Motion-preserving salvage surgery of the wrist after a scaphoid non-union or scapholunate dissociation

This article looks at salvage surgery of the wrist after a scaphoid fracture non-union or a scapholunate dissociation cause arthritic change in the radioscaphoid joint. All motion-preserving alternatives are discussed. Of the common ones of scaphoid excision and a four-corner fusion or a proximal row carpectomy, in the medium term a proximal row carpectomy retains more physiological movement and therefore better function but long-term results are less certain. In such cases the orthopaedic surgeon must discuss alternatives and tailor a specific solution to the patient.

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Injury to the wrist is common and usually affects young men. The two injuries that can result in early secondary osteoarthritis are a scaphoid fracture\(^1\) that does not heal and a scapholunate dissociation\(^2\), which causes instability.

Once degenerative change has set in salvage procedures may be needed if symptoms intrude on the patients’ ability to perform activities of daily living or activities at work.

Both injuries disrupt the continuity of the proximal carpal row. This row is then broken into two unequal parts, the smaller radial segment made up of a part or whole of the scaphoid and the longer ulnar segment of the lunate and triquetrum with or without the proximal part of the scaphoid. The extent of degeneration reflects the size of the radial segment of the proximal carpal row, which flexes after the non-union or dissociation. There is point loading between the radial segment of the proximal carpal row and the dorsal rim of the scaphoid facet of the distal radius. This, in a very quick time, leads to loss of joint cartilage. After a scaphoid non-union (Figure 1) there is a loss of wrist cartilage which is noted on wrist radiographs within five years in most patients\(^3\). The arthritis initially occurs between the radial segment of the proximal carpal row and the styloid and dorsal rim of the distal radius.

It rapidly extends to involve the articulation between the radial segment of the proximal carpal row and the scaphoid fossa of the distal radius. The next joint to get involved is that between the capitae and the proximal scaphoid with the degeneration slowly progressing (Figure 2). The radiolunate joint and that between the proximal scaphoid and the radius is preserved until very late\(^4\).

The symptoms from the degenerative arthritis do not usually reflect the radiological findings. Patients can present with episodic sharp catching or painful giving way, especially on gripping forcefully. Persistent aching is uncommon and, although patients have restricted movement, what is left permits most daily activities. Patients cannot push up taking weight on their palm. Once the symptoms have become intrusive and cannot be managed using non-surgical methods (rest, splints, analgesics NSAIDs or injections), the surgeon needs to consider possible intervention.

Surgical Options

The options the surgeon may consider include advice, debridement of osteophytes, denervation, and partial excision arthroplasty. Excision arthroplasty commonly involves excision of the scaphoid and midcarpal fusion or a proximal row carpectomy. It is very uncommon, in my experience, to need total wrist arthroplasty\(^5\) or a full wrist fusion\(^6\).
Denervation

Denervation involves a careful dissection of the branches from the superficial division of the radial and ulnar nerves from the extensor retinaculum and the identification and excision of a segment from the posterior and interosseous nerves, the latter distal to the pronator quadratus. Preoperative local anaesthetic blocks of the nerves to be divided may help identify patients who may benefit but this is not routinely done. The risks of infection on complex regional pain after surgery are very low and recovery of function is rapid, as patients do not need immobilisation in a plaster cast or splint.

The advantage is that recovery time is very short and risks are low but the benefits from this procedure are difficult to predict. At nine years 54% of patients retained benefit after such surgery and 85% of patients did not need to change their occupation.

Debridement

If there are large osteophytes on the dorsum of the radius and the contiguous part of the waist of the scaphoid these can be excised via an arthrotomy or arthroscopically to prevent osteophyte impingement. This usually improves the range of movement but relief of pain is unpredictable.

The two common options to salvage a painful wrist with a high chance of improving symptoms and still retaining some wrist movement are the excision of the scaphoid and a four corner fusion of the mid carpal joint or alternatively a proximal row carpectomy excising the scaphoid and along with it the lunate and triquetrum.

