



Pyrocarbon spacer as a trapezium replacement for arthritis of the trapeziometacarpal joint *A follow-up study of 60 cases*

Gabor SZALAY, Christof MEYER, Tanja SCHEUFENS, Reinhard SCHNETTLER, Ralph CHRIST, Iris SCHLEICHER

From the University Hospital of Giessen and Marburg University, Giessen, Germany

Rhizarthrosis is the most common degenerative joint disease of the hand, affecting about 10% of the population. We report our results with trapezium replacement using a pyrocarbon spacer. Between January 2005 and April 2010, 70 patients underwent trapeziectomy with interposition of a pyrocarbon spacer. Sixty patients were examined at an average follow-up of 23.6 (5-64) months after the operation. Six (8.6%) of the 70 implanted pyrocarbon spacers dislocated. Based on the assessment scale devised by Buck-Gramcko, 19 patients achieved a very good outcome (31.6%), 31 patients (51.6%) had a good outcome, six results were satisfactory (10%) and four patients (6.6%) had a poor result. In this study, trapeziectomy and implantation of a pyrocarbon spacer achieved good or very good results in 83.2% of cases. The high cost of the implant and the observed rate of spacer dislocation should however be considered critically. While the short-term results of this method are encouraging, long term outcomes will show whether this technique can keep up with the good results of suspension arthroplasty.

Keywords : rhizarthrosis ; trapeziometacarpal arthritis ; thumb arthritis ; pyrocarbon spacer.

INTRODUCTION

Rhizarthrosis is the most common degenerative joint disease of the hand (3). There are many differ-

ent conservative and operative treatments. Whereas early stages of rhizarthrosis tend to respond well to conservative treatment, advanced stages usually require surgical management. A number of competing operative procedures are available, all of which are intended to provide sufficient pain relief along with the best possible restoration of motion, strength and function of the thumb. We report our results with trapezium replacement using a pyrocarbon spacer.

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- Gabor Szalay, MD, Private Dozent, Orthopaedic surgeon.
 - Iris Schleicher, MD, Orthopaedic surgeon.
 - Tanja Scheufens, MD, Orthopaedic surgeon.
 - Reinhard Schnettler, MD, Orthopaedic surgeon, Professor of orthopaedic and trauma surgery.
Department of Trauma Surgery, University of Giessen and Marburg, Giessen, Germany.
 - Christof Meyer, MD, Private Dozent, Orthopaedic surgeon.
Department of Orthopaedic and Trauma Surgery, Hospital Saarbrücken, Germany.
 - Ralph Christ, MD, Orthopaedic surgeon.
Orthix Center, Augsburg, Germany.

Correspondence : Priv.-Doz. Dr. med. Gabor Szalay, Department of Trauma Surgery, University of Giessen and Marburg, Rudolf-Buchheim Str. 7, 35385 Giessen, Germany.
E-mail : Gabor.Szalay@chiru.med.uni-giessen.de

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PATIENTS AND METHODS

Pyrocarbon has been increasingly used since 1990 in joint replacements (2,13,15). The implant PI2 for trapezium replacement (Tornier Bioprofile, Grenoble, France - supplied in Germany by Orthoaktiv Augsburg, Germany), consists of a graphite core on which is applied the smooth, non-rubbing pyrocarbon alloy of 0.5 mm thickness. It is generated by hydrolysis of hydrocarbon gas. The implant is available in medium (9 × 13 mm) and large (9 × 15 mm) size. The price of the implant is currently 930 € in Germany. No special instruments are required for the implantation.

Operation indication, technique and follow-up

Patients with clinical complaints and a radiological stage 3 or 4 on Eaton's scale (8) (Fig. 1a, b, Table I) were considered for operation. The trapezium was first removed using a radiopalmar approach, through an incision 1.5 to 2 cm in length. The radial artery lies close to the lateral border of the wound; it was therefore identified and preserved early. Before the spacer was implanted a slight dent was made in the trapezoid bone to ensure that the implant was medialised in the correct position and thus reduce the risk of a spacer dislocation. The wound was closed after careful repair of the capsule. The average operation time was 43.0 (31-67) minutes. Immobilisation in a forearm cast including the metacarpal joint for 4 weeks was followed by physiotherapy.

