Flexafix: The development of a new dynamic external fixation device for the treatment of distal radial fractures
Goslings, J.C.

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Appendix C

A special application for the Flexafix device

J.C. Goslings, A.H. Schuurman, A.H. Broekhuizen †.
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Introduction

In 1910, Robert Kienböck published his study ‘Traumatic malacia of the semilunar bone’. Since his classic description, neither the cause nor a reliable treatment for lunatomalacia has been established with certainty. Although the etiology of lunatomalacia, also called osteonecrosis, is clearly related to avascular changes, as Kienböck suspected, the actual cause leading to this vascular impairment has remained unclear. The interruption of blood supply to the lunate has been attributed to primary circulatory problems, to traumatic interference with circulation or ligament injury, or, more frequently, to single or multiple fractures resulting in secondary vascular impairment. Once the lunate is affected by avascular necrosis, continued loading ultimately results in fragmentation, collapse of the lunate with altered carpal kinematics and finally arthrosis.
The diagnosis is often suspected by the presence of pain and stiffness of the wrist, some swelling and tenderness localised on the dorsal side of the lunate and a striking weakness of grip. The diagnosis is confirmed by radiographs. Bone scintigraphy and computed tomography can also provide diagnostic information. Magnetic resonance imaging has showed a high specificity in early stages of the disease. Kienböck’s disease is commonly staged according to Lichtman. Present available treatment options include immobilisation, “joint-levelling” procedures (radial shortening or ulnar lengthening), re-vascularisation procedures, various intracarpal arthrodeses, lunate excision with or without replacement, wrist denervation and salvage procedures, including proximal row carpectomy and wrist arthrodesis. Ruby treated patients with Lichtman stages I, II and III Kienböck’s disease with a combination of cancellous bone grafting and external fixation.

Recently a new form of external fixation for the treatment of distal radial fractures has been introduced. It is called “dynamic external fixation” because the external fixation device allows motion at the wrist during treatment of the fracture. To permit early functional treatment, the small AO external fixator has been supplemented by a joint allowing three degrees of rotational freedom. The centre of rotation is located at a point outside the device and lies approximately in the head of the capitate. Details of this new device, which is also called Flexafix, have been described elsewhere. This case report describes the combination of three dimensional dynamic external fixation and bone grafting for the treatment of Kienböck’s disease.

Case report

A 62 year-old right-dominant man with a symbrachydactylyia (a congenital deformation in which the fingers are short and adherent) of the left hand presented with increasing pain in his right wrist since one year. There had been no previous trauma to the right wrist, nor was there a history of rheumatoid arthritis. The erythrocyte sedimentation rate was normal; rheumatoid factors were not present. The range of motion was 50 degrees of flexion and 50 degrees of extension. Pain was elicited on palpation of the lunate. Standard X-rays of the wrist showed a cyst in the lunate without collapse (Lichtman stage II) (Fig. 1). An MRI scan showed an abnormal intensity of the signal with a cyst in the lunate bone (Fig. 2). The T1 and T2 weighted images indicated the presence of avascular necrosis in the lunate bone.
During the operation under general anaesthesia the lunate was opened. The cyst was excocleated and filled with cancellous bone from the iliac crest. To unload the lunate postoperatively, the Flexafix dynamic external fixator was placed on the wrist (Fig. 3). Two weeks later, the fixator was unlocked and the patient was encouraged to exercise flexion and extension. The fixator was removed six weeks post-operatively. The X-ray showed the onset of bone healing. At four months follow-up the patient was satisfied and reported less pain than pre-operatively. The range of motion was 50 degrees of flexion and 40 degrees of extension; radial deviation, ulnar deviation, pronation and supination were the same as pre-operatively. The X-ray at this time showed an almost complete bone healing of the defect with a remaining cortical interruption in the proximal part of the lunate (Fig. 4).
Discussion

Kienböck’s disease is still a condition with an unclear etiology and no optimal treatment. Joint-leveling procedures probably are most frequently performed at this time.\textsuperscript{20} Long-term results show good pain relief but little, if any, change in the course of slowly progressive lunate collapse.\textsuperscript{2,14,19} The main attraction of the levelling techniques is that the carpus is left undisturbed. On the other hand, the carpus is the site of the problem. Re-vascularisation procedures have been reported with good results.\textsuperscript{3,7} However, the present re-vascularisation procedures are technically demanding and long-term follow-up data are lacking.\textsuperscript{2,20} Partial carpal fusions have also been proposed for the treatment of lunatomalacia but their effectiveness is unclear.\textsuperscript{1,2,6,17} Because of the lack of predictable results of the different procedures Ruby proposed cancellous bone grafting in combination with a period of ‘lunate unloading’.\textsuperscript{20} This is thought to result in re-vascularisation of the lunate. He considered this technique simpler with more predictable results. In his point of view, possible advantages are the fact that

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Figure 3. Post-operative situation after curettage, bone graft and dynamic external fixation.

Figure 4. X-ray four months after the operation.
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it does not significantly limit the range of motion and that the technique does not change
carpal kinematics (as compared to joint-levelling procedures and arthrodeses). Further,
other procedures can still be performed afterwards. Satisfactory results were achieved
in 71% of 17 patients. However, a static external fixator was used for an average of
9.8 weeks.
The combination of cancellous bone grafting and external fixation seems logical because
the problem is treated at an important site, i.e. the lunate itself. However, in a person
who already has a disturbed wrist function it is unattractive to immobilise the wrist
joint for 6 to 10 weeks with the possible risk of increased pain and stiffness. Since our
patient only had one functional wrist, it was imperative to maintain wrist function. At
the same time however, it is important to temporarily decrease the load of the lunate,
which normally transmits 40% of the axial load on the wrist, to admit regeneration of
the bone and the surrounding cartilage. Besides that has the beneficial effect of motion
on the regeneration of articular cartilage been known for a long time. Motion can
transform granulation tissue and fibrous cells into cartilage cells. Dynamic external
fixation could thus add a new advantage to the proposed treatment. The Flexafix device
provides a means of distraction while at the same allowing active use of the hand.
The patient in this case report had a good clinical and radiological result of the operation.
A minor disadvantage of the Flexafix device used in this case is the relative complexity
of the positioning during the operative procedure as compared to the application of a
rigid external fixator. The case presented is of special interest with respect to the fact
that the patient had a symbrachydactyly on the other side. Therefore, it was essential
that the integrity of the lunate was restored to prevent collapse and that he was able to
use the hand on the operated side as soon as possible. With the Flexafix device the
patient was able to use his hand two weeks post-operatively.

Conclusion

The combination of cancellous bone grafting and external fixation seems to be a new,
logical and attractive option in the treatment of Kienböck’s disease. In the case presented,
a patient with only one functional hand and a Lichtman stage II lunatomalacia benefited
from the dynamic aspect of the Flexafix device. The functional and radiological results
in this case were good. Further studies to evaluate the use of dynamic external fixation
in the treatment of Kienböck’s disease could provide more data but these are difficult to
conduct, considering the low incidence of this condition.
Appendix C

References