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Treatment of avascular necrosis of the lunate (Kienböck's disease): a review of current literature

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ABSTRACT

Kienböck's disease is classified in the category of aseptic bone necrosis. It develops as a consequence of compromised blood supply to the bone, but its aetiology remains obscure. Vascular network supplying of the lunate is relatively delicate and in some anatomical variants is susceptible to damage.

The paper provides relatively new information about treatment options used in Kienböck's disease. Despite numerous studies, no commonly accepted algorithm has been developed. The choice of treatment method is dependent on the degree of destruction of the lunate and arthritis in carpal joints. Conservative treatment by wrist immobilization is generally used in the early stages of Kienböck's disease, because it reduces pressure on the bone and improves blood supply. Operative treatment generally refers to a symptomatic disease when conservative treatment has proven ineffective or when there are unfavourable anatomical conditions such as ulna minus variant. In general, treatment methods are divided into 3 groups: improving blood supply (revascularization), reducing pressure on the lunate (shortening osteotomy of the radius or capitate, and partial wrist fusion) and "wrist salvage" operations (wrist denervation, proximal row carpectomy, total wrist fusion). All these techniques are described and their effectiveness is discussed in the article.

Keywords: Kienböck's disease; avascular bone necrosis; bone revascularization; shortening osteotomy; partial wrist arthrodesis; outcomes of the treatment.

INTRODUCTION

Avascular necrosis of the lunate bone (Kienböck's disease) is a relatively rare pathology of one of the most important carpal bones. The disease was first noticed during the autopsy of a deceased person, and described in the mid-nineteenth century. At the beginning of the 20th century, the Austrian surgeon Robert Kienböck described the characteristic changes in the osteonecrotic lunate seen on an X-ray, and since then his name has been associated with the name of this disease. Its characteristics are as follows:

- like most avascular skeletal necrosis, lunate necrosis it is commonly seen at a young age (20–40 years). Earlier and later onset of the disease are much less frequent;
- it is more common in men than in women;
- it usually occurs in 1 wrist (unilateral disease);
- it develops slowly, and the predominant early symptom is moderate pain and limited wrist mobility.

WHY DOES KIENBÖCK'S DISEASE OCCUR?

The disease is classified in the category of aseptic bone necrosis. Necrosis of the lunate develops as a consequence of compromised blood supply to the bone, but its aetiology remains obscure. It may be related to anatomical variants in the wrist (bony and vascular), trauma of the wrist, infections and concomitant diseases such as collagenases, Crohn disease or sickle-cell anaemia [1, 2].

Blood supply to the lunate [1, 3]

The vascular system supplying the lunate has been the subject of many anatomical studies that have shown that:

- in most people, the lunate bone is supplied with blood by arterioles entering from the palmar and dorsal sides and forming a network of connections with neighbouring bones. This type of vascularization is safe and protects the bone from the negative effects of injuries or diseases;
- in about 10%, the palmar and dorsal nutrient vessels do not form connections with other bones. This type of blood supply poses a risk of ischemia of part of the bone, when one of the vessels is damaged due to injury or becomes thrombosed;
- in about 25%, the lunate has only one main nutrient vessel, entering from the dorsal or palmar side in a place devoid of articular surface. This type of vascularization is very sensitive to trauma, and rupture or coagulation of the main vessel will cause ischemia and lead to avascular necrosis.

Venous outflow from the lunate bone takes place through a fragile network of vessels that connect to the veins of neighbouring bones.

Biomechanics

The force generated during axial loading of the hand (e.g. when pushing objects, driving screws, lifting weights) is transmitted by the wrist to the bones of the forearm. The proximal pole of the scaphoid (the radio-scaphoid joint) is more compressed during these activities, absorbing about 55% of the axial load. The lunate, although located in the middle of the proximal carpal row, transmits about 35% of the force through the radio-lunate joint; the remaining 10% is transmitted by the triangular fibro-cartilage complex (TFCC). Despite its smaller share in the transmission of axial loads, the lunate is much more sensitive to injuries and overloads, due to its specific blood supply. The position of the lunate in the wrist causes it to transmit the loads that it receives partly towards the radial glenoid and partly towards the TFCC. However, these 2 surfaces against which the lunate contacts have different mechanical properties. The radial-glenoid consists of a thin layer of cartilage, strong subchondral bone and cancellous bone, has much greater resistance to shearing forces (of about 15 MPa) comparing with the TFCC which has resistance of about 10 KPa. This large difference in durability of the surfaces from the lunate may largely explain why its collapse typically occurs across from the radius [1, 3, 4].

