



Original Article

APSI scaphoid hemiarthroplasty – long-term results[☆]



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ARTICLE INFO

Article history:

Received 14 April 2017

Accepted 8 June 2017

Available online 2 August 2018

Keywords:

Hemiarthroplasty

Scaphoid bone

Necrosis

Wrist

ABSTRACT

Objective: This study is aimed at evaluating the long-term results of proximal scaphoid hemiarthroplasty for post-traumatic avascular necrosis at this institution.

Methods: Twelve patients who underwent this procedure were identified, and the mean follow-up time was 6.5 years (range: 5–8 years). All patients were male, with a mean age of 39 years (range: 28–55 years). In eight patients, the non-dominant limb was affected. The procedure was carried out through a dorsal approach and all patients underwent the same rehabilitation protocol. Cases were evaluated regarding complications, pain, range of motion, functional status (Mayo Wrist Score), and disability (QuickDASH Score).

Results: No immediate post-operative complications, such as infection or dislocation of the implant, were observed. All patients presented with peri-implant osteolysis at follow-up, on a radiograph study. None of the patients was forced to abandon their previous professional activity, although about 50% required some type of adaptation at their workplace. The mean functional capacity was, according to the Mayo Wrist Score, of 67.5 points (range: 50–80), corresponding to a satisfactory degree of function. The QuickDASH disability score presented a mean of 25 (range: 3–47.7).

Conclusion: The results of this series are in line with previously published studies about this technique. Hemiarthroplasty with a pyrocarbon implant is a safe technique for the treatment of post-fracture avascular necrosis of the scaphoid proximal pole. This technique allowed for satisfactory functional results at a mean follow-up of 6.5 years.

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Hemiarthroplastia do escafoide com APSI – resultados funcionais em longo prazo

RESUMO

Objetivo: Avaliar os resultados em longo prazo da hemiarthroplastia do escafoide proximal no tratamento da osteonecrose avascular pós-traumática na instituição.

Palavras-chave:

Hemiarthroplastia

[☆] Study conducted at Centro Hospitalar de Vila Nova de Gaia, Vila Nova de Gaia, Portugal.

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<https://doi.org/10.1016/j.rboe.2018.07.011>

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Osso escafoide
Necrose
Punho

Métodos: Foram identificados 12 pacientes submetidos a esse procedimento. O tempo médio de seguimento foi de 6,5 anos (entre cinco e oito). Todos os pacientes eram do sexo masculino, com média de 39 anos (entre 28 e 55). Em oito pacientes o membro afetado foi o não dominante. O procedimento foi feito por meio de uma abordagem dorsal e todos os pacientes foram submetidos ao mesmo protocolo de reabilitação. Todos os casos foram avaliados quanto à ocorrência de complicações, dor, amplitude de movimento, capacidade funcional (*Mayo Wrist Score*) e incapacidade (*QuickDASH Score*).

Resultados: Não foram observadas complicações no período pós-operatório imediato, como infecção ou luxação do implante. No fim do período de seguimento, todos os casos apresentavam osteólise peri-implante no estudo radiográfico. Nenhum dos pacientes abandonou a sua atividade profissional prévia à cirurgia, embora em cerca de 50% dos casos tenha sido necessário algum tipo de adaptação no local de trabalho. A capacidade funcional média foi, de acordo com o *Mayo Wrist Score*, de 67,5 pontos (entre 50 e 80), correspondeu a um nível de função satisfatório. O escore de incapacidade *QuickDASH* apresentou uma pontuação média de 25 (entre 3 e 47,7).

Conclusão: Os resultados desta série encontram-se em linha com os estudos publicados sobre essa técnica. A hemiartroplastia do escafoide com implante de pirocarbono é uma técnica segura para o tratamento da necrose avascular do polo proximal do escafoide após fratura. Essa técnica permitiu obter um resultado funcional satisfatório após uma média de 6,5 anos de seguimento.

