Tenodesis of the extensor carpi ulnaris for chronic, post-traumatic lunotriquetral instability

We describe a technique of soft-tissue reconstruction which is effective for the treatment of chronic lunotriquetral instability. Part of extensor carpi ulnaris is harvested with its distal attachment preserved. It is passed through two drill holes in the triquetrum and sutured to itself. This stabilises the ulnar side of the wrist.

We have reviewed 46 patients who underwent this procedure for post-traumatic lunotriquetral instability with clinical signs suggestive of ulnar-sided carpal instability. Standard radiographs were normal. All patients had pre-operative arthroscopy of the wrist at which dynamic lunotriquetral instability was demonstrated. A clinical rating system for the wrist by the Mayo clinic was used to measure the outcome. In 19 patients the result was excellent, in ten good, in 11 satisfactory and in six poor. On questioning, 40 (87%) patients said that surgery had substantially improved the condition and that they would recommend the operation. However, six (13%) were unhappy with the outcome and would not undergo the procedure again for a similar problem. There were six complications, five of which related to pisotriquetral problems. The mean follow-up was 39.1 months (6 to 100). We believe that tenodesis of extensor carpi ulnaris is a very satisfactory procedure for isolated, chronic post-traumatic lunotriquetral instability in selected patients. In those with associated pathology, the symptoms were improved, but the results were less predictable.
attitude of the wrist. Preliminary radiography included posteroanterior and lateral views, clenched fist postero-anterior and lateral views and views taken in ulnar and radial deviation. Two patients had a volar intercalated segmental instability deformity. In two patients the scaphoid fractures sustained earlier had healed. No radiographs were taken after operation. Bone scans carried out in eight patients were normal. Before the tenodesis procedure, all patients had an arthroscopy of the wrist and midcarpal joint at which there was evidence of gross instability indicated by stepping and gapping in the lunotriquetral joint. The mean duration between injury and arthroscopy was 3.3 years (6 to 108 months), which reflects the tertiary referrals to our centre. The mean duration between arthroscopy and tenodesis of the extensor carpi ulnaris was 14.9 months (0 to 54). The mean follow-up was 39.1 months (6 to 100). All the wrists were evaluated using the clinical scoring system proposed by the Mayo clinic.\textsuperscript{10}

**Operative technique.** Under general anaesthesia and with a pneumatic tourniquet, a dorsomedial longitudinal incision is made over the fifth compartment of the wrist (Fig. 1a). An ulnar-based retinacular flap is raised to expose the tendon of extensor carpi ulnaris. Two holes are drilled in the triquetrum taking care to maintain the bony bridge between them (Fig. 1b). Approximately one-third of the tendon of extensor carpi ulnaris is then mobilised, retaining its distal insertion, and passed through the drill holes in the triquetrum from distal to proximal (Fig. 1c). A tunnel is prepared in the posterior aspect of the triangular fibro-cortilaginous complex and the mobilised portion of extensor carpi ulnaris is threaded through it. The tendon is then finally passed through a tunnel created in the capsule of the posterior distal radioulnar joint (Figs 1d and e). With the wrist in neutral, tension is then applied to the tendon and it is sutured back to itself and the surrounding capsule (Fig. 1f). The tension is judged to be adequate when the supinated attitude of the wrist has been corrected. The retinacular flap is then closed with the tendon of extensor digiti minimi outside it. After operation the limb is immobilised in an above-elbow splint for six weeks, with the elbow in 90° of flexion and the forearm in neutral rotation. During this period the patient is allowed to release part of the splint to mobilise the elbow. The support is changed after six weeks for a below-elbow splint with the wrist in a neutral position. This is retained for a further six weeks, during which there is progressive mobilisation.

**Results**

The Mayo wrist scoring system\textsuperscript{10} is a modification of Green and O’Brien’s system.\textsuperscript{11} It comprises 100 points; 25 each are allocated to pain, function, range of movement and grip. It excludes radiological assessment and is suitable for this pattern of injury and its treatment. Since the pre- and post-operative radiographs of our patients were normal, the use of this particular scoring system seemed ideal. Functional questions relate to employment and return to work and so this method of assessment is suitable for younger patients with problems in the wrist following trauma.
Nineteen patients (41%) were graded as excellent, ten (22%) as good, 11 (24%) as satisfactory and six (13%) as poor. All the patients were asked whether they would consider having the operation again for a similar problem; 40 (87%) replied that they would, but six (13%) were disappointed with the outcome and would have preferred not to have it again. There were six complications. One patient had an injury to the dorsal branch of the ulnar nerve which recovered, but left some mild paraesthesia. Five developed pisotriquetral problems, one of whom responded to an injection of steroid, two required excision of the pisiform and one needed excision of the pisiform with decompression of the canal of Guyon. The fifth patient developed reflex sympathetic dystrophy and has persistent symptoms.