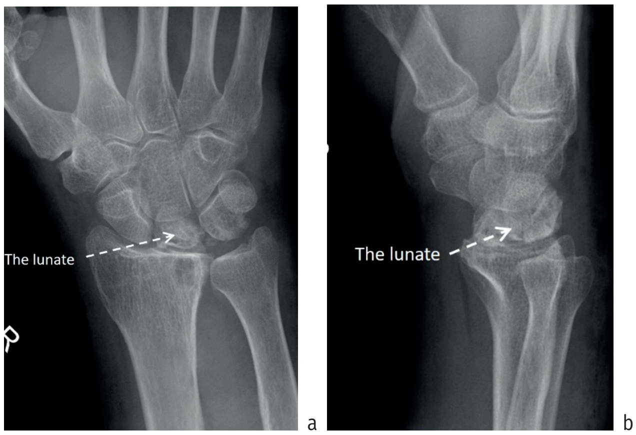

FIGURE 1. Kienböck's disease, Lichtman's classification stage IIIb: (a) p-a view; (b) lateral view

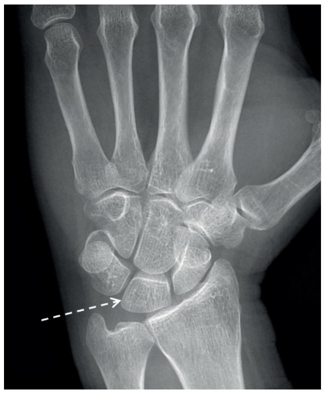

FIGURE 2. A healthy lunate bone in the other wrist (for comparison)

Etiopathogenesis

The primary cause of osteonecrosis is blood supply failure. It is caused by a disruption in the supply or outflow of blood from the bones, but the direct causes of these processes remain still obscure. Nevertheless, several theories have been tried to explain it. Potential causes of Kienböck's disease can be divided into external, related to the environment of the lunate and internal, related to the bone itself (variations of its anatomical structure). The potential causative role of other anatomical parameters has been also studied. In the study of 54 wrists, only a smaller lunate diameter, small lunate tilt angle and small inclination of the radial glenoid were significantly correlated with Kienböck's disease hypothesis [5]. A growing number of studies have suggested that immune, inflammatory, coagulation activation (potentially genetic) – trigger intraosseous venous thrombosis. It brings about increased pressure with a genuine intraosseous compartment syndrome, necrosis and remodelling of the proximal subchondral bone, where osteoclastic activity could exceed osteoblastic activity [3, 6, 7].

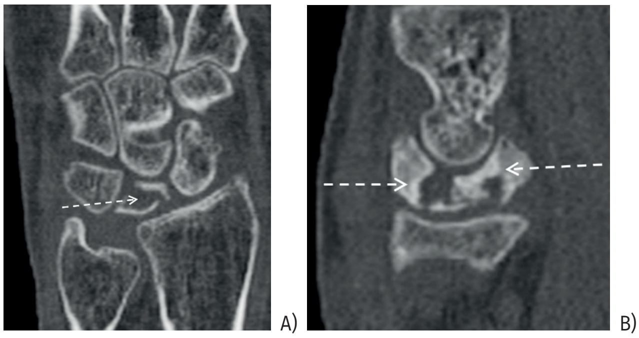

FIGURE 3. Kienböck's disease, Lichtman stage III. Computed tomography scan of the lunate in: (a) p-a view. The *ulna minus* variant is visible; (b) lateral view. Note fracture of dividing the bone in two fragments – dorsal and palmar

Staging

The severity of the disease is assessed primarily on the basis of the severity of radiological changes on an X-ray, computed tomography (CT) of magnetic resonance imaging (MRI) scans of the wrist (Figs. 1, 2, 3, 4). Stage 0 can be only determined by MRI scan. Additional information about the severity of the disease, particularly about arthritic changes in the carpal joints around the lunate can be obtained by wrist arthroscopy. The Lichtman's classification (Tab. 1) is currently the most commonly used in clinical practice and is helpful in decision making about the method of treatment [1, 2].

