Polish Annals of Medicine

Journal homepage: https://www.paom.pl

Review Paper

# Treatment methods in idiopathic avascular necrosis of the scaphoid – review

*Katarzyna Kopcik*[1], *Robert Kwinta*[2], *Agnieszka Koberling*[3]

[1] *Virgin Mary Provincial Specialist Hospital in Częstochowa, Poland*
[2] *Municipal Hospital in Zabrze, Poland*
[3] *Independent Public Health Care Institution named after doctor Kazimierz Hołoga, Nowy Tomyśl, Poland*



ARTICLE INFO

Article history
Received: January 9, 2024
Accepted: May 24, 2024
Available online: July 16, 2024

Keywords
Orthopedics
Avascular necrosis
Preiser disease

Doi
https://doi.org/10.29089/paom/189252



ABSTRACT

Introduction: Idiopathic avascular necrosis (AVN) of the scaphoid is commonly known as Preiser's disease (PD). It is a rare condition with symptoms such as pain, swelling around the scaphoid area and a reduced range of motion of the wrist. This condition occurs in the absence of an acute fracture or a fracture non-union. The disease can be diagnosed using classic radiology, magnetic resonance imaging or computed tomography. Treatment methods include surgical nad non-surgical procedures.

Aim: Main aim of the paper was to summarize most recent knowledge about treatment methods in idiopathic AVN of the scaphoid.

Material and methods: To conduct this review, we searched the databases for articles about PD. We used keywords 'Preiser disease' and 'idiopthic avascular necrosis scaphoid'. Our focus was on articles published in between 2017 and 2023, as we wanted to focus on most recent publications.

Results and discussion: Main goals of the treatment of PD are pain relief, improved hand grip strength, wider range of motion of the wrist and enhanced overall hand and wrist function. Implementing conservative management seems not to bring satisfactory results in patients with PD. Various surgical routines are the treatment of choice.

Conclusions: Stage I of the disease is the most likely treated with bone-grafting or currettage. Method of choice in stage II is vascularized bone graft, in stage III – proximal row carpectomy. Due to the rarity of the disease, there are no established recommendations regarding the treatment. Further studies are needed to extend the knowledge of the disease and potential methods of its management.

*Corresponding author: Katarzyna Kopcik; Virgin Mary Provincial Specialist Hospital in Częstochowa, Poland.*
*E-mail address: kopcik.katarzyna1@gmail.com*

## 1. INTRODUCTION

Idiopathic avascular necrosis (AVN) of the scaphoid, commonly known as Preiser's disease (PD), is a rare condition that can manifest as pain, swelling around the anatomical snuffbox, and a reduced range of motion in the wrist.[1] This condition occurs in the absence of an acute fracture or a fracture non-union.[2] Between the radius bone and the second row of the carpal bones, the scaphoid bone is located. Approximately 45% of its surface is covered by cartilaginous tissue. It has significant mobility in flexion-extension and radial-ulnar deviation. The combination of these movements with rotational ones can result in the compression of the surrounding ligaments.[3] The scaphoid bone is primarily supplied by branches of the radial artery, with the majority of these branches penetrating the distal part of this bone. In contrast, the proximal part of the scaphoid bone is the so-called marginal zone, which is dependent on the interosseous blood flow. This is because few nutrient vessels directly supply this part of the bone. A disruption of this blood supply is the cause of PD.[1,2] Research has demonstrated that approximately 70%–80% of the proximal part of the scaphoid bone is dependent on the vascularity of the radial artery, which penetrates the bone at its distal end. The distal part of the scaphoid bone is vascularized by a direct branch of the radial artery or the superficial palmar branch of the radial artery. Approximately 20%–30% of the scaphoid bone is supplied by these branches.[2,3]. No anastomoses exist between the dorsal and palmar vessels.[3] PD has four phases that can coexist. The first phase (avascular) begins after a bone infarction. In this case, ischemia causes the cartilage tissue to hypertrophy to repair the bone defect. The subsequent phase, referred to as revascularization, is associated with a heightened level of osteoplastic activity, which arises from the activity of osteoblasts and osteoclasts. The third phase (repair) involves the process of bone regrowth, which varies depending on the degree of initial bone loss and the person's response. Nonetheless, during the final phase (deformation), additional bone fragmentation transpires, which may result in proximal bone collapse or instability that can lead to osteoarthritis.[3] Diagnostic methods implemented in this condition include classic radiology, computed tomography (CT) and magnetic resonance imaging (MRI). Based on these scans Herbert and Lanzeta clasification was designed. The study conducted by Morsy et al. has identified two distinct types of scaphoid bone, namely type I, known as a 'full scaphoid,' and type II, known as a 'slender scaphoid.' The more extensive internal vascular network observed in type I may be related to the onset of PD, whose etiology can be found in Table 1.[2,4]

