Pyrocarbon Proximal Interphalangeal Joint Arthroplasty: Outcome Audit in the Patient’s Environment

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Citation

Abstract
A retrospective audit was carried out to evaluate the objective and subjective outcomes of pyrocarbon proximal interphalangeal joint replacement. Fifteen arthroplasties in 14 patients performed by the senior surgeon with a minimum follow-up interval of six months were included. Patients were visited at home, examined clinically and given questionnaires to fill in. The mean follow-up time was 27.4 months. The main indication for the procedure was pain. The patients had osteoarthritis, rheumatoid arthritis or post-traumatic arthritis. Infection and wound healing problems were not reported. Post-operatively, the range of movement improved. Radiographs were in keeping with the manufacturer’s description of lucent zones. Pain was reduced and patients were satisfied with the procedure. The evaluation at home yielded qualitative data that is not possible to obtain at an outpatient clinic. The home visits provided an invaluable insight into the impact of the procedure on the patients.

INTRODUCTION
Dysfunction of the proximal interphalangeal joint (PIPJ) may have a negative effect on the quality of life. Two commonly employed surgical techniques for this joint are arthrodesis and arthroplasty using silicone implants. Both relieve pain; the former sacrifices movement for stability and the latter attempts to preserve or restore movement, whilst maintaining stability. Burman \(^1\) was the first to report the use of PIPJ arthroplasty with a prosthetic replacement. Linscheid and Dobyns \(^2\) introduced the progenitor of today’s PIPJ prostheses. Since then, PIPJ prostheses have been developed to reproduce the natural joint surface as much as possible and to retain lateral stability.

Pyrocarbon prostheses are made with a graphite core and contain a small amount of tungsten to render them radio opaque. Pyrolytic carbon coats the core through chemical vapour deposition. The non-hinged, anatomical design is intended to produce a stable range of movement.

This study aims to evaluate the objective and subjective outcomes of pyrocarbon PIPJ arthroplasties carried out in our department between 2004 and 2008.

METHOD
A retrospective audit of PIPJ arthroplasties performed by the senior surgeon was carried out, with a minimum six-month follow-up period. Home visits were carried out when patients were examined and given questionnaires to fill in.

Our operative technique is identical to that recommended by the manufacturers with the exception that the central slip is split in the midline longitudinally, elevated at a sub-periosteal level and reflected, as opposed to the chevron tendon flap recommended by the manufacturer.

Range of movement (ROM) was measured with a goniometer. The goniometer was placed on the dorsum of the joint with the patient’s arm resting on an armrest. The active range of movement was recorded.

Grip strength was measured with a Jamar dynamometer (JA Preston Corp, Jackson, USA), with the handle at position 2. Pinch grip was measured with a Baseline pinch gauge (B&L Engineering, California, USA). All grip measurements were taken in a standard manner with the average of three readings taken as the final score.

Subjective outcome was assessed using a questionnaire similar to those used in previous studies to enable future comparative studies (Fig 1). Pain and satisfaction scores were obtained with a visual analogue scale. Other criteria, such as squeaking and joint appearance, were obtained using discreet answers, instead of free text. Preoperative variables were obtained from both the patients’ notes and the patients’ recollections during the home visit.
Data were collected on Microsoft Excel and non parametric statistical calculations were used when appropriate. A p value of less than 0.05 was considered significant.

**Figure 1**
Figure 1. Patient questionnaire

**RESULTS**

Fifteen joints in 14 patients were included in the study; 12 were female and two were male. The follow up time ranged from 7 to 44 months (mean 27.4). The mean age at operation was 62.5 years (range 38 to 82 years). Nine joints were on the dominant hand. There were three index fingers, eight middle fingers, three ring fingers and one little finger included in the study. No pyrocarbon PIPJ arthroplasty with more than 6 months follow up was excluded from this series.

The indications for the procedure were pain, stiffness and deformity. These were secondary to osteoarthritis (n=8), rheumatoid arthritis (n=4) or trauma (n=3). Patient factors such as diagnosis, hand dominance and side of hand operated on did not influence the clinical outcome and patient satisfaction.