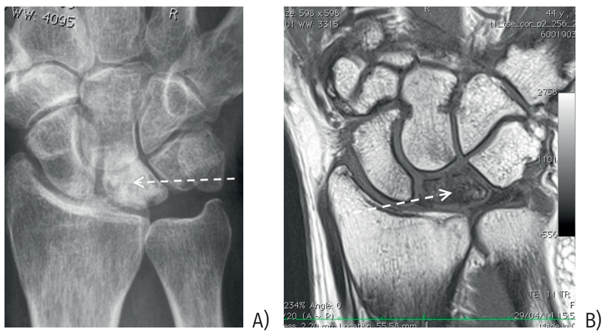

FIGURE 4. Kienböck's disease, Lichtman stage III: (a) X-ray shows clear pathologic changes in the lunate; (b) in MRI scan. Note decrease of signal saturation and subchondral fractures of the lunate

TABLE 1. Lichtman classification of the severity of radiological changes in the lunate and arthritic changes in the carpal joints

Stage	Description of radiological changes in the lunate and arthritic changes in the carpal joints
Stage 0	Normal X-ray image of the lunate bone. Changes in MRI scans indicating impaired blood supply to the bone (intraosseous oedema)
Stage I	Normal X-ray image of the lunate bone. A CT scan shows linear sclerotization, corresponding to a fracture of the lunate bone, with no significant changes in its shape and saturation
Stage II	Increased shading (saturation) of the lunate bone, compared to others carpal bones. A CT scan may show internal fractures in the bone
Stage III a	Changes in the shape, outline and structure of the lunate bone (flattening, loss of articular cartilage), increased saturation and sclerotization. No changes in the position of the lunate bone, the height of the wrist and degeneration in adjacent joints
Stage III b	Changes as in grade IIIa, but in addition to palmar DISI and loss of height (collapse) of the wrist. Secondary displacement of the scaphoid and its horizontal alignment
Stage IV	Changes as in grade IIIb and diffuse degenerative changes in adjacent carpal joints

CT – computed tomography; DISI – displacement of the lunate bone; MRI – magnetic resonance imaging

CLINICAL SYMPTOMS AND SIGNS [1, 2, 3]

The essential symptoms of advanced disease include:
- wrist pain, mainly on the dorsal side, occurring at hand movements and load;
- the pain exacerbates in the extreme wrist positions (maximum extension and flexion) and may be milder in rest position;
- tenderness (pain at pressure) on the dorsal side of the wrist, over the lunate;
- reduction of wrist mobility, especially of extension;
- weakening of grip strength and hand endurance.

Such a set of symptoms is typical for advanced disease with clearly visible changes on the X-ray. In the early stages, when the disease is radiologically "silent", the main symptom is wrist pain occurring at some activities such work or recreation, in the position of maximum wrist flexion. If the symptoms persist for several months without a tendency to subside, and especially if anatomical risk factors such as age, negative ulna variant, exposure to microtrauma or wrist trauma are present - then an imaging towards Kienböck's disease should be performed: X-ray, CT and/or MRI which help in confirmation or exclusion the diagnosis.