## 2. AIM

Main aim of the paper was to summarize most recent knowledge about treatment methods in idiopathic AVN of the scaphoid.

## 3. MATERIAL AND METHODS

To conduct this review, we searched the PubMed and Google Scholar databases for articles about PD. We used keywords such as 'preiser disease,' 'idiopthic avascular necrosis scaphoid'. Our focus was on articles published in between 2017 and 2023, including their references, as we wanted to focus on most recent publicatons. We assessed the papers by titles, abstracts and full texts, with the main inclusion criteria being that they described PD and treatment methods in this codition. Among 134 papers were identified after removing duplications; 106 articles were excluded after title's analysis and 7 papers were exluded after abstracts evaluation. Finally, 21 papers were included to the study, as they were raising the problem of the PD and its management methods. The most important criteria of exclusion was if the paper did not raise the problem of PD, was focused on AVN of other bones or other conditions, or in cases that management methods were not mentioned.

## 4. RESULTS

### 4.1. Diagnostic methods

The basic diagnostic tests for PD are X-rays and MRI.[5] Micro-computed tomography (micro-CT) imaging and 3-dimensional reconstruction are also used.[4] Diagnosis of early-stage AVN of the carpal bones is more effective using gadolinium-enhanced MRI because it is a more sensitive and specific diagnostic tool than plain X-ray. MRI also shows the viability of the bone marrow.[6]

Loss of signal on T1- and T2-weighted sequences occurs in cases of osteonecrosis. However, in the case of ischemia, hyperintensity occurs on T2-weighted images and hypointensity on T1-weighted images.[3] In 1994, Herbert and Lanzetta developed the first classification aimed at describing the progression of PD (Table 2).[2]

In 2003, Kalainov et al. they distinguished two types of disease states, based on the analysis of MRI images.[3] Type 1 is a change in the necrosis signal and it is observed in the entire bone (complete scaphoid), type 2 presents involvement mainly of the proximal pole of the bone (terminal scaphoid). Type 2 covers approximately 42% of the bones.[5] Type 1 may have been associated with the development of nonunion, AVN, or PD be-

**Table 1. Summary of PD etiology.**

| Post-traumatic | Non-traumatic | |
|---|---|---|
| | Secondary | Idiopathic |
| It is the result of frequent repetitive microtraumas | • Development secondary to present:<br>• congenital hypoplasia of the thumb<br>• systemic disease (lupus erythematosus, systemic scleroderma, vasculitis)<br>• corticosteroid therapy (general, topical)<br>• chemotherapy<br>• smoking<br>• cardiovascular risk factors | Microtrauma causes and possible risk factors have been excluded |

**Table 2. Herbert and Lanzetta classification.**

| Herbert and Lanzetta classification | |
|---|---|
| Stage 1 | Normal X-rays, normal CT images, vascular problems in MRI |
| Stage 2 | Sclerosis and bone density on conventional radiographs, subchondral cysts on computed tomography |
| Stage 3 | Fragmentation of the proximal pole of the scaphoid, pathological fractures |
| Stage 4 | Collapsed bones with symptoms of wrist instability, later accompanied by symptoms of wrist osteoarthritis |

**Table 3. Stages of PD according to Schmitt.**

| Stage | MRI aspect |
|---|---|
| Initial stage | Cancellous bone at the proximal pole of the scaphoid – changes in the bone marrow and osteosclerosis. Increased signal intensity on T2-weighted images – focal bone marrow edema. Scaphoid shape is still maintained |
| Advanced stage | 'Nipple sign' – proximal collapse<br>Pathological fractures – located peripherally, intersecting with sclerotic areas, oblique or longitudinal to the longitudinal axis of the scaphoid bone,<br>The induration at the proximal pole deepens. |
| Final stage | Increased density of the entire scaphoid bone.<br>No hyperenhancement is detectable |

cause it is characterized by poorer blood supply.[4] Type 2, on the other hand, has a better prognosis due to lower susceptibility to fragmentation.[3] In 2011, Schmitt et al. determined the imaging equivalents of the discussed basic pathoanatomical changes. A 3-layer distribution was identified (Table 3).[2]