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Introduction

The scaphoid is the most commonly fractured carpal bone. It presents a complex three-dimensional anatomy and a precarious vascular supply, especially proximally.¹⁻⁵

The loss of bone continuity results in injury to the scaphoid vascularization and, consequently, impairs mechanism of resolution of the fracture.⁵ In proximal-third fractures, complete loss of vascularization of this segment can be observed in up to 40% of the cases, with osteonecrosis of the proximal segment.^{6,7}

Consolidation fracture at the scaphoid level generally progresses to osteoarthritis, according to the scaphoid nonunion advanced collapse (SNAC) pattern, with pain and functional disability at wrist level. There is no consensus on the treatment of these lesions.⁸⁻¹⁰

The surgical treatments classically indicated for the treatment of SNAC lesions are: partial resection of the scaphoid; proximal carpectomy; intracarpal arthrodesis (lunar-capitate-trapezium-trapezoid four-corner arthrodesis). These procedures present specific technical complications – scaphoid resection and proximal carpectomy are associated with an increased risk of progression to wrist osteoarthritis and decreased grip strength; in turn, arthrodesis procedures are associated with a decrease in the range of motion.¹¹⁻¹⁵

In more advanced cases, with generalized intercarpal and radiocarpal osteoarthritis, arthrodesis or total wrist arthroplasty may be indicated. Radiocarpal arthrodesis is associated with an important limitation in hand and wrist function. Total wrist arthroplasty is a technique without consistent results in the literature; short-term functional improvements have been observed, but long-term high rates of complications, such as aseptic detachment, have been observed.¹⁶⁻¹⁹

Partial or total scaphoid resection (proximal fragment) results in a collapse of the proximal row. Adaptive Proximal Scaphoid Implant (APSI – Tornier Cie., Montbonnot, Saint Martin, France) hemiarthroplasty uses a mobile pyrocarbon interposition implant to replace the proximal pole of the scaphoid. This technique aims at avoiding a proximal row collapse, maintain carpal kinematics during wrist movements, and minimize the evolution to carpal collapse and osteoarthritis.²⁰

Most studies published in the scientific literature on the use of this type of implant present only short-term results.²⁰⁻²³ The present study was aimed at evaluating the long-term results of interposition hemiarthroplasty of the scaphoid with a mobile pyrocarbon implant in the patients from this institution. The complications associated with the procedure, pain, range of motion, functional capacity, disability, and patient satisfaction with the procedure were assessed at the end of a mean follow-up time of 6.5 years.

Material and methods

Twelve cases of this type of hemiarthroplasty were retrieved at this institution. All patients were male, with a mean age of 39 years (range: 28–67 years).

In eight patients, the non-dominant side was affected. Of the 12 patients evaluated, eight performed professional activities with high physical and functional demands on the wrist.

Preoperative images were collected in all patients, from simple wrist radiographs to computed tomography and nuclear magnetic resonance when the attending surgeon deemed it necessary.

The biographic data and the classification of patients according to the SNAC degree (according to the classification proposed by Vender et al.⁸) observed in the initial radiographic

Table 1 – Biographic data and preoperative degree of SNAC lesion.

Patient	Age	Gender	Follow-up time	Occupation	Affected limb	SNAC
1	46	Male	7	Metal worker	Dominant	1
2	34	Male	5	Gravedigger	Non-dominant	2
3	38	Male	6	Civil construction	Dominant	1
4	33	Male	8	Civil construction	Dominant	1
5	28	Male	7	Physical therapist	Non-dominant	1
6	55	Male	5	Secretary	Non-dominant	2
7	35	Male	7	Civil construction	Non-dominant	1
8	44	Male	7	Secretary	Non-dominant	1
9	37	Male	6	Electrician	Non-dominant	2
10	40	Male	8	Metal worker	Dominant	2
11	35	Male	5	Factory worker	Non-dominant	1
12	42	Male	7	Secretary	Non-dominant	2

study are described in [Table 1](#). The study was approved by the Ethics Committee of the institution, and all patients signed an Informed Consent Form for participation in the study.

