Post-Traumatic Instability of the Metacarpophalangeal Joint of the Thumb

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ABSTRACT: Of eighty-six patients with collateral ligament instability of the metacarpophalangeal joint of the thumb, sixty-six (77 per cent) had ulnar and twenty (23 per cent) had radial instability, while in addition twenty-four had fractures and twenty-nine had volar subluxation of the proximal phalanx. Of the sixty-nine patients operated on, sixty-five had an ab- instability referred to me for office care (from August 1972 through January 1975), all such patients admitted to the Hospital for Joint Diseases, New York City, for surgical treatment (August 1963 through July 1972), and those admitted to the Massachusetts General Hospital, Boston, for surgical care (August 1972 through January 1975). Patients referred to the Emergency Ward or the clinics of these hospitals who did not require admission or surgery were not included. The patients considered in this review, therefore, were those who were most seriously injured and those who continued to have symptoms after receiving conservative care.

The patients’ ages ranged from fourteen to sixty-seven years. Eleven were less than twenty years old; forty-three were twenty to thirty-nine years old; thirty were forty or older; and no age was recorded for two. Fifty-two patients were male and thirty-four were female.

Mechanism of Injury

No patient was included in this series who had evidence of rheumatoid arthritis affecting the hand. Eleven patients could recall no specific injury preceding the onset of symptoms. Forty-one had injured the thumb in a fall, twelve while skiing. Nineteen had injuries caused by the impact of a moving object such as a ball or falling box. Eight had struck an object with the thumb, some while boxing. Seven had been injured when the thumb was pushed, deflected, or twisted by a friend or spouse. Few patients could recall precisely the direction of the injuring force, but most believed that the thumb had been pushed “backwards” (into extension). None of the patients were gamekeepers.

Bone Injury

A bone injury at the site of attachment of the collateral ligament was visible on the roentgenograms of twenty-four thumbs: in nineteen with ulnar and five with radial instability (Fig. 1). In these twenty-four thumbs the bone lesion was a fracture fragment that involved more than 10 per cent of the articular surface of the proximal phalanx in nine and was a small avulsion fragment or bone defect at the site of attachment of the collateral ligament to the proximal phalanx in eleven and to the metacarpal head in four. The nineteen bone lesions associated with ulnar instability included eleven avulsions and eight articular fractures, while the five lesions associated with radial instability were four metacarpal avulsions and one phalangeal articular fracture. All of the metacarpal avulsion fractures were associated with ulnar instability.
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of the twenty-nine thumbs with volar subluxation also had fractures. The volar subluxation was first recognized less than three weeks after injury in ten patients and more than three weeks after injury in nineteen.

Treatment

Of the eighty-six patients, sixty-nine were operated on and seventeen were treated successfully with an Orthoplast splint or plaster gauntlet cast that immobilized the thumb, including the interphalangeal joint. Of the sixty-nine patients treated surgically, forty-eight were operated on more than three weeks and twenty-one, less than three weeks after injury. The forty-eight patients operated on more than three weeks after injury included twenty-two in whom the thumb had been immobilized in a plaster cast immediately after injury (twelve for three weeks and ten for less than three weeks); two who had declined surgical treatment initially but were eventually operated on when symptoms persisted after three weeks of immobilization; and twenty-four in whom the thumb had not been immobilized by a splint or cast after injury.

Of the twenty-one patients who were operated on less than three weeks after injury, nineteen (eighteen with ulnar instability and one with radial instability) had either the collateral ligament or the avulsed bone fragment reattached at the site of rupture using one or two Kirschner wires, a pull-out wire, or interrupted sutures, and two had a tendon graft to reconstruct the ulnar collateral ligament. In two of these patients, a Kirschner wire was also passed through the joint to maintain reduction of a volarly subluxated proximal phalanx after ligament repair by suture.

Of the forty-eight patients who were operated on for post-traumatic instability more than three weeks after injury or for chronic instability without known trauma, six had the collateral ligament sutured (four, the radial collateral and two, the ulnar collateral ligament), thirty-eight had tendon-graft reconstruction of either the radial or the ulnar collateral ligament, four had arthrodesis of the metacarpophalangeal joint as the first operative procedure (two with radial and two with ulnar instability), and one had Kirschner-wire fixation of the joint at the time of tendon-graft reconstruction.
Operative Findings

Of the fifty-two patients surgically treated for ulnar instability, twenty-one were operated on within three weeks of injury and thirty-one, after three weeks. The following lesions were found: a ligament ruptured or avulsed with or without a fracture fragment in forty-eight patients (forty-seven with a distal and one with a proximal lesion) (Figs. 3-A and 3-B) and an apparently uninjured ulnar collateral ligament in four patients, of whom two had a stretched or torn adductor apparatus and two had subluxation of the extensor pollicis longus.