TREATMENT

Despite numerous studies on the results of treatment of Kienböck's disease, no commonly accepted algorithm has been developed. Although most of studies shows results of various surgical treatments, the conservative measures still play an important role, and can be effectively used for years, although, they do not prevent the constant, slow progression of the disease. As mentioned earlier, in Kienböck's disease there is no simple correlation between the severity of the lunate destruction, wrist degeneration and the severity of symptoms. Therefore, even patients with Lichtman stages IIIb and IV (Tab. 1), who, theoretically, should suffer from severe pain and functional impairment, can do quite well in their daily and vocational activities. An indication for surgical treatment is a symptomatic disease that causes significant pain, impairs the dexterity of the hand, affects the patient's quality of life and limits his or her professional activity. The choice of treatment methods is generally dependent on the degree of destruction of the lunate and arthritis in carpal joints adjacent to the lunate. The algorithm of these treatments is shown in Table 2 [1, 3, 8].

TABLE 2. Indications for conservative and surgical treatment, depending on the stage of Kienböck's disease

Stage	Method of treatment
Stage 0	Wrist immobilization and anti-inflammatory treatment
Stage I	Immobilization of the wrist. Consider shortening osteotomy of the radius in patients with ulna minus variant
Stage II	Revascularization of the lunate. Shortening osteotomy of the radius in patients with ulna minus variant. The capitate shortening osteotomy. Wedge osteotomy of the distal radius, increasing its radial inclination
Stage III a	Treatment methods the same as in stage II
Stage III b	Partial wrist arthrodesis with or without lunate resection, proximal row carpectomy. Consider always wrist denervation
Stage IV	Proximal row carpectomy, total wrist fusion. Consider always wrist denervation

Conservative treatment: immobilization of the wrist

Conservative treatment is generally used in the early stages of Kienböck's disease (Lichtman stages 0–I). Wrist immobilization in a splint or orthosis relieves the lunate and improves blood supply to the bone. It should be noted that the greatest internal pressure in the lunate occurs in its extreme positions, especially in the maximal dorsiflexion (it even exceeds the average systolic blood pressure). Therefore, keeping the wrist in a neutral position reduces the internal pressure and improves local conditions of blood circulation. If the disease is reversible (Lichtman stages 0–I), immobilization can restore normal vascularization of the bone and prevent disease progression. The duration of immobilization ranges from 2 to even 4 months, and non-steroidal anti-inflammatory drugs may be additionally beneficial [1, 2, 4]. Although Lichtman stages 0 and I suggest conservative treatment, but presence of anatomical variants predisposing to the disease (ulna minus, type I bone structure) prompts many surgeons to consider surgical treatment [1, 2, 4].

Operative treatment

Surgical treatment generally refers to a symptomatic disease when conservative treatment has proven ineffective or when there are anatomical variants, suggesting risk of proregression of the disease [1, 8]. The decisive arguments are clinical symptoms, but results of imaging (X-ray, CT or MRI) are very helpful. The choice of the method of surgical treatment depends on:

- degree of bone ischemia;
- degree of destruction of the lunate and changes in its position in the wrist;
- presence and degree of arthritis in the adjacent midcarpal joints.

Usually, the indications for particular method of surgery are based on Lichtman classification, which has proven to be accurate and reliable in predicting the outcomes of treatment with particular methods (Tab. 2). In general, treatment methods can be divided into 3 groups:

- improving blood supply to the lunate (revascularization);
- reducing the mechanical load (compression) on the lunate (shortening osteotomy of adjacent bones: the radius or capitate and partial wrist fusion);
- "wrist salvage" operations, reducing pain and improving wrist function.

These treatments will be shortly presented in the next part of this article.

Lunate preserving surgical treatments

These methods leave the lunate on site and are focused on improvement of blood supply to the lunate or on reduction of the mechanical load on the bone. They include lunate revascularization, decompression osteotomies, partial wrist arthrodesis with lunate preservation and lunate reconstruction.

1. Revascularization of the lunate with vascularized bone grafts (pedicled from the distal radius or free from lateral femoral epicondyle)

The indication for this operation is the disease in stages Lichtman II–IIIa. Important pre-condition for this surgery is the absence of previous operations within the dorsal side of the distal radius, including arthroscopic interventions. It is technically demanding operation, requiring microsurgical skills. The bone fragment in the distal radius that is used for the revascularization, is supplied by 2 arteries: the 4th and 5th extensor compartment artery (4,5th ECA) which are branches of the anterior interosseous artery. The operation is performed from the dorsal approach on the wrist. The bone graft harvested form the distal radius is then moved distally, towards the lunate and is pressed into place in a hole drilled in the lunate. Next the wrist is immobilized in the plaster cast for 6 weeks, until the graft integrates with the recipient bone [1].

