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Joint Replacement Surgery for Complicated Fractures of Small Joints of Hand: Results of Five-Year Follow-up Study

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Abstract
Introduction: *Complicated Intra articular fractures of fingers are prone to stiffness, chronic pain, deformities and post traumatic arthritis with conservative treatment. Attempts for fixation also result in a high incidence of joint stiffness, pain and secondary arthritis. Ideal treatment should avoid the above complications and provide an early mobilization of a stable and congruent joint. The purpose of this study was to investigate the results of complicated intra-articular fracture of the fingers treated with total joint replacement.*
Methods and Materials: *From January 2012 to December 2013 a total of eighteen joints (seventeen patients) with complicated intra-articular fracture of the fingers (PIP and MCP joints) were treated by total joint replacement using silicone implants. Of the 18 cases, 8 involved metacarpophalangeal joint, and 10 involved proximal interphalangeal joint. All patients were followed up for mean of 62 months and the results were assessed using total active motion (TAM) of fingers.*
Results: *Subjective, objective and radiographic results were evaluated. There was phalangeal shortening (4mm) in 1 case and rotation (> 15 degrees) in 1 case. Based on Total Active Motion Score (TAM), the overall rate of joint motion function was 87.1%.*
Conclusion: *Total joint replacement can be a reliable and effective option for treatment of complicated intra-articular fracture of the fingers.*
Keywords: *Complicated fractures, Joint Replacement, Metacarpo-phalangeal joint, Proximal interphalangeal joint.*

Introduction

Intra articular comminuted fractures of proximal inter-phalangeal (PIP) and Metacarpo-phalangeal (MCP) joints are common injuries. The usual treatment methods are open or closed reduction and internal or external fixation. Because of the complex nature of the injuries and small size of the fragments, fixation remains unstable, requiring

immobilization for a period ranging from two to six weeks. Immobilization often leads to stiffness of varying degrees and extension lag, which results in reduction of the grip strength. This also makes the joint prone to stiffness, chronic pain, deformities and post traumatic arthritis.[1] Even surgical treatments of unstable fractures have incidence of hardware-related adhesions, tendon rupture, and infections.[2]

In painful arthritis of PIP joints as well as in rheumatoid arthritis of the finger joints, joint replacement is an established alternative to joint arthrodesis.[3] It has good results when there is an intact or reconstructable central dorsal aponeurosis, intact collateral ligaments and a good bone stock of the finger.

One of the advantages of PIP joint replacement is maintenance of the joint motion with diminished pain and early return of function. The disadvantages can be loosening, dislocation and pain. [4,5,6,7,8,9]

This pilot study was done to observe the results of treatment of the small joints of the hand, with total joint replacement using silicone implant. The mean period of observation was 5 years.

In a period of 24 months, eighteen joints (10 PIP and 8 MCP) in seventeen patients were operated with joint replacement using a silicone implant where fixation was not possible due to various reasons.

Five years follow-up showed satisfactory results with no major complications.

Methods and Materials

18 joints (17 patients) which presented between January 2012 and December 2013 with complicated fractures of PIP or MCP region with non-salvageable joint, were selected for the procedure.

The mean age of patients was 37.3 years (range 18-52 years). Of the 18 cases, 8 involved metacarpophalangeal joint, and 10 involved proximal interphalangeal joint. Roadside accidents were the cause of injury in 9 patients. Three patients had a domestic injury, three had sports injury, two had industrial injury, one had history assault. (Figure No.1)

Fractures which were comminuted with bone loss, neglected with stiff, painful and/or deformed joints were considered complicated (non-salvageable). (Figure No.2)

The risks and benefits were discussed in details with the patients.

The patient position was supine with pronated hand. Wrist block anesthesia was given using Xylocaine. Rubber tourniquet was applied to the finger. A dorsal curving incision was taken over the PIP/MCP joint till the extensor apparatus was exposed. An incision was made between the central tendon of the extensor mechanism and the lateral band on one side of the digit, and the dorsal joint capsule was opened. The head of the proximal phalanx/metacarpal was resected using a micro oscillating saw. A rasp/awl combination instrument was used to make canals in the base of middle phalanx/proximal phalanx. Sequential trial implants were fitted and joint movement and stability assessed. (Figure 3(b)) PIP *Neu Flex* MCP/PIP Finger Joint Implant (*Depuy*) of suitable size was implanted. (Figure No.3)

