. Four hundred and twenty-seven patients in these studies had rheumatoid arthritis, 19 had osteoarthritis and one had psoriatic arthritis. There were four randomised trials (one about post-operative therapy), three prospective cohort studies, three prospective case series (two about post-operative therapy), one case study about post-operative therapy, and the remaining were retrospective case series. Missing data was obtained from two authors, to assist in reviewing the rigour of the studies, but many authors could not be contacted.

The randomised controlled trial study found to specifically compare post-operative regimes for metacarpophalangeal arthroplasty (8) randomised patients into postoperative therapy groups that both included dynamic splinting, but the treatment group also included continuous passive motion. These researchers found no difference between treatment groups. Thomsen, Boeckstyns and Leth-Espensen(2003) (9) and retrospectively reviewed consecutive patients who had either dynamic MCP extension splinting, or had static splinting that was removed for exercises post-operatively. They found that residual extension lag was significantly less ($p = 0.002$) in the dynamically-splinted group, concluding that postoperative dynamic splinting was useful. Groth, Watkins and Paynter, (1996)(10) retrospectively compared patients who had dynamic flexion with those who had dynamic extension splinting, and found that those who had post-operative dynamic flexion splinting had greater post-operative MCP flexion. Burr, Pratt and Smith (2002)(11), Burr and Pratt (1999)(12) focussed their research on post-operative therapy, but neither study had a comparison treatment group. No further studies compared post-operative treatment regimes, therefore the results of the remaining studies can only be appreciated as a combination of surgery, implant and post-operative therapy.

One outcome common to nearly all postoperative patients in every study was the relief of pain once the diseased joint had been removed by surgery. Negative outcomes such as wound infection, implant loosening and migration were reported, in small proportions. Compliance with splinting and therapy was not discussed. Sixteen studies described the outcome of different implants and postoperative therapy regimes for MCP arthroplasty.

Features common to many regimens (Table 1) were postoperative avoidance of any hand activity for the first three to six weeks and long-term avoidance of ulnar forces on the fingers. Nearly all regimens began between the second and seventh postoperative day.

Regimens could be divided into two main categories with regard to splinting and exercise. Static splint regimens involved removal of the splint for active MCP range of motion exercises, and dynamic splint regimens involved active-assisted MCP extension and active MCP flexion exercises within the splint.

STUDY AND DESIGN		PARTICIPANTS	TREATMENT	OUTCOME	POTENTIAL FOR BIAS
Escott, Ronald, Judd and Bogoch 2010(13) Prospective cohort		N=33 with RA MCP flexion mean 89-91° extension lag mean 61-65°.	Treatment groups had Neuflex or Swanson joint prostheses. Day 4-6 Resting Splint, neutral wrist, 40° MCP flexion, 10-20° Week 1-3 MCP AROM flexion and extension and PROM for wrist and IP Patients were instructed to remove the splint only for ROM exercises during the next 3/52 3/52 PROM MCP flexion and extension of joints 4/52, splint removal for light ADL and ROM Splint wear at times of risk and at night. 6/52 splint at night only, and strengthening initiated Night splinting to minimum of 3/12 Patients educated to avoid positions of deformity.	One Year Outcomes: Both group showed significant improvement in mean Sollerman score and all 6 MHQ domains (p=.001), and MCP extension (mean ROM not provided) Both groups showed significant increases in grip strength improved significantly at the larger Jamar grip position 4 but not smaller positions 2&3 No significant differences between treatment groups, except those with Swanson implants demonstrated higher Michigan Hand Outcomes Questionnaire scores.	Patient selection included highly variable patients Detection of outcome may be inadequate at one year. Detection of outcome may not be powered Detection suffers from no comparison group
Harada, Okumura and Takahashi 2010(14) Retrospective case series		11 patients with RA mean AROM MP 52/95 Mean grip 5.1 kg	Patients had Swanson or Avanta silicone implants. Day 4-5: An outrigger splint was used for MPJ extension. Rubber band was pulled on an angle toward the radial-sided finger. Active flexion and passive extension of MPJ on the outrigger splint was started. 2/52 An outrigger splint was added for MP flexion. Outrigger splints for MP flexion and extension were used alternately every hour and alternately each night. 3-4 /52: Active and gentle passive motion of MPJ. 6 /52: Use of hand in light ADL.	mean follow-up 8.7/12 (4-14) mean AROM MP 5/65 Mean grip 4.9 kg	Patient selection included highly variable patients Detection of outcome may be inadequate at one year. Detection of outcome may not be powered Detection suffers from no comparison group Attrition of patients from series
Chung, Burns, Wilgis, Burke, Regan, Kim and Fox 2009.(15) Prospective cohort		N=70 with RA Michigan Hand Outcome Questionnaire mean score =37/100 (18) Grip=5.7(6) Key Pinch=3.5(2)	Patients had Swanson implants. Day 5-7 Dynamic MCP extension splint all times for 6/52 6/52 light ADL, splint worn in evening only 12/52 splint is discharged, normal ADL allowed.	One Year Outcomes: Michigan Hand Outcome Questionnaire mean score =59/100 (22) Grip=6.2(5) Key Pinch=3.1(2)	Patient selection included highly variable patients Detection of outcome may be inadequate at one year. Detection suffers from no comparison group