All seven patients who were employed or had a hobby requiring intensive use of their hands returned to work or resumed their hobbies. Complications reported included deformity, stiffness, instability and subluxation. Three patients had subsequent soft tissue corrections, two for stiffness and one for instability. The primary procedures for these three patients took place in the first 15 months of this series, although these complications had no statistical association with increasing experience, patient age and diagnosis. There were no infections, implant failure or problems with wound healing. Tables 1a, b and c. Patient data, range of movement and outcome

Key to Tables: ADLs – activities of daily living; MUA – manipulation under anaesthetic; N/A – not available or applicable; OA – osteoarthritis; RA – rheumatoid arthritis; RCL – radial collateral ligament; ROM – range of movement; UCL – ulna collateral ligament

Patient data, range of movement and outcomes are shown in Tables 1a-c. The average preoperative degree of movement was 47.9 and increased to 67.7 postoperatively. However, this did not reach statistical significance. The mean change in degrees of movement was 15.3 (range –21 to 90 degrees). Patients with osteoarthritis tended to be in a greater degree of fixed flexion preoperatively than the post traumatic group. The 60-69 year old age group gained more ROM, whilst those in the 70 plus age group fared worse (p 0.036, test).

**Figure 2**
Table 1a. Patient data
Grip strength measurements were taken post operatively for all patients. Pinch tests were undertaken appropriate to the finger operated on. The hand operated on was compared to the other hand. There were no preoperative values available for comparison. The mean grip strength on the operated hand was 39.27 lbs (range 8 to 76.3 lbs) and on the contralateral hand 41.13 lbs (range 8 to 95 lbs). The pinch, lateral and tripod grip of the operated hand, when matched for age and sex, were on the low end of normal or below normal.

Postoperative x-rays were available for 13 of the 15 joints. Radiographs were taken between 2 and 34 months postoperatively (mean 10.85 months). Coronal angulation was found in five patients, ranging from 0 to 15 degrees. One joint was subluxed and loosened, in a non-dominant, osteoarthritic left ring finger. There were no findings of subsidence or erosion of the joints. We found that all prostheses were surrounded by an apparent zone of lucency 0.8 to 1mm in thickness, in keeping with the manufacturer’s literature, and representing the pyrolytic carbon layer.

Figure 5
Figure 2a. Preoperative x-rays showing AP and lateral views of left ring finger
Pain scores on the visual analogue scale decreased from the pre-operative average of 7.6 (range 0 to 10) to 1.7 postoperatively (range 0 to 7), which was significant (p<0.05, paired T test). There was a correlation between the level of preoperative pain and the degree of reduction of pain (p 0.014, Spearman’s Rho).

Ten joints were considered by the patient to look better following surgery, two remained the same and three appeared worse. Of interest, one patient whose joint looked worse after the arthroplasty reported to be satisfied with its appearance. Patients reported squeaking in six joints.

Satisfaction with the procedure scores ranged from 0 to 10, with 57.1% of patients reporting satisfaction at seven or more (mean 6.86). The only patient who scored zero had postoperative stiffness, and four patients scored 10. When asked whether they would undergo the same procedure again, ten patients responded yes, one no and two were unsure.

**DISCUSSION**

To date, there are four published works that look at the postoperative outcomes of pyrocarbon PIPJ arthroplasties with an average follow up time of more than 12 months (Branam et al., 2007; Bravo et al., 2007; Herren et al., 2006; Tuttle and Stern, 2006). Branam et al. reported on almost the same cohort of patients as Tuttle and Stern, with the average follow-up time increased from 13 to 19 months, and comparing them with a series of silicone joint replacements. Bravo et al. had the largest number of patients (n=50). The outcomes measured by Branam et al. and Bravo et al. were similar, which allows comparison of data from the two centres. Herren et al. compared the outcomes of using dorsal and palmar approaches, and the radiological findings. There have yet to be any reports on the outcomes of the procedure on a British population.

The conclusions reached in these previous studies in terms of outcome and patient satisfaction are similar to our series. The procedure significantly reduced pain. Range of movement was improved in both flexion and extension, but not significantly. A common outcome was hyperextension of the PIPJ, which is likely to be due to detachment or redundancy of the volar plate. This did not, however, appear to cause problems with the functioning of the finger.