Tourniquet was released and hemostasis was obtained. The dorsal capsule and extensor apparatus was sutured back using 4-0 non-absorbable sutures. Skin was sutured using 3-0 Non absorbable sutures. Post op Xray was done on 2nd day of surgery, followed by a gradual and supervised range of movement exercises. (Figure No.4)

Results

The mean follow-up time was for 63 months (range 48-72 months). Of the initial 19 patients (20 joints), two were lost to follow-up after a year, leaving 17 patients ie.15 males and 2 females, ie. 18 joints in the study group. 8 involved metacarpophalangeal joint, and 10, proximal interphalangeal joint. (FigureNo.5)

Regular follow up was maintained, for five years, which included clinical examination, subjective satisfaction and X-rays.(Figure 6&7)

Average days taken to resume all activities were 29.5 days, with the maximum duration being 42 days and minimum being 21days. (Figure No.8)

No patient had any radiologic signs of loosening, heterotopic bone formation or dislocation.

The fingers had, on an average, 5 degrees of flexion deformity to a further painless flexion of 90 degrees. (Figure No.9). The range of motion was measured with a goniometer. Kleinert and Verdan's Total Active Motion assessment (TAM) system was employed to assess the results. [18] The TAM score was calculated by the following formula: TAM = [MCP + PIP + DIP flexion] - [MCP + PIP + DIP extension lag]

Ratings were obtained by comparing with the contralateral finger. Information related to resuming of work and activities of daily living was also recorded.

The average TAM score at the end of five years was 227 and average TAM percentage was 87.1%. (Figure No.10, 11, 12)

Figure No.1: Mode of Injury

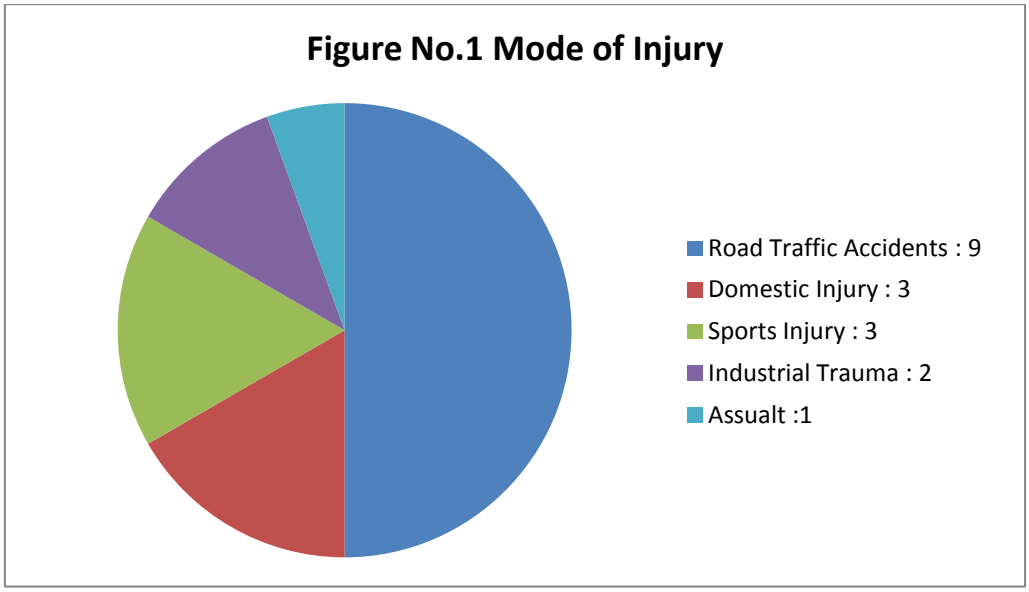

Figure No.2: X Ray (a & b) and CT Scan (c, d & e) of a complicated (untreated) intra-articular fracture of base of middle phalanx of ring finger