STUDY AND DESIGN	PARTICIPANTS	TREATMENT	OUTCOME	POTENTIAL FOR BIAS
Pettersson, Wagnsjo, Hulin 2006(16) Randomised trial	N=40 with RA Mean pain 3.5-4.5/10 Mean extension deficit 51-53° Mean MCP arc of motion = 33°	Patients randomly allocated to have NeuFlex or Sutter implants. Day 0-5 hand immobilised in plaster, only PIP joints free. Day 5 active mobilisation was started 3-5/24. Static splint allowed full PIP ROM, restricted MCP 0- 20°and stabilised the MCP in radial and ulnar deviation and gave volar support for t MCPs 6/52 splint replaced by night extension splint used for the first year to prevent ulnar deviation. Gradually increased motion initiated without radial and ulnar pressure 8/52, daily activities without weight bearing in ulnar direction were allowed. 3/12, no restriction except for ADL or work.	One Year Outcomes Mean pain 2.8-3.5/10 Mean extension deficit 20-21° Mean MCP arc of motion =49°	Patient selection included highly variable patients Detection of outcome may be inadequate at one year. Detection suffers from no comparison group
Nunez and Citron, 2005(17) Case series (uncertain if prospective)	N=seven patients, 10 implants with OA Mean pain = 68%, mean MCP arc of motion = 43°, patient-perceived strength 31 %, patient-perceived satisfaction 44%	Patients had Ascension two piece unconstrained prosthesis. First 48 hours Patient asked to flex fingers in post-operative dressing After 48 hours, dressings are removed and patients may use passive assistance to achieve full ROM as soon as possible.	Follow-up one to four years one patient had a slight temporary wound inflammation Mean pain = 3%, mean MCP arc of motion = 52°, patient-perceived strength 86%, patient-perceived satisfaction 93%	Detection of outcome may be inadequate at one year. Detection of outcome may not be powered Detection suffers from no comparison group
Rettig, Luca and Murphy 2005(18) Retrospective case series	N=12 with OA Metacarpophalangeal joint flexion was 53° no excessive MCP ulnar deviation	Patients received Swanson implants, some had grommets over their implants. Day 0 to 3-7 Patients were placed in a bulky wrist, MCP PIP immobilization and flexion commenced Day 3-7Gentle active extension and flexion Until 6-8/52 night, static extension splint. 4/52 strengthening program.	6-8/52 MCP flexion 59° Nine patients noted excellent overall improvement, three said good overall improvement Nine may not be powered patients stated excellent pain relief, one patient had good pain relief, and two had satisfactory pain relief. Nine patients 9 reported functional improvement > 75% Seven patients were able to perform the Jebsen-Taylor functional assessment within the normal time.	Detection of outcome may be inadequate at one year. Detection of outcome may not be powered