Compared to MRI, plain X-ray can show scaphoid sclerosis but without visible fractures. However, MRI shows signal changes in the scaphoid bone, either only in the proximal pole or diffusely. Late radiographic changes include fractures and cystic lesions.[7] In a study by Morsy et al. micro-CT imaging and 3-dimensional reconstruction were used to examine the anatomy of the intraosseous vessels of the scaphoid and scaphoid shape and screw position on the intraosseous vascular structure.[4]

### 5. Management

Treatment options in idiopathic AVN of the scaphoid are various, including conservative and invasive methods. It is generally believed that surgical treatment is more favourable in all stages of PD.[8] Among invasive methods one can distinguish vascularized bone graft (VBG), proximal row carpectomy (PRC), closed radial wedge osteotomy (CRWO), arthroscopic debridement and curettage, replacement with silicone implants, four-corner fusion or wrist arthrodesis.[8–11] Recent research and technology allowed the implementation of customized, 3D modeled prosthesis in patient th PD, what was described by Kemler.[12] In literature there is also a report of a case of PD in young female successfully treated with a combination of VBG with a temporary dorsal spanning bridge plate.[10] Based on Mayo modified wrist score (MMWS), one can divide patients into four stages of the disease.[8] According to Kazemi et al. patients with stage II or III of PD benefit more from surgical treatment than conservative management.[8] Researchers pointed out that stage II patients revealed better outcomes after undergoing VBG, while stage III patients – after undergoing PRC.[8] Improvement in range of motion and pain relief was evaluated in both groups of patients.[8] Studies on stage IV patients revealed conflicting evidence, but there is a general inclination toward therapies using implants.[8] So far, there is not enough evidence and data on stage I patients to draw a definitive conclusion on choosing surgical method of management.[8] Treatment methods of PD are briefly summarized in Table 4.[8]

In literature one can find case reports of PD with various treatment methods administrated. A brief summary of selected cases is presented in Table 5.[10,12–17]

## 6. DISCUSSION

Literature describes various methods of the management of idiopathic AVN of the scaphoid. Treatment option is being selected based on the patient's individual state and the disease's stage.

A vascularized bone graft is an autograft consisting of cortical or corticocancellous tissue. It is harvested with an attached vascular pedicle to enhance the integration and healing of the graft and the bone.[18] VBG is in most cases used in stages I and II of the PD.[19] Besides avascular necrosis, the graft can be applied also in cases of post-traumatic scaphoid non-unions.[20–22] The graft can be obtained from the distal radius, iliac bone or from medial femoral trochlea (MFT) osteochondral flap.[11,19,23] When preparing the VBG it is important for the physician to preserve blood vessels of the graft, which can be used as stems.[20] What is more, appropriate preparation of the recipient's scaphoid is vital. It is based on the removal of affected bone and fibrous tissue, evaluation of blood supply, examination of the stage of arthritis at the radiocarpal joint, followed by measurement of the affected area to tailor the graft.[20] Debridement of the scaphoid poles should be performer until the reveal of robust bone with visible bleeding.[20] VBG method shows a potential in preventing wrist collapse and is useful also when treating coexsistant PD and Kienbock disease.[19] VBG's ability

**Table 4. Summary of the treatment methods in PD.**

| Stage (MMWS) | Treatment options |
|---|---|
| Stage I | Non-invasive treatment – not favourable<br>Bone grafting<br>Curettage with bone grafting |
| Stage II | Non-invasive treatment – not favourable<br>Vascularized bone graft<br>Closed radial wedge osteotomy |
| Stage III | Non-invasive treatment – not favourable<br>Proximal row carpectomy<br>Vascularized bone graft<br>SILASTIC implant |
| Stage IV | Non-invasive treatment – not favourable<br>Proximal row carpectomy<br>SILASTIC implant |