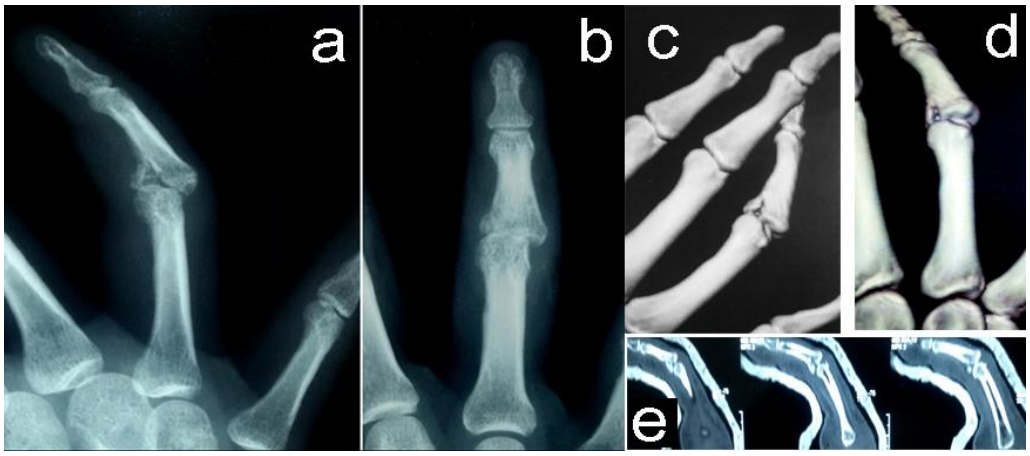

Figure No. 3: Instruments and implants used for surgery - Rasp/Awl combination instrument (a), Trial implants (b), Trial Implants (c)