Scaphoid excision and Four Corner Fusion

When the arthritis between the scaphoid and the radius is severe and painful the surgeon can consider excising the scaphoid distal part. This therefore is an excision arthroplasty similar to a trapeziectomy. The main risk of carpal collapse into a dorsal intercalated segment instability (DISI) pattern with the lunate tilting to face dorsally is mitigated by performing a midcarpal fusion.

The articulation preserved for wrist motion is the radiolunate joint. If this joint is involved then the surgeon must consider whether this procedure is appropriate. This joint is usually preserved in scapholunate dissociation (SLAC) or scaphoid non-union (SNAC).

Choice

Clinicians have considered this for a SLAC or SNAC wrist because it maintains carpal height, This maintains the best length of the muscle tendon units across the wrist so there is no weakening of the muscles used to perform tasks. So surgeons have traditionally considered this option when they have wanted to retain maximum strength in the hand.

Figure 1 - This radiograph demonstrates the features of a late result of a scaphoid fracture non-union. The Scaphoid Non-union Advanced Collapse (SNAC) wrist shows arthritis between the distal scaphoid and the scaphoid facet of the distal radius. The radiolunate joint and that between the proximal scaphoid and the radius is preserved. Note the hatching on the radial aspect of the proximal capitate where there is point loading. There is also arthritis between the capitate and the lunate. In this case a proximal row carpectomy is contraindicated so a scaphoid excision and a four corner fusion would be a reasonable alternative.

Figure 2 - This radiograph demonstrates a Scapho-Lunate Advanced Collapse (SLAC) wrist with radioscaphoid and midcarpal osteoarthritis. Note on the lateral radiograph that the lunate is tilted to face backward- the Dorsal Intercalated Segment Instability (DISI) pattern.
Advice
Patients are told that the scaphoid will be excised and the mid-carpal joint will be fused. They will be immobilised in a plaster cast for a while between six and 12 weeks. Patients are informed that their wrist movement will be reduced and that the procedure does not restore normality. They are warned of the other risks of non-union, mal-alignment of the wrist joint, ulnar sided pain in addition to the usual surgical risks of infection, stiffness, algodystrophy and nerve injury. All other alternatives are discussed and a shared decision is made.

Technique
My preference is to do this procedure through a dorsal longitudinal incision centred over the middle finger ray. The extensor retinaculum is divided transversely and the stout septum between the third and fourth extensor retinaculum is divided. This allows the distal part of the retinaculum to be retracted, exposing the Extensor Pollicis Longus tendon and the tendons of the fourth compartment. These are retracted radially and ulnar-wards to expose the dorsum of the wrist capsule.

The posterior interosseous nerve is identified as it courses to the dorsum of the wrist. A one-centimetre section is excised from as proximal as the incision permits. Once the nerve is divided the radiocarpal joint is entered distal to the Lister’s tubercle and the capsulotomy extended radially to the styloid. On the ulnar side the incision is oblique through the middle of the dorsal radiotriquetral ligament towards the triquetrum and then distally for one centimetre. The incision into the capsule then goes radially to the scaphoid and the dorsal radially based flap is elevated from the carpal bones fully exposing the mid carpal joint.

The scaphoid is then mobilised and removed using sharp dissection and a periosteal elevator. The palmar ulnar corner of the scaphoid tuberosity can at times cause a problem as it is very strongly attached. Sometimes the scaphoid is large and may need to be divided using Lambotte osteotomes. Bone nibblers are used to complete the excision. When dealing with a SNAC wrist we usually retain the proximal scaphoid. The area is washed and any debris removed.