**Table 5. Summary of selected cases of PD in literature.**

| Study | Patient's sex, age, pain location | Treatment | Effects |
|---|---|---|---|
| Seungbae Oh et al. (2023) | F/68, left wrist | Proximal row carpectomy with a distally based capsular interposition technique | Total pain reduction after 3 months;<br>return to all activities;<br>range of motion - 30° of flexion, 60° of extension<br>MMWS - 80% of grip strength was measured (25/31 kg) |
| Tomori et al.(2018) | F/55, right wrist | Pnitial corticosteroid treatment<br>Surgical management - the fragmented proximal scaphoid and the entire lunate were resected;<br>second surgery agter 4months – resection of a part of the distal scaphoid and a part of the radial styloid | Total pain reduction;<br>25° of extension and 26° of flexion ;<br>MMWS - 60 points<br>The patient's grip strength was 20.4kg |
| Salunkhe et al.(2022) | F/23, left wrist | Proximal row carpectomy | Total pain reduction;<br>Full range of motion three weeks after surgery |
| Catapano et al.(2022) | M/32, both wrists, | Initial corticosteroid treatment - pain relief for 8 months;<br>surgery using 1,2 intercompartmental epiretinal vascularized bone graft (1,2-ICSRA) (VBG) (surgery performed only on the right wrist) | Total pain reduction;<br>grip strength increase from 7kg to 20kg;<br>functional range of motion from 60 degrees flexion bilaterally to 30 degrees extension on the right and to 45 degrees on the left |
| Fujibuchi et al. (2022) | M/10, left wrist | Treatment with a thumb spica cast and then orthoses | the scaphoid bone developed properly |
| Pennington et al. (2023) | F/20, right wrist | VBG was performed using the 1,2 intercompartmental epithelial artery (ICSRA) using a temporary dorsal wrist-spanning bridge plate. | Total pain reduction;<br>near-full wrist range of motion |
| Kemler (2023) | F/30, right wrist | Initial unsuccessful treatment with a vascularized pedicled bone graft.<br>Four years after diagnosis, the diseased scaphoid prosthesis was replaced with a 3D-modeled prosthesis. | Total pain reduction;<br>wrist flexion increase from 10 to 25 degrees<br>wrist extension increase from 60 to 63 degrees<br>grip strength increase from 14.7 to 19.3 kg |

to prevent osteocytes from apoptosis is also worth mentioning.[19] Studies show that vascularized bone grafts treatment tends to present more promising effects, both mechanically and biologically, than non-vascularized grafts.[19] Closed radial wedge osteotomy (CRWO) is another surgical method that can be applied.[8,9] Tomori and co-workers held a study based on seven patients that underwent CRWO. The result was clinically satisfying, with positive pain management, range of motion and grip strength preservation.[9] It is worth mentioning that in 4 out of 7 patients radiography images presented disease progression, regardless of the good clinical outcome.[9] Among complications that ocurred one can list extensor pollicis longus tendon rupture and osteoarthritis combined with deterioration of the distal radioulnar joint.[9]

Conservative management options, such as immobilization and non-steroids anti-inflammatory drugs (NSAIDs) in stage I of PD mostly result in pain relief, with no other improvements of patient's state.[8] Kazemi et al. reported that non-operative management may effect in a slight deceleration of development of higher stages of the disease.[8] Surgical methods in this stage include bone grafting alone or combined with bone curettage, but they tend rather to slow disease progression than to total remission.[8] It is important to note that there is currently insufficient published data necessary to provide precise recommendations regarding the surgical treatment of stage I PD.[8] Preferred method used in stage II of the idiopathic AVN of the scaphoid is VBG, as immobilization and NSAIDs provide only pain relief and improved range of motion, with no favour in stopping the disease's progression.[8] VBG shows a potential in bone healing and scaphoid collapse prevention.[8,19,24] Further research and data is needed regarding the implementation of closed radial wedge osteotomy. Current data revealed reduction of painful sensations and inhibition of bone ischaemia.[8] CRWO seems to be especially favourable in patients with coexistence of Preiser and Kienbock disease (avascular necrosis of the lunate).[8] Non-surgical treatment, such as immobilization or physiotherapy, seems not to have positive influence in stage III PD.[8] Primary method in this stage is PRC, and VBG is considered as a secondary option.[8] Another method that can be implemented in stage III is SILASTIC implant.[8] Among positive outcomes that were revealed after these procedures one can list pain relief and improvement of hand function and range of motion.[8] In stage IV, non-invasive methods provide only pain alleviation, with no other improvements.[8] Researchers revealed positive outcomes of PRC and SILASTIC implants in this stage, including pain management, increased range of motion of the wrist and hand capability.[8] In summary, the initial implementation of conservative treatment in patients, even in the early stages of the disease, appears to be unjustified, as it is associated with a slight improvement in their condition, primarily related to the alleviation of pain symptoms, with minimal increases in wrist range of motion, overall hand function or grip strength.[8,19] According to researchers, surgical intervention should be the method