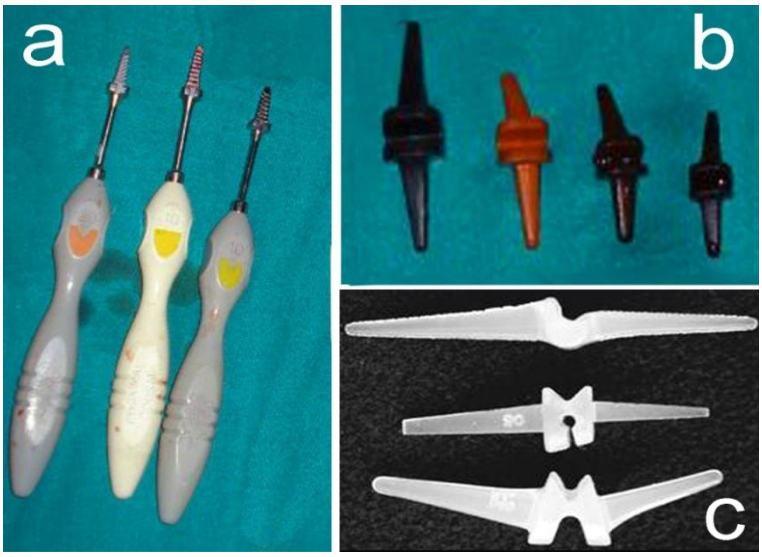

Figure No. 4 : Immediate post-operative x ray of finger

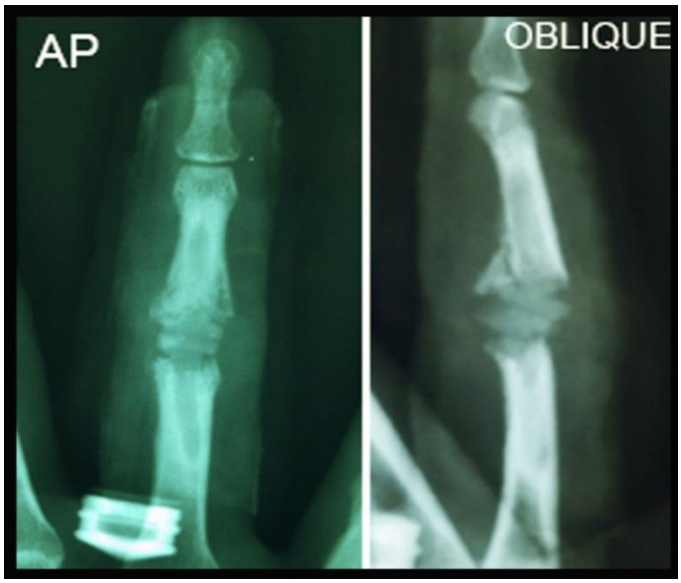

Figure No. 5 Distribution of sites of Injury

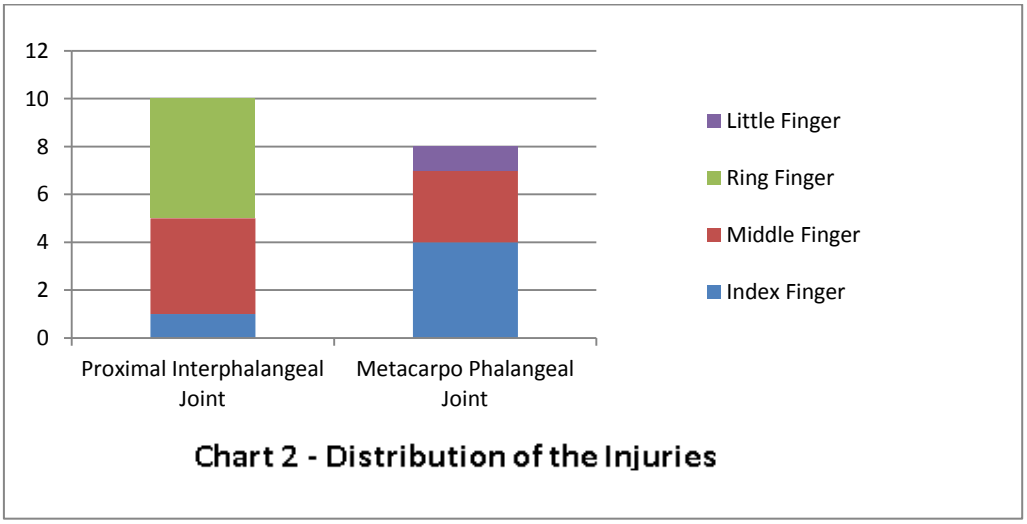

Figure No.6: 2-years after surgery

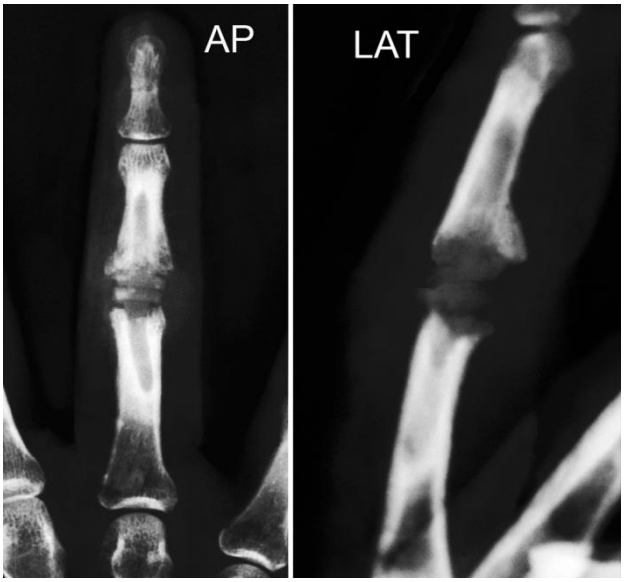