Attention is then turned to the mid carpal joint, which is usually unaffected. The surfaces of the capitate, hamate, triquetrum and lunate are cut back to good bleeding bone using a combination of rongeurs, osteotomes and a 4 mm burr. The area is washed to remove debris, and packed with cancellous bone. We prefer to obtain good quality cancellous bone from the patient’s opposite iliac crest. This is morcellised using a bone cutter and packed into the mid carpal joint. The joints are stabilised using 1.1 mm Kirschner wires, with attention being paid to correct any dorsal tilting of the lunate. The position is checked on image intensifier.

Once a satisfactory position is obtained we prefer to hold position using a circular plate (Figure 3). There are many alternative ways of holding the bones in position and the surgeon needs to be familiar with a few of these techniques.

The capsule is then closed with a few interrupted sutures. The transverse split in the extensor retinaculum is quickly closed with a running absorbable suture. The wound is infiltrated with a long acting local anaesthetic. The longitudinal skin incision is closed and the wrist bandaged. We routinely apply a plaster of Paris cast on the palmar surface to immobilise the wrist.
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Tricks and tips

There are three problems that

can be avoided by attention to technical detail:

1. Range of wrist movement is retained if the DISI is
corrected. So careful attention to this and checks before stabilisation using intra-

operative fluoroscopy helps avoid a fusion in persistent DISI position.

2. Radial tilting of the hand can be avoided by allowing the capitae to find its neutral position and by not trying to locate the capitae into the cup of the lunate. This causes a fusion where the capus will assume a position of radial deviation as the radiolunate ligament is rendered slack in this manoeuvre. So, as it regains its taut position, the lunate tilts radially.

3. The third problem is the pain on the ulnar side. This needs attention to ensure that the triquetrum is not fused so it protrudes towards the ulna leading to secondary impaction after the four-corner fusion.

Outcome

This procedure needs the midcarpal bones to fuse. This takes up to 12 weeks and the wrist requires immobilisation in a plaster slab or wrist support. It requires the fusion of normal joints; around 5% of cases have failure of union and may need re-arthrodesis. It is usual to retain 60% of movement but this is not predictable and some patients can lose much more than this. Most patients retain 80% of grip strength but around 25% continue to experience some pain even after solid midcarpal fusion.

Salvage for a failed four-corner fusion is a total wrist replacement or a total wrist fusion.

Proximal row carpectomy

This is an arthroplasty that excises not just the scaphoid but also the remainder of the proximal carpal row and includes excision of the lunate and the triquetrum.

This needs the articular cartilage on the proximal capitae and the lunate facet of the distal radius to be preserved. Low-demand patients are considered suitable for this. The concern about a proximal row carpectomy is that the carpal height is reduced thereby weakening the muscle tendon units of the long flexors and extensors of the fingers and wrist. In addition there is concern about rotational stability of the new joint. This procedure has been considered for those not needing forced grip in their daily and work activities.

Advice

Patients are advised that they will need to protect the hand from forceful use for a few weeks. They are told that the weakness in their hands will persist and that a proportion of them will continue to have some pain in the wrist. They are also warned of weakness in tasks needing forearm rotation, such as opening doors.

Technique

The approach to the wrist is exactly the same as for four-corner fusion. After the scaphoid and radius osteophytes are excised the lunate and the triquetrum are removed. Care is taken to retain the radio-

scapho-capitate ligament when dealing with the radial styloid. The capsule closure is as before.

Tricks and tips

The surgeon needs to be aware of the shapes of the capitae. Those with a distinct ridge are more likely to have point loading and early degenerative change in the new joint between the capitae and radius.

Aftercare

The hand is elevated initially and the wrist may be immobilised in a plaster of Paris slab for the first week or so and then the wrist supported by a wrist splint. Full activities, which are not forceful, are permitted from the outset.

Radiographs are obtained and follow-up is arranged for six and 12 weeks.

Outcome

The wrist movement surprisingly does not improve significantly after a proximal row carpectomy. Once again patients usually retain two-thirds their range of movement and 80% of their maximal grip strength. However 5% need salvage surgery and around 25% continue to experience some pain, even after a proximal row carpectomy.