STUDY AND DESIGN	PARTICIPANTS	TREATMENT	OUTCOME	POTENTIAL FOR BIAS
Moller, Sollerman Geirjer, Kopylov and Tagil 2005(19) Randomised trial	N=30 with RA, one psoriatic arthritis Active ROM =32° (range 8–58°) This was assumed to be MCP flexion. Mean MCP Extension deficit= 42-47 (2-86)	Patients randomised to Swanson or Avanta implants Day-7 hand mobilized in a dynamic extension splint, aiming to achieve 45° flexion. Night static palmar splint with MCP slightly flexed. PIP extension splint used if there was tendency to flex PIPs instead of MCPs. 4 /52goal was 70° flexion. If flexion was restricted, a dynamic flexion splint was used. 6 /52 light loading permitted, dynamic extension splint weaned 12/52 Splints discharged and loading as permitted by pain.	Two year follow-up Active ROM improved Patient selection included to 42°(range 20–60°) after surgery (p= 0.04) highly variable patients in the Avanta group, whereas no Detection suffers from no significant improvement was seen in the therapy comparison Swanson group. group. Mean MCP Extension deficit= 16-19 (1-43)	
Parkkila, Belt, Hakala, Kauppiainen and Leppolahti 2005(20) Randomised trial	N=53 patients with RA, 58 hands operated.	Patients randomised to receive Sutter or Swanson prostheses. All received physiotherapy for 2/12, seven having continuous passive motion in and out of hospital. 2/12 five patients had finger manipulation if they were stiff.	Four - Five year follow-up Five patients died, one was lost and two highly variable patients had strokes. Six patients (three from each group) had revision surgery. More patients Attrition of patients showed osteolysis around the implant, if Detection suffers from no they had Sutter implants, over Swanson group implants.	
Thomsen, Boeckstyns and Leth-Espensen 2003(21) Retrospective case series	N=22 Pre-operative measures not available	Patients received Swanson implants. Group 1 Dynamic splint_ Day 6-4/52 dynamic extension and radial deviation splint used continuously active assisted flexion and passive extension exercises encouraged during the same period. Patients attended physiotherapy 3-5/7. Week 4-6/52 dynamic splint was night only Group 2 No dynamic splint Day 0-5/7static splinting, exercises as described above were encouraged without the splint, static splint retained between exercises. 2/52 day time static splinting discontinued 2-4/52 night static splinting	Group 1 Dynamic splint(<i>n</i> = 41) nearly 5 years follow up Extension lag 10 (0-50) Flexion 60 (5-90) Range of movement 45 (5-80) Ulnar deviation 10 (0-30) Group 2 No dynamic splint (<i>n</i> = 29)) nearly 2 years follow up Extension lag 20 (0-45)* Flexion 60 (30-80) Ulnar deviation 10 (0-20) * <i>p</i> = 0.002 Patient selection may have included highly variable patients-no data Detection of difference in outcome may not be powered Attrition of patients high from both groups	

STUDY AND DESIGN	PARTICIPANTS	TREATMENT	OUTCOME	POTENTIAL FOR BIAS
Radmer, Andresen and Sparman 2003 (22) Prospective Case series	N=eight women with RA marked ulnar deviation. mean active flexion = 30 (15-40°) mean extensor lag 55° (40-100)°.	Patients received WEKO hinged implants Day 0 - 2or 3 hand immobilized in palmar forearm plaster splint Day 2-3 - 6/52 dynamic splint. Position not described Exercises for the fingers were performed out of the splint, without restriction. Exercises not described.	One Year Outcomes: 20/28 prostheses had migrated mean active flexion = 30(22-35°) mean extensor lag 42° (40-48)°. average ulnar deviation 20° (0-50)°	Detection of outcome may be inadequate at one year. Detection of outcome may not be powered Detection suffers from no comparison group
Ishikawa, Murasawa and Hanyu 2002(23) Retrospective case series	N=64 with RA, 20 implants into the thumbs Mean MCP flexion= 72-73° Mean MCP extension lag=35-39° Pain=23-28/100	Patients received Swanson implants, some had grommets over their implants. Those with thumb implants received a 'flexible hinge toe implant'. Day0-5 a 'short arm splint' was worn Day 5 - 6/52 dynamic splint (assumed to be MCP extension) with AROM and PROM of MCP joints	Mean follow-up six years 12 revision surgeries Mean MCP flexion= 49-50° Mean MCP extension lag=15-28 Pain=0-6/100	Patient selection included highly variable patients Attrition of patients from series Detection suffers from no therapy comparison group
Burr, Pratt and Smith, 2002 (11) Prospective Case series	n = 15 with RA	Swanson prostheses Day 5-7 - 4/52:Two static splints, alternated 24 hourly, with MCP at 0° in one splint, and 60° flexion in the other. No ADL	Mean MCP flexion unchanged; improvements in pain, MCP extension, and power grip At 8/52	Detection suffers from no therapy comparison group ncies of studies reporting inadequate at 8/52
Burr and Pratt, 1999 (12) Case study	n = One patient with RA	3/52 biofeedback to finger flexors and extensors no heavy lifting 4/52 IP ROM, MCP flexion , RD 3-10x hourly, 4/52 Light ADL 8/52 normal ADL 12/52 return to work, heavy lifting	0-15° MCP extension and 60-70° MCP flexion at 8/52.	
King, Simmons and Hayes, 1998 (8) RCT	n = 25 with RA	"Silicone arthroplasty" Day 2-7 Dynamic MCP extension splint with RD, until 6/52 Night MCP 0° for 12/52 MCP and IP ROM 3-10 every hour 2 hours in splint; RD at 4/52 Treatment group IP ROM, received MCP CPM No pinch for 12/52	at 5/12 CPM group did not achieve significant increases in ROM or strength MCP flexion at 8/52.	Detection of outcome may be inadequate at 5/12 Detection suffers from no therapy comparison group