Patient population

The patients were offered the choice between denervation, isolated trapeziectomy, suspension arthroplasty according to Epping, as well as trapeziectomy combined with interposition of a pyrocarbon spacer. Between January 2005 and April 2010, 70 patients, of whom 60 are included in this study, opted for trapeziectomy with interposition of a pyrocarbon spacer. Four patients were excluded from the follow-up group on account of a spacer dislocation which resulted in a conversion to suspension arthroplasty. Sixty patients, 44 women (73.3%) and 16 men (26.7%) with an average age of 58.5 (39-87) years were examined at an average follow-up of 23.6 (5-64) months. Forty-five patients (75%) had idiopathic arthritis, six (10%) had posttraumatic arthritis and another nine (15%) had arthritis resulting from a rheumatic condition. Radiology revealed stage 3 arthritis on Eaton's scale in 29 patients (48.3%), and stage 4 arthritis



Fig. 1a, b. — Stage 3 rhizarthrosis on Eaton's scale in (AP and lateral view) with significant destruction of the saddle joint and subchondral sclerosis.

in 31 patients (51.7%) (8). Of the 60 patients examined at follow-up, 40 (66.6%) were still working, 20 (33.3%) were retired. Thirty (50%) spacers were implanted on the right side and 30 (50%) on the left side.

Clinical and radiological follow-up. Evaluation score

All patients were subjected to a clinical and radiological follow-up examination; this was based on the scheme initiated by Buck-Gramcko to evaluate the results of operations for rhizarthrosis (4). Questions were also asked concerning postoperative complications, the duration of postoperative inability to work and the number of physiotherapy sessions. Pinch strength was measured with a device called Mannerfelt-Ulrich intrinsic meter (Heinrich C. Ulrich, Werkstätten für Medizintechnik, Ulm, Germany) by calculating the mean value of three measurements. The neutral-zero method was used to measure palmar and radial abduction. Subjective pain was assessed by the patient preoperatively and also during the follow-up examination; distinction was made between absence of pain, rest pain, pain during slight and

Table I. — Eaton's scale (8)

Stage 1	Joint Space is regular Widening of joint space (Joint swelling/Bruise)
Stage 2	Slight joint space narrowing Fragments < 2 mm diameter
Stage 3	Significant destruction of the saddle joint Subchondral sclerosis or cyst formation Fragments > 2 mm diameter. Normal scapho- trapezial joint
Stage 4	Involvement of both TMC and STT joints

heavy exercise. The radiological check made postoperatively as well as during the follow-up examination included radiographic images of the first ray of the affected hand in standardized anterior-posterior and lateral position. Special attention was paid to position and structural changes of the implant as well as to erosion and osteolysis of the nearby bone.

RESULTS

Complications

Five (7.14%) of the 70 implanted pyrocarbon spacers were found to have dislocated within the first three months, although their initial postoperative position was correct (Fig. 2a, b). In one patient (1.43%), dislocation was detected after 41 months without any history of trauma. In two patients, surgical revision was performed by expanding the existing dent in the trapezoid bone, to centralize the spacer even more. The spacer was then re-inserted and a capsular plication was performed. The further development of these patients was uncomplicated ; they were included in the retrospective study. The other four patients (three female and one male) denied having the spacer re-implanted and were treated with a suspension arthroplasty after removal of the spacer. No cases of bleeding, problems in wound healing or infection were observed.

Two patients with a correctly positioned implant as well as full and painfree range of motion of the thumb developed type I Complex Regional Pain Syndrome (CRPS). The appropriate therapy led to complete healing. Both patients evaluated their outcome as good. One patient developed causalgia of



Fig. 2a, b. — AP and lateral radiographs 4 years after trapeziectomy and trapezium replacement using a pyrocarbon spacer in a patient with rhizarthrosis, showing volar dislocation of the spacer which occurred without any trauma.

the superficial radial nerve, requiring surgical neurolysis. Although his spacer was correctly positioned and the basal joint could be moved freely and without pain, the patient evaluated the outcome as poor on account of persisting pain and dysaesthesia. One patient who reported no complaints at 22 months and assessed her short-term outcome as excellent, presented at our outpatient clinic seven years after implantation of the spacer. She complained of progressive pain in the first ray of the operated hand. Radiographs showed axial subsidence of the spacer into the distal scaphoid and obvious proximalisation of the first metacarpal, which was not present on the previous radiographs (Fig. 3a, b).