Figure 4 - This patient had midcarpal fusions on both sides using stout Kirschner wires. Note the solid fusion and the preservation of radiolunate joint height. Note that on the right the radial styloid has been excised to avoid impingement between the trapezium and the radial styloid on radial deviation.

Figure 4 - This patient had midcarpal fusions on both sides using stout Kirschner wires. Note the solid fusion and the preservation of radiolunate joint height. Note that on the right the radial styloid has been excised to avoid impingement between the trapezium and the radial styloid on radial deviation.
Salvage for a failed proximal row carpectomy is a capitate hemi-replacement or a total wrist fusion.

So on the current evidence whether the patient is offered one or the other procedure very often comes down to the preference of the surgeon.

Outcomes in comparison

We investigated the function of the wrist and hand after a four-corner fusion and proximal row carpectomy and found that pain relief was comparable but the axis of wrist movement was parallel to that of the normal wrist after a proximal row carpectomy and was more vertical after a four-corner fusion. Function as assessed by the timed Sollerman hand function test was better and quicker after a proximal row carpectomy but tasks needing forearm rotation were more compromised after a proximal row carpectomy. We used two patient reported outcome questionnaires, the Patient Evaluation Measure and Michigan Hand Questionnaire (MHQ) after a proximal row carpectomy. We found that patients with a proximal row carpectomy in 23 patients, patients had 61% of range and 79% of strength. Another study in 24 patients at 10 years found similar range and strength but noted radiographic arthritis in 52%. But at 15 years 46 of 61 patients had persistent pain and were dissatisfied and arthritis between the capitate and radius was observed on radiographs and 12 of 61 (19.6%) needed full wrist fusion.

After midcarpal fusion 37 patients were reviewed at 8 years and had range and strength that was similar to that seen after a proximal row carpectomy but 10/37 (27%) had developed radiolunate arthritis. However, after either of these two procedures my clinical experience is that the need for further surgery after a successful operation is very low.

Other options:
Total Wrist Fusion, Total Wrist Arthroplasty

In those patients with persisting disabling pain after these motion-preserving procedures or in those where the extent of arthritis precludes these operations, the surgeon may consider a total wrist arthroplasty or total wrist fusion. Both these procedures improve pain.

Fusion of the wrist gives more certain control over wrist pain but has a profound impact on the function of the arm. The risks of fusion surgery are well established. Non-union is unlikely but complications were noted: 50 of 71 (70%) wrists fused, with reoperation to remove the fusion plate needed in 20%. Eighteen wrists were left with permanent problems. 55 of 71 (77%) wrists fused had a stable pain-free wrist after a total wrist fusion. Total wrist fusion is a reliable procedure but has a high problem rate and 1:4 will continue to have problems.

The other alternative is to perform a total wrist arthroplasty. Total wrist arthroplasty has evolved over recent decades and we now have experience and information on indications, techniques, complications and their salvage. As our knowledge and experience of wrist arthroplasty in patients with post-traumatic arthritis increase this may become the intervention of choice especially when motion-preserving procedures fail.

Conclusion

We found that patients with a proximal row carpectomy had restricted movement, but retained the dart-throwing axis. Patients having a scaphoid excision and four-corner midcarpal fusion lost the dart-throwing axis of movement. There was nearly 65% loss of area of circumduction compared to the opposite wrist. Peak strength was similar after each of these operations. Patients reported better outcomes (PEM, MHQ) after a proximal row carpectomy but took longer to perform activities requiring forearm rotation. Based on our findings, a proximal row carpectomy is better, at least in the medium term.

If pain relief is inadequate the surgeon can consider either a wrist arthroplasty or a full wrist fusion using a custom fusion plate.

Of the two procedures that preserve motion, the proximal row carpectomy is superior in the medium term as it retains the natural axis of wrist movement. But late reviews suggest that 1:4 cases will continue to have or develop wrist pain after either of these two common motion-preserving procedures.

References