of choice in PD therapy. Further studies are necessary to expand knowledge in this area, particularly concerning the surgical treatment of stage I of the disease and the use of new implants in stage IV. Although, due to the rarity of the disease, there is no official consensus regarding the management methods.[10,19]

The methods for treating PD are certain to evolve in the future. Promising approaches, still requiring extensive research, include complete replacement of the scaphoid, capitate resurfacing, and the use of new types of implants for total wrist arthroplasty.[8] A significant limitation of these methods appears to be the availability of highly specialized centers and personnel, coupled with the rarity of idiopathic AVN of the scaphoid bone.

## 5. CONCLUSIONS

(1) Main goals of the treatment of PD are pain relief, improved hand grip strength, wider range of motion of the wrist and enhanced overall hand and wrist function.
(2) Implementing conservative management methods seems not to bring satisfactory results in patients with PD.
(3) Method of choice in stage II PD is vascularized bone graft, and in stage III – proximal row carpectomy.

### Conflict of interest
None of the authors declare any conflict of interest.

### Funding
None of the authors declare any source of funding.

### References
1 Claessen FMAP, Schol I, Kolovich GP, Ring D. Avascular Necrosis of the Scaphoid Preiser Disease. *Arch Bone Jt Surg*. 2020;8(1):94–98. https://doi.org/10.22038/abjs.2019.39187.2047
2 Bergman S, Petit A, Rabarin F, Raimbeau G, Bigorre N. Preiser's disease or avascular osteonecrosis of the scaphoid: An updated literature review. *Hand Surg Rehabil*. 2021;40(4):359–368. https://doi.org/10.1016/J.HANSUR.2021.03.005.
3 Sokolow C, Bourcheix L. Preiser's disease. *Hand Surg Rehabil*. 2022;41(5):533–541. https://doi.org/10.1016/J.HANSUR.2022.06.004.
4 Morsy M, Sabbagh MD, van Alphen NA, Laungani AT, Kadar A, Moran SL. The Vascular Anatomy of the Scaphoid: New Discoveries Using Micro-Computed Tomography Imaging. *J Hand Surg Am*. 2019;44(11):928–938. https://doi.org/10.1016/j.jhsa.2019.08.001.
5 Alao U, Mohamed M, Hughes M, Fischer J. Idiopathic avascular necrosis of the scaphoid and lunate. *Orthop Trauma*. 2017;31(4):274–278. https://doi.org/10.1016/J.MPORTH.2017.05.005.
6 Afshar A, Tabrizi A. Avascular Necrosis of the Carpal Bones Other Than Kienböck Disease. *J Hand Surg Am*. 2020;45(2):148–152. https://doi.org/10.1016/J.JHSA.2019.05.022.
7 Lin JD, Strauch RJ. Preiser disease. *J Hand Surg Am*. 2013;38(9):1833–1834. https://doi.org/10.1016/J.JHSA.2013.06.019.
8 Kazemi M, Daliri M, Moradi A. A systematic review on the management of idiopathic avascular necrosis of the scaphoid (Preiser's disease). *Orthop Traumatol Surg Res*. 2023;109(3):103480. https://doi.org/10.1016/j.otsr.2022.103480.
9 Tomori Y, Sawaizumi T, Nanno M, Takai S. Closing Radial Wedge Osteotomy for Preiser Disease: Clinical Outcomes. *J Hand Surg Am*. 2019;44(10):896.e1–896.e10. https://doi.org/10.1016/j.jhsa.2018.11.007.