Another, more sophisticated technique is use of free vascularized bone graft (VBGs) form the lateral femoral condyle. Jiga et al. reported results of the treatment of 31 patients with advanced (Lichtman stages IIIa, IIIb) Kienböck's disease. Bone grafts were fixed to the lunate with a headless compression screws. At an 8-month follow-up, all patients had complete graft healing, were pain-free and obtained acceptable functional outcomes. The authors conclude that free VBG from the lateral femoral condyle represent a reliable method of lunate revascularisation or reconstruction in advanced Kienböck's disease. Their main advantages are the constant vascular anatomy, straightforward graft harvesting technique and possibility to harvest several graft types according to the requirements at the recipient site [9].

2. Transverse shortening osteotomy of the radius

It belongs to the operations that decompress the lunate. The indication is the disease in stages Lichtman I–IIIa, with the "ulna minus" variant of the distal forearm. The surgery is usually performed from the palmar approach, to avoid damage the blood supply to the distal radius, leaving the room for possibility of later revascularization. The shortening of the radius should be about 1 cm, because a larger loss in length could impair the function of the distal radioulnar joint. The incision is made in the paraphyseal area, which facilitates fixation of the radius with dedicated titanium plates. The results of this treatment are generally satisfactory: pain subsides, wrist mobility and grip strength improve. Despite clinical improvement, in most cases the radiological pattern of the lunate bone does not improve, remaining at the same level on the Lichtman scale as before surgery. The literature notes that the results of shortening osteotomy of the radius are better in younger (<30 years) than in older patients, and are particularly beneficial in children, in whom even full revascularization and bone recovery have been observed [1, 8].

3. Shortening osteotomy of the capitate

It is the next operation that decompress the lunate. The indication is the disease in stages Lichtman II–IIIa, i.e. moderately advanced, when the wrist is in a neutral or "ulna plus" variant (it should be avoided in the "ulna minus" variant). Even with the significant destruction of the lunate bone, the effectiveness of this operation in the long term is relatively good. It is performed from the dorsal approach and – after the capitate is exposed – an excision of a 2–3 mm thick "slice" of bone is performed using a small oscillating saw. Next the bone is fused with 1 or 2 cannulated compression screws, such as those used for scaphoid fixation. After the operation, the wrist is immobilized in a short splint for 6 weeks, after which rehabilitation begins. Radiological images of the wrists 1 year after the osteotomy of the head bone shortening are shown in Figure 5.

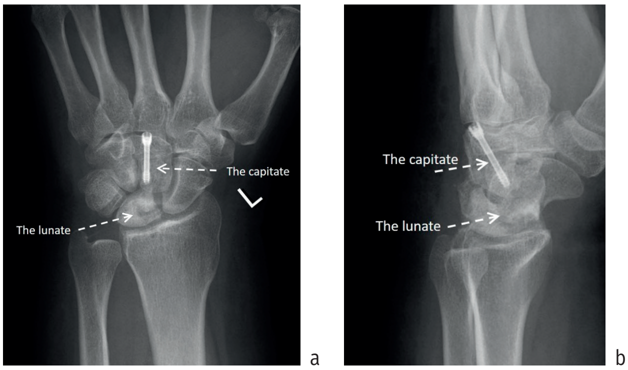

FIGURE 5. Shortening osteotomy of the capitate. X-ray one year after surgery: (a) p-a view; (b) lateral view

An interesting variant of this technique is distal capitate shortening osteotomy combined with an arthrodesis to the base of the third metacarpal bone. Fouly et al. reported results of surgery for Kienböck's disease (Lichtman stages II or IIIa) in neutral ulnar variance patients, by distal capitate shortening with capito-metacarpal fusion. The authors operated on 12 patients at a mean age of 25 years. At a mean follow-up of 20 months all patients achieved bony union at the fusion site. The patients experienced reduction of wrist pain, increase of wrist of motion and grip strength, as well as improvement of hand function as assessed by the Modified Mayo Wrist Score (MMWS). All differences between the pre-operative and post-operative variables were statistically significant. Post-operative (at 12 months) MRI demonstrated better lunate vascularization in 4 patients. The authors conclude that distal capitate shortening combined with capito-metacarpal fusion represents a new reliable method in the treatment of early stages of Kienböck's disease with neutral ulnar variant [10].