STUDY AND DESIGN	PARTICIPANTS	TREATMENT	OUTCOME
Groth, Watkins and Paynter, 1996 (10) Retrospective case series	n = 34 patients, 46 hands with RA	Timing not recorded Treatment group Dynamic MCP flexion splint Night static splint, MCP 20–30° flexion	Uncertain of follow-up duration Treatment group had significantly less MCP flexion than cohort, but more MCP extension
Stothard, Thompson and Sherris 1991 (Prospective cohort)	N=25 patients with RA Mean ulnar deviation preoperatively 34°	Thirteen patients had Swanson MCP implants and crossed intrinsic transfer, 12 patients had MCP implant only. Day 3 static resting hand splint with high ulnar borders for all patients, removed four times daily for active radial deviation, flexion and extension. Day 8-10 PROM ;no further details 3/52 splint worn at night only, light ADL 4/52 commenced occupational therapy, no further details	Follow-up 6-33/12 Five patients lost to follow-up Mean ulnar deviation 8° One infection occurred, one required amputation Five patients in each treatment group had occasional pain or pain on use of hand. Eighteen patients had much improved function, three had no function and three hand decubiti post-operatively. Crossed intrinsic transfer resulted in greater ROM

ADL=Activities of Daily Living, MCP= metacarpophalangeal, IP= interphalangeal joints; RD= radial deviation; CT= controlled trial; ROM= range of motion, RA=rheumatoid arthritis OA=osteoarthritis

Table 1. Studies reporting post-operative therapy for metacarpophalangeal arthroplasty, their design and outcomes.

4. Discussion

Sixteen studies described the outcome of different implants and postoperative therapy regimes for MCP arthroplasty. Two of these studies compared the efficacy of one regimen over another, one of these being prospective. Sambandam, Gul and Priyanka (2007)(25) state that 'most studies undermined the importance of this aspect (post-operative treatment) of the procedure' with regards to first carpometacarpal joint arthroplasty, but their claim could be expanded to arthroplasty of other joints of the hand. Post-operative protocols for splinting, activity and exercises are not always well-described, so although there were numerous studies about MCP arthroplasty, they are not included in this review.

Hand therapy for other conditions such as flexor tendon repair also offers multiple postoperative regimens. For example, healing tendons of the hand usually receive motion, but it may be passive, active, or a combination of all of these. The rationale for the various exercise regimens is based on biological healing of the tendon and the strength of the surgical repair, thus its ability to withstand stress without rupturing or gap formation (26,27). These patients usually have normal anatomy preoperatively, leaving few patient variables. Postoperative therapy regimens for MCP arthroplasty are also based on principles of healing and scar formation, but are not prescribed according to the patient's preoperative hand impairment, the type of implant used, or soft tissue balancing procedures performed. For example, patients having undergone extensor tendon rebalancing and recentralization may benefit from avoidance of passive flexion or avoidance of the extremes of flexion, much like a postoperative extensor tendon repair regime. The literature suggests that postoperative therapy for MCP arthroplasty has not been prescribed in this manner; rather, standard protocols have been designed and applied to consecutive patients.

To compare the efficacy of a new protocol, many patients would be required for allocation to various postoperative therapy groups. Their outcomes would have to be analyzed according to what protocol they received with the implant, surgery, and preoperative status as variables. The first difficulty in forming control or comparison groups lies in the infrequency of this procedure; for example Ring et al.(8) took three years to include 25 hands in their study.

The most common source of bias in the studies was selection bias, which occurs when patients are chosen for treatment or control groups as a result of characteristics that are expected to affect their outcome. Randomization is designed to control the confounding effects of differences between subjects at baseline, and the randomized trial is recommended as the best method of determining treatment efficacy. Here lies the second difficulty in forming control or comparison groups. Patients undergo MCP arthroplasty at all stages of their disease, evidenced by the wide range of motion deficits between the studies of Burr and Pratt, in which the case study patient had nearly normal preoperative MCP motion, and Burr et al., in which some patients had only 25° of MCP flexion. Measures of pain also varied widely in the latter study, ranging from "zero" to "eight out of ten." These baseline measurements demonstrate the difficulty in obtaining a homogeneous, comparable group of patients with rheumatoid arthritis.