For this procedure, a dorsal arthrotomy approach was used between the third and fourth extensor compartments. A careful partial styloidectomy (in order to avoid the impairment of the extrinsic ligaments) was associated with hemiarthroplasty in cases of significant osteophytosis, or in cases of space conflict for implant placement.

The procedure was performed with a tourniquet, after exsanguination; all patients were operated on by the same surgeon, under general anesthesia and fluoroscopic control. After the proximal pole of the scaphoid was resected, different sizes (small, medium or large) were tested to determine the appropriate size of the implant to be used. The tests allowed the surgeon to assess the level of bone resection, the need for a styloidectomy, and the range of motion and stability of the implant through the range of motion of the joint, under direct vision. The implants are available in three sizes, which are the same as those used in the tests.

At the end of the procedure, the joint capsule was completely repaired in order to maximize the stability of the implant. No postoperative drains were used. After the procedure, a forearm plaster splint was made. All patients were discharged from hospital on the day after the surgical procedure.

All cases were followed-up in outpatient consultations after surgery and underwent the same protocol of postoperative physical therapy for approximately three months. In the immediate postoperative period, finger mobilization was encouraged. Between the second and third postoperative weeks, the plaster splint was removed and the patients started active wrist mobilization; the use of the operated wrist was not allowed at that moment.

On the sixth postoperative week, patients were allowed to perform activities of daily living with the operated limb. From that moment onwards, physiatric therapy treatment focused on improving the range of motion and muscle strength.

The mean follow-up time was 5.5 years (range: 4–7). At the end of the follow-up time, all patients were assessed for pain, range of motion, functional capacity, disability, and satisfaction with the procedure. Pain intensity was determined

based on the visual analog scale (VAS); range of motion was assessed using a goniometer; grip strength was measured with a dynamometer. The Mayo Wrist Score and the QuickDASH score were used to assess functional capacity and associated disability at the end of follow-up time. Data were collected and processed using statistical software (SPSS – IBM, New York, United States, 2014).

Results

No cases of periprosthetic infection, instability of the implant, or complications related to the surgical incision were observed in the immediate or long-term postoperative period.

At the end of the follow-up time, all patients presented correct implant positioning in the proximal row of the carpus. Despite the good positioning, in the radiographic study at the end of the follow-up time all cases showed some degree of peri-implant osteolysis and progression of the degenerative wrist alterations (osteophytosis and decreased joint line space; [Fig. 1](#)). The implant positioning in the proximal row and the degree of osteolysis around the implant (especially at the distal end of the capitate) render the interpretation of radiographic results (such as the interruption of Gilula lines) less reliable ([Fig. 1](#)).

None of the patients had to change his professional activity after the lesion was surgically corrected, although half of the patients reported a need for adaptation to the functions performed in the workplace after surgery. Prior to surgery, in eight of the 12 cases, the patients' professional activities were considered to be of high demand for the wrist.

All patients reported less pain after surgery; the mean intensity was 22.33 (3) on VAS (0–100). All patients reported the persistence of some degree of pain after surgery, of mild intensity (from 5 to 41).

All patients had a decrease in range of motion when compared with the contralateral side at the end of the follow-up time. [Table 2](#) presents the range of motion observed at the end of the follow-up time.

The mean functional capacity, according to the Mayo Wrist Score, was 67.5 points (range: 50–80), which is considered to



Fig. 1 – Radiographic study at the end of the follow-up time – implant is well positioned in the proximal row, with peri-implant osteolysis, and progression of degenerative changes.

be “fair.” The mean QuickDASH score was 25 (range: 3–47.7). The complete results are shown in [Table 3](#).

The area where all patients presented most disability was during more intense exercise and in transporting or working with heavy weights.

Regarding the degree of satisfaction with the surgery, 11 patients reported being satisfied or very satisfied with the surgery and only one patient reported dissatisfaction.