Hegazy et al. reported results of treatment with this technique of 22 patients, 8 women and 14 men in a mean age of 36 years, with Kienböck's disease. Twelve patients were in Lichtman stage II, whereas 10 in stage IIIa. At an average follow-up of 2.5 years, the stage II group showed significant reduction of pain (from 6 to 0.5 in Numeric Rank Scale, NRS), increase of wrist range of motion 57–73% (comparing to healthy wrist), increase of grip strength 54–75%, and improvement of hand function as assessed by MMWS, 51–78 points. All these differences (baseline vs. final) were statistically significant and clinically meaningful. Patients with stage IIIa showed also improvement, but the changes were nonsignificant: pain (NRS 6 vs. 4), wrist range of motion (52% vs. 55%), grip strength (46% vs. 57%), and MMWS (36 vs. 50). The authors conclude that capitate shortening with capito-metacarpal arthrodesis shows good results in patients with stage II Kienböck's disease, but not in those with stage IIIa. Moreover, it cannot prevent carpal collapse, therefore they do not recommend this technique for treating stage IIIa patients [11].

4. Partial arthrodesis of the wrist with preservation of the lunate

Indications to this surgery are similar as to shortening osteotomy of the capitate. The spectrum of bone fusions include scapho-capitate (SC), scapho-trapezio-capitate (STC) – Figure 6, scapho-trapezio-trapezoid (STT) or capitate-hamate (CH) arthrodesis. Mechanical studies have shown that the reduction in pressure on the lunate after all these operations is a max. of 10–15%, which seems modest, but clinical outcomes are optimistic, showing significant reduction of symptoms and increase of grip strength in most patients [1, 2, 8]. Obviously, after this procedure mobility of the wrist remains limited. It should be noted that these surgeries do not change the natural course of the disease which tends to slow, but progressive destruction of the lunate.

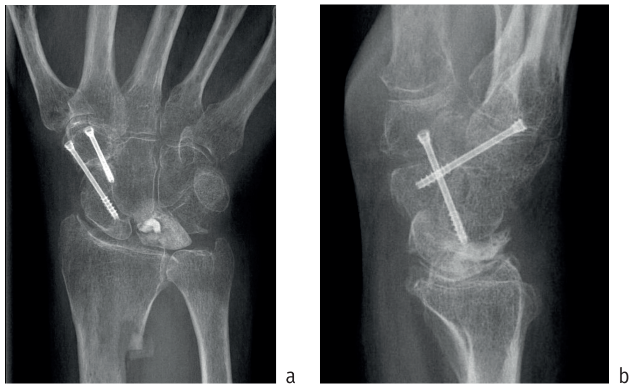

FIGURE 6. Scapho-trapezio-capitate arthrodesis in the treatment of Kienböck's disease. X-ray image one year after surgery: (a) p-a view; (b) lateral view

Collon et al. reported results of treatment of Lichtman stage IIIa, b Kienböck's disease by scapho-capitate fusion. The group comprised 17 patients with advanced Kienböck's disease: 4 in stage IIIa and 13 in IIIb. At a mean of 6 years follow-up, the mean pain level decreased from baseline NRS 8 points to 4 with activity, and 1 at rest. The wrist range of motion was 91° and grip strength was 76% of the contralateral side, the average DASH score was 19 points (score representing normal/moderate hand function) and the Patient Reported Wrist Evaluation (PRWE) score was 23 points (normal/moderate hand function). All these differences (baseline vs post-operative) were statistically significant. The preoperative mean modified carpal height ratio decreased significantly to an average of 1.14 at the final follow-up, but the average carpal-ulnar distance ratio was not altered. The radioscaphoid and scapholunate angles were restored to their normal range. Four scapho-capitate joints failed to fuse, but no reoperations were necessary. The authors conclude that scapho-capitate fusion for advanced Kienböck's disease maintains wrist motion and significantly relieves pain and their results are comparable to those of scapho-trapezio-trapezoid fusion [12].