Figure No.7: X ray of the finger at 4-years follow-up

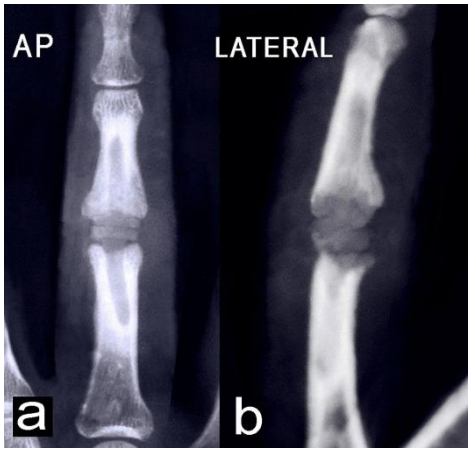

Figure No.8: Days to work

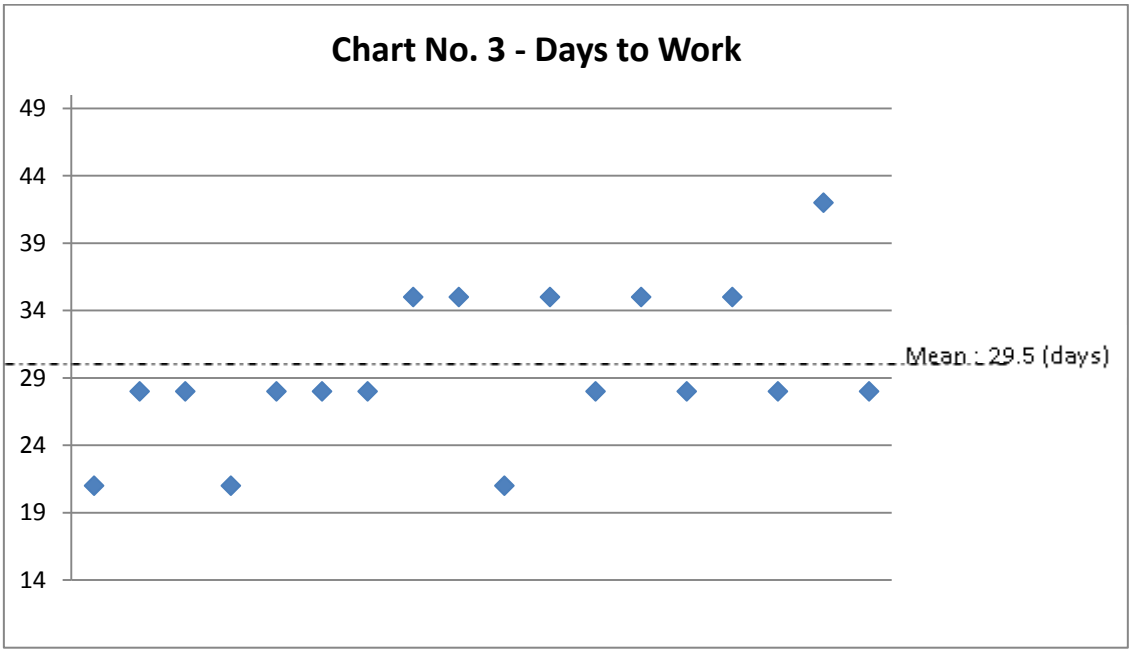

Figure No.9: Range of motion 4-years after surgery

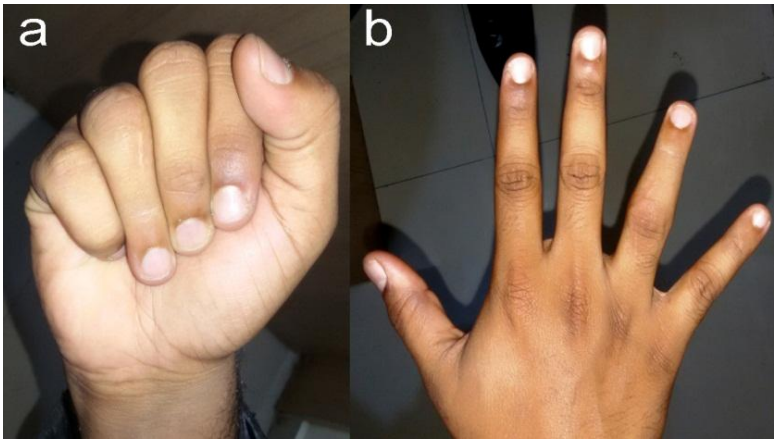

Figure No.10: Total Active Motion (TAM)