Discussion

The treatment of SNAC lesions is still a matter of debate; several techniques have been proposed for the treatment of this pathology. Most involve some type of carpal arthrodesis (with a consequently decreased range of motion) or proximal carpectomy (typically with loss of wrist and hand strength). In more advanced cases, wrist arthrodesis may be indicated.⁸⁻¹⁵

When compared with hemiarthroplasty, arthrodesis is associated with a considerable period of postoperative immobilization to achieve complete bone union. These techniques also present their unique complications, which are associated with the material used to achieve arthrodesis – infection, migration, or material failure; joint prominence of the material – and the biological process of arthrodesis – delayed consolidation, nonunion, and pseudoarthrosis.⁸⁻¹⁵

The goal of hemiarthroplasty of the proximal pole of the scaphoid is to replace the proximal pole of the carpal scaphoid and thereby prevent proximal row collapse. The use of implants made of silastic, metal, or ceramic was not an effective option since they were associated with a significant rate of failure or associated synovitis.^{24,25}

The APSI implant is made of pyrocarbon, a material that is biochemically inert, biocompatible, and highly resistant to abrasive wear. This material presents a modulus of elasticity and density equal to that of the cortical bone, which minimizes the risk of stress shielding.²⁶

With this implant, proximal pole hemiarthroplasty can be performed by arthrotomy or through arthroscopy, as described by Gras et al.²³

The use of fluoroscopic imaging control during the surgical procedure allows an assessment of the scaphoid resection level and of the congruence of the implant, its behavior, and its stability with wrist movements.

The complications described with this technique are implant dislocation (volar or dorsal), peri-implant osteolysis, inadequate implant sizing (which may predispose to radial styloid conflict or dislocation), persistent pain and limitation, and progression of the degenerative alterations at the wrist level.²³

To date, few follow-up studies on this type of arthroplasty have been conducted. In the series of cases published by Pequignot et al.,²⁰ APSI prosthesis interposition arthroplasty allowed the restoration of a satisfactory level of wrist function, without mechanical complications; at the end of six years of follow-up, carpal height was maintained. The retrospective study by Grandis et al.²¹ presented similar results, with a satisfactory functional outcome, including improvement of pain, range of motion, strength, and return to professional activity, with a high rate of satisfaction with the procedure.

A prospective study by Daruwalla et al.,²² with a mean follow-up of 18 months, showed similar results – improvement of pain, range of motion, strength, return to work activity, and functional disability assessed by the DASH Score – without complications associated with the

Table 2 – Assessment of mobility at the end of follow-up time.

Patient	Flexion (°)	Contralateral (°)	% Contralateral	Extension (°)	Contralateral (°)	% Contralateral	Radial deviation (°)	% Contralateral (°)	% Contralateral	Cubital deviation (°)	Contralateral (°)	% Contralateral
1	27	50.94	0.53	35	58.33	0.6	10	23.81	0.42	13	34.21	0.38
2	8	50.00	0.16	13	61.90	0.21	6	22.22	0.27	8	21.62	0.37
3	69	84.15	0.82	57	72.15	0.79	17	26.98	0.63	28	32.94	0.85
4	43	69.35	0.62	39	68.42	0.57	12	23.08	0.52	26	39.39	0.66
5	50	83.33	0.6	48	82.76	0.58	19	44.19	0.43	32	78.05	0.41
6	42	79.25	0.53	37	72.55	0.51	21	40.38	0.52	27	44.26	0.61
7	20	62.50	0.32	23	82.14	0.28	9	30.00	0.3	11	31.43	0.35
8	26	81.25	0.32	32	86.49	0.37	8	34.78	0.23	22	53.66	0.41
9	41	61.19	0.67	43	58.90	0.73	14	21.88	0.64	31	46.27	0.67
10	28	50.91	0.55	37	60.66	0.61	12	20.00	0.6	17	28.81	0.59
11	31	72.09	0.43	36	97.30	0.37	8	25.81	0.31	19	65.52	0.29
12	40	78.43	0.51	38	80.85	0.47	10	25.64	0.39	27	50.00	0.54
Mean	35.42	68.62	0.51	36.50	73.54	0.51	12.17	28.23	0.44	21.75	43.85	0.51

Table 3 – Pain assessment, Mayo Wrist Score, and QuickDASH at the end of follow-up time.