Another, novel option of lunate preserving surgical treatment is partial wrist fusion via limited lunate excision with preservation of the proximal lunate surface and scapho-luno-capitate (SLC) fusion. This operation consists in decortication of the articular surface of the scaphoid and capitate at the SC joint and filling the space between scaphoid, lunate, and capitate bones with a structural iliac crest bone graft. The SC and luno-capitate junction is next fixed with two 1.4 mm K-wires. Prior to fixation, correction of the scaphoid rotation is performed to restore the normal carpal height. Shams et al. reported outcomes of this operation in 20 patients with a mean age of 28 years with stage IIIa Kienböck's disease. At the mean of 1 year follow-up, pain decreased from a mean of 6 to 0.6 in the NRS scale, movement of the wrist (flexion-extension) improved of 13%, grip strength of 33% and the Mayo Wrist Score of 40 points. Radiological parameters of the wrist improved also and bone union was achieved in all patients. The authors conclude that scapho-luno-capitate fusion with partial lunate excision and preservation of the proximal lunate surface is a valuable option for treating stage IIIa Kienböck's disease [13].

Lunate replacement by pisiform bone, osteochondral bone graft or a prothesis

When the lunate is collapsed, with no chance for reconstruction, it may be still useful to preserve the overall anatomy of the carpus. The main indication appears to be Lichtman stages IIIb and IIIc, with no significant cartilage damage. In this situation, the lunate replacement seems to be a reasonable option. The material for replacement which has been used included the pisiform bone, a rib cartilage graft, or an artificial implant, which is currently being done by 3D printing [1, 4, 14, 15]. At the moment there is not enough evidence that this treatment is superior over the conventional techniques, and a reliable comparison of the outcomes requires more studies and longer follow-up.

"Wrist salvage" operations

These operations are performed when the lunate is collapsed and arthritic changes are present in the adjacent midcarpal joints. There are some important preconditions for these operations, such as absence of arthritis in radio-scaphoid and radio-triquetral joints (for partial wrist arthrodesis) or in luno-capitate joint (for proximal row carpectomy).

1. Resection of the lunate with partial wrist arthrodesis

It is a surgery classified as a "wrist salvage" operation, reducing pain and improving wrist function. The indication is the disease in the Lichtman IIIb stage, i.e. considerably advanced, with significant destruction of the lunate and with arthritic changes seen in the midcarpal joints adjacent to it. The prerequisite for the success of this operation is the absence of arthritis in the radio-scaphoid and radio-triquetral joints. The operation is performed from the dorsal approach: after excision of the lunate, one of the previously described midcarpal arthrodesis is performed: scapho-trapezoid or scapho-capitate. Midcarpal arthrodesis prevents the loss of wrist height and allows stabilization of the scaphoid, which otherwise would tend to dislocate after excision of the lunate [1, 8].

2. Proximal row carpectomy (Fig. 7)

It is also a "wrist salvage" operation. It is performed in advanced disease (Lichtman stages IIIb and IV). The pre-condition for its success is the absence of luno-capitate joint arthritis and good quality of the cartilage covering the head of the capitate. Excision of the proximal carpal bone gives fairly good results in the medium to long term, although it does not prevent the slow development of carpal osteoarthritis. However, this does not always lead to the need for total wrist arthrodesis.