Objective parameters

A radial abduction over 40° was achieved by 36 patients (60%), 30-40° by 21 patients (35%), 20-

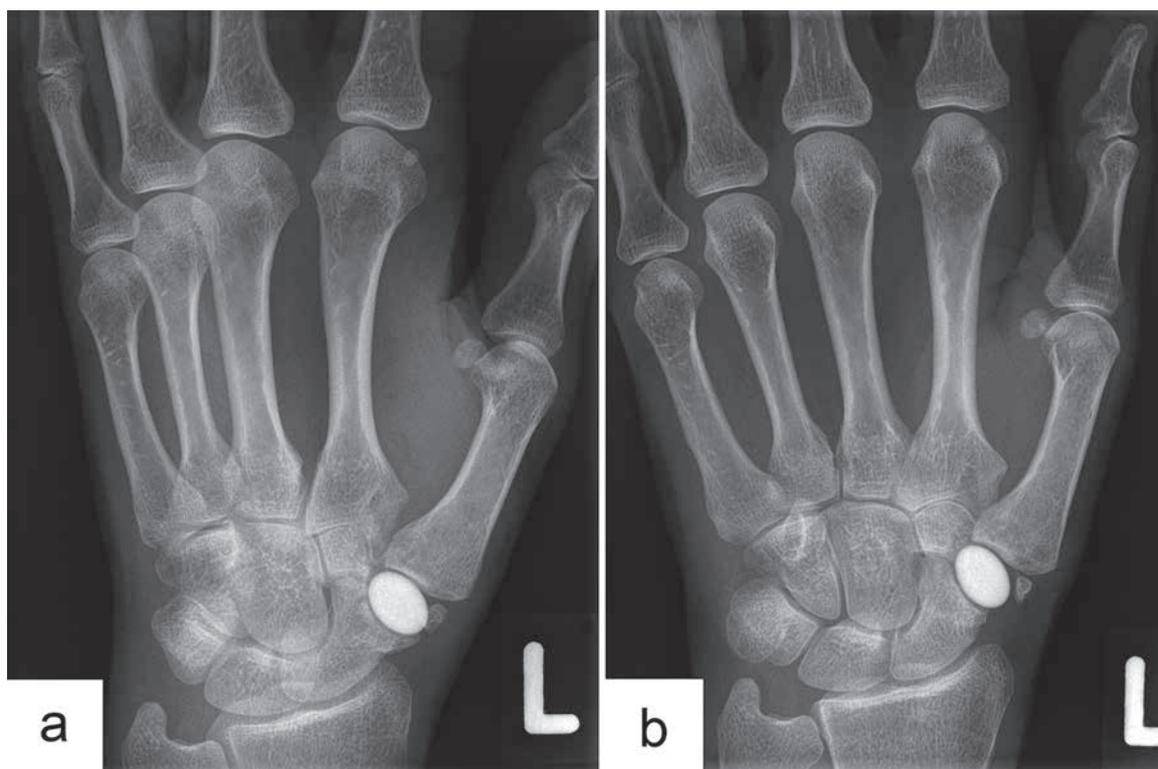


Fig. 3a, b. — AP and lateral radiographs 7 years after trapeziectomy and trapezium replacement with a pyrocarbon spacer in a patient with rhizarthrosis, showing axial subsidence of the spacer into the distal scaphoid and obvious proximalization of the first metacarpal, which was not present on previous films 22 months after surgery.

30° by 3 patients (5%). No patient had less than 20° radial abduction (mean : 48°). In 34 patients palmar flexion was over 40° (56.7%), in 22 patients 30-40 (36.7%), in 3 (5%) patients 20-30° and only in one patient (1.7%) less than 20° (mean value : 42°). Pinching strength on the operated side in comparison to the other side, was 60-79% in seven patients (11.7%) and 80-100% in 46 patients (76.7%) In six cases (10%) the pinching strength approximated that on the non-affected side and only one patient (1.7%) had a value of less than 60%.