Patient	VAS	Mayo	QuickDASH
1	21	75	20
2	41	50	47.7
3	5	80	3
4	23	65	35
5	35	65	20
6	23	70	15
7	17	65	35
8	15	70	35
9	9	80	20
10	29	60	35
11	31	65	15
12	19	65	20
Mean	22.33 (3)	67.5	21.975

procedure. The case of volar dislocation of the implant after trauma, due to a fall, which required revision surgery, was noteworthy.

Another prospective, arthroscopic procedure published by Gras et al.²³ reported improvements in pain, range of motion, strength, functional capacity (Mayo Wrist Score), and disability (DASH Score), with a follow-up of 8.7 years. However, six complications were observed: one case of acute implant subluxation, two cases of volar subluxation of the implant, and three cases of conflict with the styloid process, requiring revision surgery.

The present results demonstrated improvements in the degree of pain, although with persistence of slight pain (mean of 22.33 [3]). These results are in line with those published by Daruwalla et al., but lower than those observed by Gras et al.,²³ that may suggest that the use of an arthroscopic approach can be associated with lower post-operative pain, even in the long-term. Pain complaints may be due to biomechanical alterations after hemiarthroplasty, progression of the degenerative process despite surgical treatment, the peri-implant osteolysis process, or to other causes.

At the end of the follow-up time, patients presented a decreased wrist range of motion in flexion/extension and in radial and ulnar deviation when compared with the contralateral joint. These results are similar to those reported by Daruwalla et al.,²² although with a longer follow-up time. The decrease in the range of motion may be associated with biomechanical alterations in the joint after hemiarthroplasty, scar tissue retraction after the fracture and after surgical treatment, and progression of the degenerative process, among others.

In the present study, the mean disability according to the QuickDASH score was 25, similar to that observed in the series by Daruwalla et al.²² (20), despite the longer follow-up time. The study by Gras et al.²³ presented better results than those observed in the present series, which may indicate that the arthroscopic procedure is associated with a lower degree of disability. The higher disability observed in the present study may also be due to the fact that a significant number of patients (eight out of 12 cases) performed professional activities with high physical and functional demand on the wrist joint. High-demand professional activities are possibly

associated with increased wear-out of the joint, with a faster progression to degenerative alterations and decreased functional capacity.

The mean Mayo Wrist Score of 67.5 points (range: 50–80) observed in the present study corresponds to a “fair” function, which is in line with the studies by Pequignot et al.²⁰ and Grandis et al.²¹ The results presented by Gras et al.,²³ with a mean score of 79.6 points on that same scale, although in the “fair” range of function, are superior to those observed in the present study. The better functional results observed in the series by Gras et al.²³ may be due to the lower surgical aggression (arthroscopic procedure) or to the fact that cases with the worse functional outcome and greater pain intensity (two cases) underwent four-corner fusion.

Pyrocarbon implants were shown to be a safe alternative, with low risk of infection, implant failure, or dislocation. It is also important to mention that the information regarding salvage procedures in the cases of failure of this type of arthroplasty is scarce, only presented in the study by Gras et al.,²³ who did not report on the difficulties or complications inherent to the procedure.

Conclusion

APSI arthroplasty is a safe technique for the treatment of SNAC-type scaphoid lesions. In the patients studied, after a mean follow-up of 6.5 years, this treatment allowed the maintenance of wrist function at a “fair” level, in accordance with the Mayo Wrist Score, and with a functional disability score of 25 (QuickDASH score). These results are in line with studies published to date, despite being limited by the small sample size. More prospective studies with a greater number of cases are needed to validate this technique for the treatment of SNAC lesions.

Conflicts of interest

The authors declare no conflicts of interest.

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