The other three sources of bias described by the Cochrane Collaboration(7) were present in the reviewed studies. Performance bias occurs when patients receive a variation in duration,

quality, or quantity of the treatment being studied, which was suspected in the continuous passive motion (CPM) study by Ring et al. Ring et al. describe the application of CPM in detail, except passive forces are described as "low" and treatment quantity is described as "as tolerated." As a result, the reader remains unsure of what amount of passive force is ineffective, as well as what quantity of treatment per day is ineffective.

Detection bias is determined if the timing of assessment, the outcome assessment used, or knowledge of the assessor of the patient's previous state could miss any relevant aspect of the outcome. This may have occurred in the study by Groth et al.,(10) in which some preoperative data were unavailable and patients were assessed at different postoperative time frames. Detection and comparison of outcomes between studies are only possible when the same outcome measures are used in a standardized manner. The researchers in this review all measured range of motion, but at different time frames (Table 1). Those who measured pain, cosmesis, and function applied different assessments at different time frames. The challenge of outcome measurement in rheumatology has led to the formation of focus groups such as OMERACT (Outcome Measures in Rheumatoid Arthritis Clinical Trials), who have made recommendations for outcome measures to be used in drug trials. OMERACT recommendations are not fully relevant to hand therapy research; however, the process of forming a focus group, and the development of assessment guidelines that allow comparison between homogeneous patients, is possible (28).

Attrition bias is determined if the loss of patients in the study is significant or varies between the treatment and control groups. This is common in long-term studies involving patients with rheumatoid arthritis, and was experienced by Groth et al.,(10) who were unable to obtain long-term follow-up of the patient group who received their extension protocol. Long-term follow-up is an issue with rheumatoid populations. These patients undergo numerous surgical and drug interventions, while their disease progresses and fluctuates, making the long-term effects of the MCP surgery and therapy difficult to define. Once more, large numbers of patients in each treatment group would be required to decrease the effects of attrition bias and to dilute the effects of subsequent interventions.

The difficulties of past studies guide the planning of future studies. Although the issues of low patient numbers, variable preoperative status, additional surgical and drug interventions, and chronic disease cannot be altered, study designs can. Large randomized trials may not be possible; however, samples of patients, paired according to preoperative status, may be allocated to different treatment protocols. Standardized measurement of pain, cosmesis, impairment, disability, and impact on the patient, made at similar postoperative time frames, would further assist in determining treatment efficacy.

5. Conclusion

This review suggests that *all* regimens contribute toward an increase in MCP motion and an increase in hand function, but despite the efforts of patients and clinicians, hand therapists remain unaware of the most effective postoperative protocol for MCP arthroplasty or the suitability of each regimen for specific implants and soft-tissue

procedures. Difficulties in researching this topic include low patient numbers, highly variable preoperative status, lack of guidelines for outcome measures and time frames, and the effects of subsequent interventions received by the patient. The nature and size of the population with rheumatoid arthritis and MCP arthroplasty do not readily fit the randomized, controlled trial design. Paired sample designs are suggested, as well as the formation of standard outcome measures, for better comparison of results between patients.

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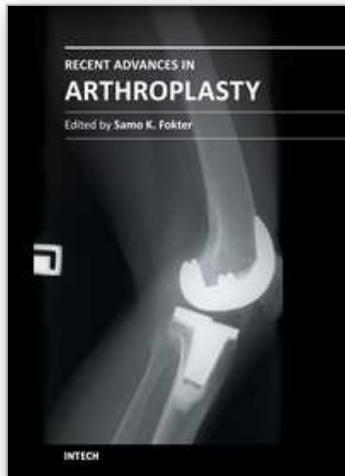
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The purpose of this book was to offer an overview of recent insights into the current state of arthroplasty. The tremendous long term success of Sir Charnley's total hip arthroplasty has encouraged many researchers to treat pain, improve function and create solutions for higher quality of life. Indeed and as described in a special chapter of this book, arthroplasty is an emerging field in the joints of upper extremity and spine. However, there are inborn complications in any foreign design brought to the human body. First, in the chapter on infections we endeavor to provide a comprehensive, up-to-date analysis and description of the management of this difficult problem. Second, the immune system is faced with a strange material coming in huge amounts of micro-particles from the tribology code. Therefore, great attention to the problem of aseptic loosening has been addressed in special chapters on loosening and on materials currently available for arthroplasty.

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