Discussion
The lunotriquetral alignment is composed of dorsal, palmar and proximal components. The palmar fibres are the strongest and lend maximum stability to the joint. They are disrupted if complete dissociation between the lunate and the triquetrum occurs,

Two patients with a previous history of scapholunate repair and another two with healed fractures of the scaphoid were the only patients who presented with this pattern of injury. Three others had mild pain on the radial side of the wrist, their symptoms were predominantly on the ulnar side. In the remaining 39 patients, there was no evidence of abnormality on the radial side but clear clinical and arthroscopic evidence of instability. The exact mechanism of isolated lunotriquetral injury is not understood. Some authors have suggested that a reverse perilunate pattern of injury, which progresses from the ulnar to the radial side, can occur when there is forced extension, radial deviation and intercarpal pronation at the wrist.

We believe that this rare reverse perilunate pattern probably occurs as a result of a fall on the hypothenar eminence and was the cause of the lunotriquetral dissociation in our patients. Chronic repetitive stress on the wrist can also predispose to this instability, as was shown by Schroer et al. in a group of paraplegic patients. Finally, ulnar-positive variance can lead to a tear of the triangular fibrocartilaginous complex and ultimately injury to the lunotriquetral ligament. The reverse perilunate pattern of injury progresses from the ulnar to the radial side in a staged fashion. The first step is dorsal detachment of the triangular fibrocartilaginous complex, which results in a supinated attitude of the wrist. This is then followed by disruption of the lunotriquetral ligament. All our patients had a supinated attitude of the wrist. Lunotriquetral tenderness and a positive lunotriquetral ballottement test were also essential for the diagnosis of this condition. Numerous other conditions can also give rise to pain on the ulnar side of the wrist. All our patients had a diagnostic arthroscopy to confirm injury to the lunotriquetral ligament and to exclude other coexistent pathology.

The treatment of lunotriquetral injuries is uncertain. Reagan et al. reported good results with conservative treatment in acute tears less than three months after injury by immobilisation in a cast for six weeks. They also recommended primary open repair of the ligament in acute cases in which a static pattern of deformity was visible on radiographs. None of the patients referred to us had acute tears. Lunotriquetral arthrodesis and a four-corner fusion have been recommended for chronic symptomatic tears of the lunotriquetral ligament. Pin et al. described 11 patients who had undergone a lunotriquetral arthrodesis. All achieved bony fusion but three still had considerable pain. Nelson et al. reviewed 22 patients retrospectively all of whom achieved bony union after fixation using a Herbert screw and a K-wire. Kirschenbaum et al. assessed 14 patients with a lunotriquetral arthrodesis. Fusion was present in 12 who noticed a moderate reduction in the movement of the wrist post-operatively. Trumble et al. used an assortment of intercarpal fusions for treating the problem. Their experience of one case of lunotriquetral fusion was unsatisfactory, but four patients who underwent four-corner fusion had good results. These studies indicated that good results can be achieved by lunotriquetral fusion using a compression screw and immobilising the wrist for a sufficient period of time. However, others describe disappointing results.

We believe that to maintain the kinematics of the lunotriquetral joint as close to normal as possible, the joint itself should be spared. After complete disruption of the lunotriquetral ligament, the triquetrum moves away from the lunate during supination. This, combined with the detachment of the posterior aspect of the triangular fibrocartilaginous complex, gives the typical supinated appearance to the wrist. Tenodesis of the extensor carpi ulnaris corrects this subluxation of the triquetrum by creating a sling on the dorsal aspect and allowing a more anatomical movement between the proximal row of carpal bones. The aim of the procedure is not to recreate the anatomy but to improve the kinematics. Tenodesis of the extensor carpi ulnaris is appropriate when there is dynamic lunotriquetral instability and the radiographs are normal. This pattern can only be fully appreciated during arthroscopy. Further progression of the reverse perilunate pattern of displacement produces midcarpal instability, which is associated with development of the volar intercalated segmental instability deformity as seen on radiographs. This involves disruption of the radiocarpal ligaments which act as a secondary restraint in the absence of the lunotriquetral ligament. Two of our patients who were operated on had a volar intercalated segmental instability pattern on the pre-operative radiograph. One had a poor result and the other was only satisfactory. We therefore do not recommend tenodesis of the extensor carpi ulnaris in the presence of a static volar intercalated segmental instability deformity.

Two patients with poor results had additional osteochondral lesions and one developed reflex sympathetic dystrophy. Two other patients had a further injury resulting in disruption of the scapholunate ligament in addition to dam-
age to the ligament reconstruction. Both patients declined further surgery. A common sheath envelopes the tendons of extensor carpi ulnaris and flexor carpi ulnaris. Excessive tension on the tenodesis is likely to displace the pisiform and the flexor carpi ulnaris in a dorsal direction, resulting in increased pressure in the pisotriquetral joint. This may have been the cause of problems in the pisotriquetral joint in some of the patients.

Concern has been expressed regarding the durability of tendon reconstructions for rupture of ligaments. Six of our patients had a follow-up of between six and 12 months, 19 had more than three years and eight more than five years. We are, therefore, encouraged that our technique is standing the test of time.

Tenodesis of the extensor carpi ulnaris is a satisfactory procedure for isolated, chronic post-traumatic lunotriquetral instability. It is easy to perform and reproducible results can be expected. In patients who have associated problems in the wrist the symptoms can usually be improved, although the results are less predictable.

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References