Herren et al. reported nearly half of their cohort to show implant migration on x-ray, with one requiring joint fusion. A further three cases had increased radiolucent lines. This is in contrast with our study population which did not have any observable implant migration found on x-rays. It is not clear why such a large number of implants migrated in that study.

Preoperative pain scores were not recorded, but retrospective scores are reported to be reliable. Surprisingly, the degree of pain relief afforded by the procedure did not influence the level of satisfaction; instead being able to extend the joint further seemed to please patients more.

Squeaking was deemed an unsatisfactory outcome by patients in previous studies. The patients in our study who reported squeaking found it a curiosity rather than a negative outcome. One described entertaining her grandchildren with her musical joint. The incidence of squeaking in our group of patients was marginally lower than previous reports.

Although statistical calculations were carried out in this
study, the results were interpreted with caution. With the
small number treated, they were liable to Type I and Type II
errors, and reliance on statistical significance was therefore
minimised.

In our practice, the clinical decision to proceed with
arthroplasty is a balance of the benefit the procedure can
provide, the expectations of the patient and the actual
demand placed upon the hands on a daily basis. The
surgeon’s judgement of surgical success should incorporate
the perspective of the patient.

In an effort to collect data as efficiently as possible, our
follow-up was carried out in patients’ homes. This provided
an invaluable insight into how the procedure had impacted
upon their lives and activities of daily living. The situation is
far removed from the clinical setting, where hand function is
divorced from the common duties of opening doors for
visitors and making them cups of tea.

Quantitative data allow objective assessment outcome
following surgery. There are a number of well-validated
tests that quantify various aspects of hand function. None are
specific to small joint replacement and generic tools may not
be appropriate in the presence of other health problems. Self-
reporting is an integral part of tools such as the DASH Score
but self-reporting of physical function may not be entirely
reliable in the elderly population [10]. We opted to use hand
measurements commonly employed by hand therapists that
were easy to administer and a simple questionnaire utilised
in previous studies [5-7]. This allows future comparisons of
outcomes between centres.

However, it is the patients who reap the benefits of the
procedure and to each patient the outcome is unique.
Quantitative data, unfortunately, do not wholly capture this
human element of the patient’s subjective outcome. The
home visits provided the opportunity to collect both
quantitative and qualitative data. Each visit was a snapshot
of how the arthroplasty had impacted upon the patient’s life
and on those around the patient. The patient’s expectations
of the procedure, the eventual outcome and daily activity
levels were all put into context during the home visit.

Home visits have been shown to identify more problems in
the elderly population than in clinic assessments [11]. In our
experience, they also added an extra dimension to the data
we collected from our patients. Qualitative data collection
can be obtained from the researcher’s observations, provide
a deeper understanding of the patient experience and allow
for the variability of individuals, which quantitative data
cannot accommodate [12]. We offer short descriptions of two
cases which illustrate how home visits offer further
information unavailable at a clinic. Patient 3 lives alone in a
house with a large garden she keeps herself. We observed
that the garden was well-kept, she was able to grip door
handles and operate the latch with ease. She used a normal
biro pen to mark on the visual analogue scale her pain scale
with no awkwardness or discomfort. Upon leaving, we noted
a large pile of cards on a table. The patient stated she had
returned to her hobby of making intricate greeting cards,
which required intensive use of her fingers. Patient 12 lived
with her husband in a cottage. She was her husband’s main
carer and it was evident during the home visit that she
tended to all his needs, including dressing him. Her husband
was dressed in full Scottish regalia, which requires grip
strength to fasten buckles and manipulate a heavy kilt.
Despite not having hobbies, being able to care for her
husband was a priority to her.

As a result of this study, some issues with our service
provision have been highlighted. We have considered
implementing peri-operative home visits by the hand
therapists. The quality of data collection was reduced by
incomplete preoperative home visits. It is necessary to employ a
more structured approach to data collection and recording
for future audits as part of our service development in this
area, with the aim of conferring greater benefit to our
patients.

In conclusion, the procedure improves the range of
movement and reduces pain. Patient selection is key to
providing maximum benefit. Home visits provide a useful
insight into the overall hand function of patients after joint
reconstruction in the hand. In our view, semi-qualitative data
obtained from satisfaction questionnaires should carry more
weight in the judgement of outcome in reconstructive hand
surgery.

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