Subjective parameters

During preoperative interviews all patients complained of persistent pain, or pain on extension of the hand. On the visual analog scale, the pain in the first ray was rated at 6.98 (4-10). Postoperative interviews found 54 patients (90%) completely painless, or having only pain with major exertion of

the operated hand. No one complained of continuous pain ; 4 patients (13.3%) reported pain on minor exertion. Postoperatively pain in the operated hand was rated at 1.35 (1-8) on the visual analog scale. Forty-six patients (76.7%) reported an improvement in strength and 13 patients (21.7%) reported no change. One patient (1.7%) stated a deterioration compared to the preoperative status. In terms of dexterity on the operated side, 40 patients (66.7%) reported an improvement, 17 (28.3%) reported no change and 3 patients (5%) a deterioration. Before surgery no patient could use the hand fully in daily activities. Forty-four patients (73.3%) (20 retired, 24 still working) reported using their hand to a certain extent. Sixteen patients (26.7%) (9 retired, 7 at work) reported using their hand to a minor degree in daily life and none was unable to use his/her hand at all.

After surgery, 29 patients (48.3%) (12 retired, 17 at work) could use their hand fully in daily activities.

Use of the hand to a certain degree was reported by 26 patients (43.3%) (13 retired, 13 at work). Four patients (6.7%) could only use the hand to a small extent, although suffering no pain. One patient could not use his hand at all. The cosmetic result was considered very good by 44 patients (73.3%), good by 15 patients (25%) and satisfactory by one. In the subjective global assessment 23 patients (38.3%) considered the outcome as very good, 28 patients (46.7%) as good, 4 patients (6.7%) as satisfactory and 5 (8.3%) as poor. Fifty-two patients (86.7%) stated that they would opt for a re-operation with this technique, 8 (13.3%) would not.

Radiological results

AP and lateral radiographs of the affected hand were taken at the time of follow-up examination to check the position of the spacer in comparison to the radiographs immediately after the operation. Two patients with a spacer dislocation were treated with repositioning of the spacer, which thereafter remained correctly in place. In one patient, axial subsidence of the spacer into the distal pole of the scaphoid was observed after 7 years; it was not present at the 22 month follow-up. In none of the other patients were erosions, osteolysis in the adjacent bones or structural changes of the implant documented. Proximalization of the first ray was not observed (Fig. 4a-c).

Postoperative treatment

After removal of the forearm cast, all patients received physiotherapy with an average of 10.3 (0-24) sessions. Return to work took place after 8.2 (1-14) weeks. The retired patients needed 11.9 (6-40 weeks) of convalescence until they could use their hand without restrictions.

Assessment based on Buck-Gramcko's scale

Based on the assessment scale devised by Buck-Gramcko 19 patients attained a very good operation outcome (31.7%), 31 patients (51.7%) a good outcome, six patients a satisfactory (10%) and four patients (6.66%) a poor outcome.



Fig. 4a-c. — CT scan after trapeziectomy and trapezium replacement using a pyrocarbon spacer in a patient with rhizarthrosis. The postoperative radiograph and the 3D-reconstruction show a correctly positioned pyrocarbon spacer. The implant completely fills the defect after trapeziectomy. It articulates with the scaphoid bone, the trapezoid bone and the base of the first metacarpal, ensuring an optimal range of motion, stability and normal length of the first ray.

DISCUSSION

Rhizarthrosis is the most common type of arthritis in the hand, affecting about 10% of the population. Operative treatment should be performed with a reliable, uncomplicated procedure, restoring inasmuch as possible strength, range of motion and dexterity in the hand, as well as providing a significant reduction of pain. The wide range of published surgical procedures (denervation, arthrodesis, arthroplasty, hemiarthroplasty, simple trapeziectomy, suspension arthroplasty) shows that none of these procedures can regularly provide a fully satisfactory outcome (1-15).

Denervation of the basal joint is a simple, fast, low-risk and low-cost method; if performed

correctly, it relieves pain without requiring a protracted stay in hospital. Merk and Rudigier reported 12 months after the operation complete restoration of strength and motion in 92% of the patients ; 58% were still painfree 33.7 months post-operatively (12).

Arthrodesis of the basal joint provides stability in the first ray as well as a significant reduction of pain. According to published results the large majority of patients are satisfied, experience only minimal complications, and describe the results as good and very good (9).

Prosthetic arthroplasty of the basal joint has only found limited acceptance. Aseptic loosening was observed in 64% after 5.7 years, which gave rise to continuous improvements in implant design (5). In a case series with 100% good and very good clinical results, the authors reported only 8% loosening after 27 months (11). Biomechanical improvements and also a more critical indication may be a reason for these better results (11).