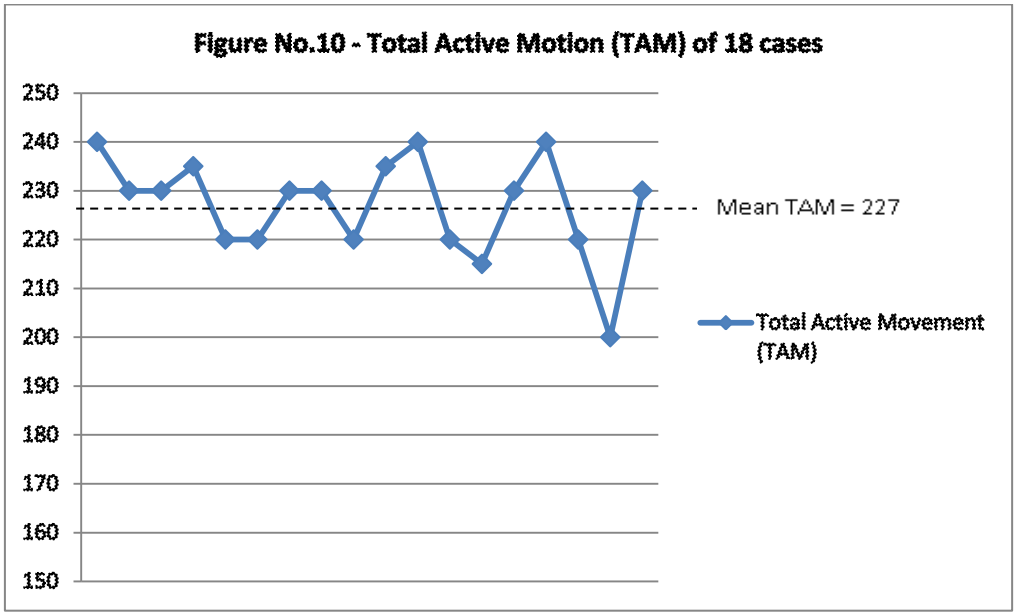

Figure No.11: Total Active Motion (TAM) Percentage

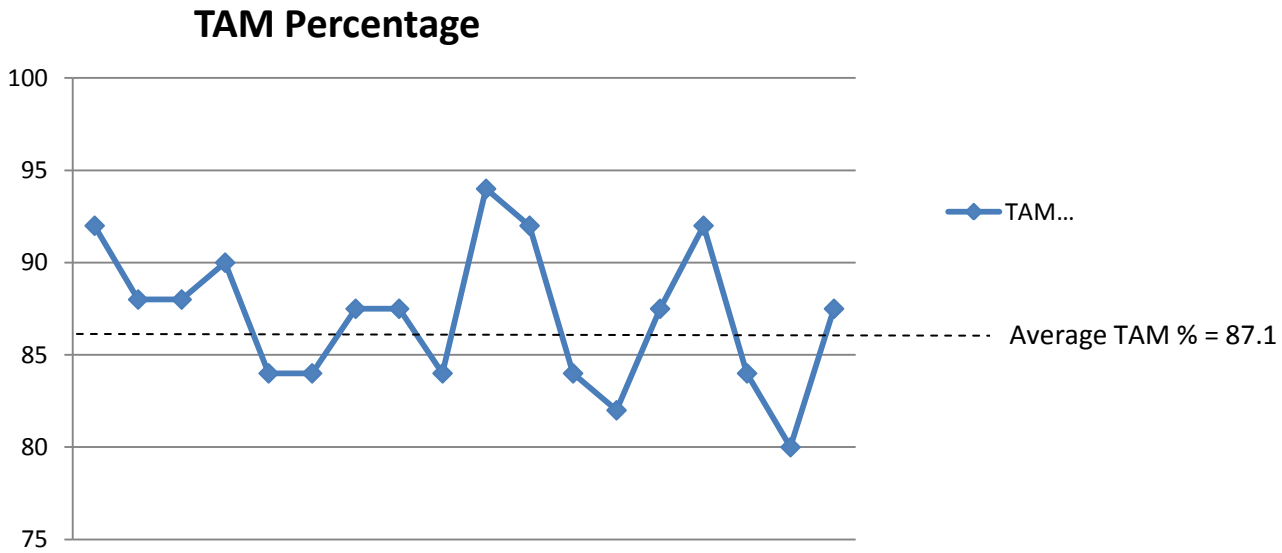

Figure No. 12: Master chart

	Joint	Indication	Follow up	TAM	TAM %
1	PIP ring finger	10 days untreated fracture of base of middle phalanx	72	240	92%
2	PIP ring finger	Comminuted neglected fracture of head of proximal phalanx	62	230	88%
3	PIP ring finger	Old untreated stiff PIP joint	63	230	88%
4	PIP middle finger	3 week old maluniting fracture base of middle phalanx	67	235	90%
5	PIP middle finger	Comminuted fracture of head of proximal phalanx with bone loss	64	220	84%
6	PIP index finger	Closed comminuted fracture head of proximal phalanx	67	220	84%
7	PIP middle finger	Closed comminuted fracture head of proximal phalanx	67	230	87.5%
8	PIP middle finger	Closed comminuted fracture head of proximal phalanx and base of middle phalanx	62	230	87.5%
9	PIP ring finger	Closed comminuted fracture head of proximal phalanx	65	220	84%
10	PIP ring finger	Closed comminuted fracture head of proximal phalanx	67	235	94%
11	MCP little finger	Neglected and painful fracture head of 5th MC	52	240	92%
12	MCP index finger	2 week old comminuted displaced fracture of head of 2nd MC	48	220	84%
13	MCP middle finger	2 week old comminuted displaced fracture of head of 3rd MC	48	215	82%
14	MCP index finger	Comminuted fracture head of MC	72	230	87.5%
15	MCP index finger	Neglected and painful fracture head of MC	67	240	92%
16	MCP index finger	Comminuted fracture head of MC	64	220	84%
17	MCP middle finger	Unreduced fracture dislocation of PIP joint	63	200	80%
18	MCP middle finger	Comminuted fracture base of proximal phalanx	62	230	87.5%
	Mean		**62.88**	**227**	**87.1%**