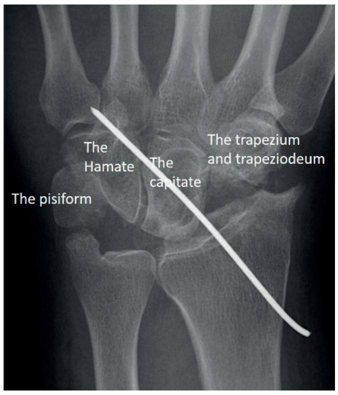

FIGURE 7. X-ray of the wrist 1 month after proximal row carpectomy, before retrieval of K-wire

Palliative operations

1. Wrist denervation

In advanced disease (usually Lichtman stages IIIb and IV), when the patient's symptoms are troublesome, but the mobility of the wrist is relatively good, wrist denervation may is a reasonable option. Most often, candidates for this operation are working patients who, for fear of a longer period of inability to work, do not agree to a large "wrist salvage" operation. Also people who are not yet determined to undergo risky surgery interfering with their wrist, because they function quite well.

In this situation denervation offers alleviation of pain as an alternative to more invasive procedures such partial wrist arthrodesis or proximal row carpectomy. There are several techniques of this procedure; main classification include total and partial wrist denervation. Partial wrist denervation is more popular technique because is less demanding than total denervation and results of both techniques are roughly the same. Partial wrist denervation consists in resection of a 1 cm od terminal branch of the posterior interosseous nerve (PIN) alone, or, with additional resection of fragment of the anterior interosseous nerve (AIN) – Figure 8. Total wrist denervation is achieved by cutting additionally, from separate incisions, small cutaneous branches of the ulnar, median and radial nerves. The current literature provides a convincing evidence that wrist denervation is a reliable and reproducible surgical technique in terms of pain relief and preservation of function in painful osteoarthritic conditions of the wrist. It should be considered in patients presenting with painful wrist that is still mobile, regardless the initial aetiology [1, 2, 8].

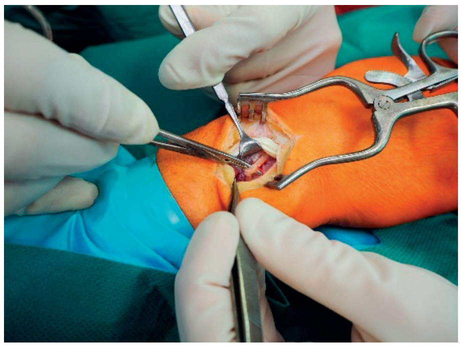

FIGURE 8. Terminal branch of the PIN exposed at the operation

2. Definitive wrist arthrodesis (total wrist fusion)

The indication for it is the IV stage of the disease, with predominant severe wrist pain and significant impairment of wrist function. Most often, patients have previously performed other surgeries that have proven to be ineffective or temporarily effective. In the author institution this operation was never performed for Kienböck's disease, and rarely in severe post-traumatic carpal degeneration. This operation is performed with the use of a specially designed dorsal plate.

FINAL CONSIDERATIONS AND CONCLUSIONS

The data presented in this review are in line with current guidelines on the diagnosis and treatment of Kienböck's disease developed in the last 10 years [16, 17]. Evolution of Kienböck's disease is predictable only to a certain extent. In most cases the course is progressive, but another, more successful scenario can be expected:

- it can lead to the destruction of the entire wrist and the need of total wrist fusion due to severe pain;
- it can cause collapse of the wrist, but without severe pain, thus not requiring surgical intervention;
- it can stop at any stage, causing some slight to moderate limitation of wrist mobility and hand dexterity.

The main goal of the treatment of Kienböck's disease, in most cases, is not to heal (recover) the lunate, but to reduce the patient's complaints, improve function of the wrist and the entire hand. It does not necessarily mean an improvement in the condition of the affected lunate. The results of the treatment of Kienböck's disease presented in the literature do not allow for an unambiguous statement whether surgical intervention at each stage of the disease significantly changes its natural course or only brings temporary (or permanent) clinical improvement. To date, none of the surgical techniques that have been developed, including bone revascularization, can cure the disease. One of the most important positive prognostic factors is the patient's age at the time of diagnosis: in adolescents and young adults (<30 years), ischemic and early necrotic lesions in the lunate may completely recover as a result of conservative or simple surgical treatment (usually distal radius shortening). At a later age, treatment is aimed at slowing down the progression of necrosis of the lunate and preventing degeneration of the entire wrist.

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