The short-term results of hemiarthroplasty of the basal joint by means of a pyrocarbon implant were first reported by Martinez de Aragon *et al* (10) : 81% of the patients were satisfied, 71% had no pain post-operatively ; however they observed a subluxation of the first metacarpal base in 20.4% of the patients. Revision surgery was necessary in 30.6% of the patients.

Trapeziectomy brings about a proximalization of the first ray. It leads to a significant reduction in strength and entails a tendency to thumb adduction and instability (1). It is a technically simple, low-risk and low-cost procedure and achieves results comparable with those reported with more sophisticated surgical methods. In recent studies results of isolated trapeziectomy were comparable to those of Epping's suspension arthroplasty (14).

Suspension arthroplasty has gained general acceptance as a good method to treat rhizarthrosis (3). The original procedure was modified in many ways over the past 25 years (1,3,8,16) ; good or very good results were reported in 70-80% of cases (3,16).

Trapeziectomy followed by interposition of a pyrocarbon spacer is an alternative option that has not yet been given much attention. In this study, 83.3% of the patients had good or very good results ; 86.7% of the patients would opt for re-opera-

tion with this procedure. It can thus be considered a valuable alternative to the established surgical methods (1,3,9,11,16). The anatomic length of the first ray can be maintained so that strength and stability are likely to be permanently restored, without adduction displacement. An average pinching strength on the operated side of more than 80% among 24 patients (79%), as well as good mobility of the first ray indicate that this procedure is able to withstand the high, multi-axial demands imposed on a hand (1,9,15). Even a waitress and a forest worker in our group of patients were able to perform their work full time after the surgery. A tennis player and a golfer were able to practise their sport after the operation without any restrictions. This procedure thus appears to be suitable even for individuals who put strain on their hands or practice a manually demanding sport.

The occurrence of 6 spacer dislocations among 70 patients (8.6%) should however be taken into consideration. We wondered at first whether this could not be related with our operative technique, particularly as we had not reinforced the lateral joint capsule with a tenoplasty, as recommended by the manufacturer. However all the dislocations occurred in a volar direction, presumably because of the weakness of the volar capsule after excision of the trapezium. In all patients who underwent a revision operation, we found indeed that there was no weakness of the dorsal or lateral capsule, whereas the volar capsule was clearly weak and insufficient in all patients. As we had not performed initially a tenoplasty to reinforce the lateral capsule, all tendons remained available to perform a suspension arthroplasty. during the revision surgeries, which were performed through a dorso-radial approach.

In all patients, a notch had been made in the trapezoid bone, as recommended, as this achieves a medialization and an additional stabilisation of the spacer. It did not however prevent the dislocation of the spacer in a volar direction in 6 patients. This should be a reason to reconsider the operation technique : an additional reinforcement of the volar capsule would be a possible solution. Some form of fixation of the spacer to the adjacent bone could also be considered, but this would require further studies.

Postoperative rehabilitation following trapeziectomy may be considered as a further disadvantage of this procedure. After suspension arthroplasty according to Epping, gentle strengthening exercises within the cast are possible a few days after the procedure. In comparison, immobilisation during four weeks is necessary after a spacer implant procedure.

Both cases of CRPS type 1 (6.7%) may be regarded as unrelated with the specific type of procedure chosen; the literature reports comparable rates, sometimes even higher. Both the average time before return to work among the working patients, and the time needed by the retired patients to resume their normal activities and use the hand fully is comparable with the times needed when using alternative procedures (1).

While the short-term results of this method are encouraging, long-term outcomes will show whether it can keep up with the good results provided by suspension arthroplasty.

Another point of concern in this case series is the observation of an axial subsidence of the spacer into the distal pole of the scaphoid in a young and active patient 7 years after implantation of a pyrocarbon spacer. With longer follow-up, similar cases may perhaps be expected. Only long-term results will thus decide whether this procedure will come in general use.

Considering the high rate of spacer dislocations, which does not appear to be related with the operating technique, added to the high cost of the implant, and the possibility to achieve comparable or even superior results with trapeziectomy or suspension arthroplasty, we eventually discontinued using this implant.

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