Discussion

The PIP is not a pure hinge joint. It has a natural range of motion of 0–100° with a roll and glide movement around an imaginary screw axis with a variable center of rotation due to the alternating tensing and relaxing mechanism of the collateral ligament system.[10] Maintaining the normal joint mechanics is essential for optimum functioning. Complicated intraarticular fractures cannot be anatomically reduced by closed technique sowing to the very small fragments of fractured bones, and open reduction and internal fixation predisposes the joint to stiffness. Irrespective of the treatment method, immobilization is usually mandatory, that almost always results in a significant amount of joint stiffness. There is also a vast incidence of secondary arthritis of the joint. Thus, the available fixation methods demand some compromise that is usually obtained by sacrificing a significant degree of movements

Small joint replacements may open up a new avenue in the management of such complicated fractures, though large scale studies have to be undertaken to study all the possible complications and the longevity of such procedures. [15, 4, 5, 6, 8, 10] It can be an option in such non-salvageable cases to maintain function, joint stability and a painless range of motion. Several models of PIP joint prosthesis were developed. [10,11,12] Constrained silicone prosthesis with hinge joints, originally developed for patients with rheumatoid arthritis, as well as semi-constrained prosthetic systems used in posttraumatic and idiopathic arthritis often led to joint instability and prosthetic fractures.

In review of literature, the range of motion after PIP joint replacement is quite satisfying but best results are achieved in patients with degenerative and posttraumatic arthritis compared to patients with rheumatoid arthritis. The median active range of motion is mentioned between 30° and 47° for the pyro-carbon prosthesis (ASCENSIONTM), 30–44° for silicone prosthesis, 47° for AVANTA SBi, 29–60° for a ceramic prosthesis (Moje®) and 29–37° for vascularized toe joint transfer. [3,4,13,14, 15]

Common postoperative complications with PIP joint replacement mentioned in the literature are (1) tendon adhesions leading to loss of motion, (2) migration of the prosthesis/heterotopic bone formation/aseptic prosthesis loosening, (3) swan neck deformity and (4) infection of the implant bed [4,5,6,7,8,9]

The operative approach has always been a point of discussion in finger-joint replacement therapy. [16] Some authors prefer the dorsal approach [10, 17] and some the palmar approach[18,19] stating they would have less rates of tenolysis because the extensor tendon apparatus remains intact. Herren et al. found a significant smaller range of motion in pyrocarbon prosthesis after the dorsal approach (32°) compared to the palmar approach (53°). [19]. A typical disadvantage of the palmar approach is the bowstring of the flexor tendon and the dorsal subluxation of the base of the middle phalanx producing a swan neck deformity because the palmar plate has to be incised.[18]

In the largest series, 82 PIP joint prostheses were investigated (46 degenerative, 17 posttraumatic, 19 rheumatoid arthritis).[7] The mean PIP range of motion was 31° pre- and 47° postoperatively at an average follow-up of 64 months. Seventy percent were free of pain; in 11 fingers, 12 (15%) secondary procedures such as tenolysis of the extensor tendon had been necessary and an additional two revisions with implantation of new prosthesis because of dislocation (one patient had rheumatoid arthritis). Three prostheses showed radiologic signs of loosening and only a few patients showed heterotopic bone formation; however, no reoperation was needed. The best results were seen in patients with posttraumatic and degenerative arthritis.

Thus, long-term follow-up investigations are needed to rule out the clinical relevance and biodynamic impact of such heterotopic bone formation.

Conclusion

Joint replacement can be used as an alternative to fixation in complicated comminuted fractures involving PIP & MCP joints, as an alternative to arthrodesis. It provides a good range of motion and pain relief.

Long-term follow-up is needed to assess biodynamic impact, its longevity and other complications like heterotrophic bone formation around the prosthesis.

Grants: Nil

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