10 Pennington M, Milano M, Fletcher D, et al. A Nine-Year Follow-Up of Stage II Preiser's Disease Treated With a Temporary Dorsal Wrist-Spanning Plate: A Case Report. *Cureus*. 2023;15(10):e46474. https://doi.org/10.7759/cureus.46474.
11 Zenke Y, Oshige T, Menuki K, et al. Four-corner fusion method using a bioabsorbable plate for scapholunate advanced collapse and scaphoid nonunion advanced collapse wrists: a case series study. *BMC Musculoskelet Disord*. 2020;21(1):683. https://doi.org/10.1186/s12891-020-03709-0.
12 Kemler MA. Replacement of a destroyed scaphoimodelled prosthesis. *BMJ Case Rep*. 2023;16(11). https://doi.org/10.1136/bcr-2023-257125.
13 Fujibuchi T, Imai H, Jono A, Kiyomatsu H, Miura H. Preiser disease in a child before complete ossification of the scaphoid: a case report. *BMC Musculoskelet Disord*. 2022;23(1):1–5. https://doi.org/10.1186/S12891-022-05226-8/FIGURES/3.
14 Oh S, Park HW, Kang SH, Lim D, Park IJ. Coexisting Kienböck's and Preiser's Disease of the Wrist: Experience with Proximal Row Carpectomy with Dorsal Capsular Interposition Technique. *Orthop Surg*. 2023;15(9):2477–2481. https://doi.org/10.1111/os.13776.
15 Catapano J, Overduin OO, Von Schroeder HP. Bilateral Preiser Disease in a Patient with Sickle Cell Anemia. *J Hand Microsurg*. 2020;14(3):255–259. https://doi.org/10.1055/S-0040-1714452.
16 Tomori Y, Motoda N, Ohashi R, Sawaizumi T, Nanno M, Takai S. Preiser disease after repeated local glucocorticoid injections: A case report. *Medicine (Baltimore)*. 2018;97(38). https://doi.org/10.1097/MD.0000000000012413.
17 Salunkhe R, Abhyankar R, Deshmukh A, Shevate I, Sravan VJ. A Rare Case of Preiser Disease Affecting a Young Female. *Cureus*. 2022;14(12):e32955. https://doi.org/10.7759/cureus.32955.
18 Klifto CS, Gandi SD, Sapienza A. Bone Graft Options in Upper-Extremity Surgery. *J Hand Surg Am*. 2018;43(8):755–761.e2. https://doi.org/10.1016/j.jhsa.2018.03.055.

[19] Tomori Y, Nanno M, Takai S. Clinical outcomes of nonsurgical treatment for Preiser disease. *Medicine (Baltimore)*. 2020;99(4). https://doi.org/10.1097/MD.0000000000018883.

[20] Elzinga K, Chung KC. Volar Radius Vascularized Bone Flaps for the Treatment of Scaphoid Nonunion. *Hand Clin*. 2019;35(3):353–363. https://doi.org/10.1016/j.hcl.2019.03.012.

[21] Higgins JP, Giladi AM. Scaphoid Nonunion Vascularized Bone Grafting in 2021: Is Avascular Necrosis the Sole Determinant? *J Hand Surg Am*. 2021;46(9):801–806.e2. https://doi.org/10.1016/j.jhsa.2021.05.014.

[22] Fujihara Y, Yamamoto M, Hidaka S, Sakai A, Hirata H. Vascularised versus non-vascularised bone graft for scaphoid nonunion: Meta-analysis of randomised controlled trials and comparative studies. *JPRAS open*. 2023;35:76–88. https://doi.org/10.1016/j.jpra.2022.12.001.

[23] Alolabi N, Lovy AJ, Shin AY, Bishop AT. Medial femoral trochlea flap reconstruction: Clinical outcomes and perspectives. *J Plast Reconstr Aesthet Surg*. 2021;74(9):1991–1998. https://doi.org/10.1016/j.bjps.2020.12.063.

[24] Kara T, Gunal I. Preiser's disease treated by pronotor quadratus pedicled bone graft. *J Plast Surg Hand Surg*. 2014;48(6):455–456. https://doi.org/10.3109/2000656X.2014.971803.