All of the twenty-one patients operated on early had rupture of the ulnar collateral ligament or an avulsion of its phalangeal attachment. The ruptured ulnar collateral ligament was found to be superficial and proximal to the adductor apparatus, as described by Stener, in three of these twenty-one patients (Fig. 4). The adductor expansion was torn, stretched, or thin in three of the patients operated on early.

All of the seventeen patients who were operated on for radial instability had a damaged radial collateral ligament (Figs. 5-A and 5-B). In six patients the ligament was torn from its phalangeal attachment and in four, from its metacarpal attachment. In the remaining seven patients, the site of detachment could not be determined but the ligament appeared stretched and attenuated. In two patients, the abductor-dorsal expansion was also thin or stretched. In two others, operated on more than six weeks after injury, there was a small convex sulcus in the articular cartilage on the dorsal third of the head of the metacarpal, apparently caused by pressure of the subluxated dorsal articular margin of the proximal phalanx. In no patient was there evidence of severe osteoarthritis or extensive cartilage erosion.

Surgical Technique

The techniques used in this series varied somewhat since forty-six of the patients were treated by me and twenty-three, by other members of the staffs of the two hospitals. The principles of surgical technique for reconstruction of the collateral ligament, however, were similar. In the patients operated on within three weeks, either the ulnar or the radial collateral ligament was resutured or reattached (except for two who had reconstruction of the ligament by tendon graft). In the forty-eight patients operated on late, a tendon graft was used for reconstruction of the ulnar collateral or the radial collateral ligament in thirty-eight; a tendon suture was performed in six; and arthrodesis, in four.

The techniques to be described are those used by me.

Primary repair: Under regional block anesthesia, a mid-axial incision three centimeters in length and centered at the metacarpophalangeal joint of the thumb is made on the injured side. After sensory branches of the radial nerve are identified and retracted, the dorsal expansion is
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For late reconstruction of a radial or ulnar collateral ligament from its phalangeal attachment, a tendon graft should be placed volar to the mid-shaft plane of the proximal phalanx so that the graft will prevent volar displacement of the phalanx. Proximally, the graft is woven through the remnant of the ruptured collateral ligament.

FIG. 7

Diagram showing the steps in the reconstruction of the ulnar collateral ligament for late post-traumatic instability: (a) a mid-axial incision is made; (b) the adductor dorsal expansion is transected; (c) the expansion is retracted; (d) a hole is drilled volar to the midline of the proximal phalanx; (e) (dorsal view) a tendon graft is drawn through the hole; (f) parallel incisions are made in the remnant of the collateral ligament; (g) the tendon graft is woven through the collateral ligament remnant (or through the bone if the remnant is not present) and the two parallel limbs of the graft are sutured to each other; and (h) the adductor-dorsal apparatus is closed and "double-breasted" if lax.

Secondary repair: Using the same exposure described for primary repair, remnants of the collateral ligament are identified. If the ulnar collateral ligament is ruptured, there is usually a sturdy remnant of ligament still attached to the metacarpal neck. In this event, a 2.8-millimeter hole is drilled transversely across the base of the proximal phalanx from its radial to its ulnar side and volar to the axis of motion (Fig. 6). A figure-of-eight pull-out suture is passed through one end of a tendon graft (usually from the palmaris longus), drawn through the hole in the base of the proximal phalanx, and tied over a button on the opposite side of the thumb. The free portion of the graft is then run to the metacarpal head, where it is secured by making parallel longitudinal incisions in the remnant of the collateral ligament and weaving the graft through the portion of the ligament between these incisions. If the collateral ligament remnant is not firm, the graft is secured proximally by making two adjacent drill holes in the metacarpal head, connecting them, and then passing the graft through the resulting tunnel. In either event, the remaining free portion of the graft is then run distally so that it lies parallel, volar, and adjacent to the portion of the graft coming from the phalangeal drill hole. Any deformity at the metacarpophalangeal joint is corrected and the tendon graft is sutured to the remnants of the collateral ligament. The parallel segments of the graft are also sutured to each other. Thus, the collateral ligament reconstruction duplicates the normal collateral ligament passing distally and volarly from the metacarpal head to the base of the proximal phalanx. Reconstruction of either the ulnar or the radial collateral ligament prevents volar subluxation of the proximal phalanx as well as excessive radial or ulnar deviation at the metacarpophalangeal joint. The adductor-dorsal expansion is then resutured in patients with reconstruction of the ulnar collateral ligament. In a radial collateral ligament reconstruction, the adductor-dorsal expansion is resutured in similar fashion. The expansion is "double-breasted" if it is lax, by using mattress sutures (Fig. 7). Postoperatively, the thumb is held for four weeks in a plaster-of-Paris gauntlet cast extending from the thumb tip to the mid-forearm. At the end of that time, the sutures are removed and the thumb is protected with a removable splint for five additional weeks.

Of the sixty-five patients who were operated on for ligament abnormality, twenty-five were not available for evaluation more than three months after operation because they often lived several hundred miles away, had been discharged from care, and had returned to their regular activities after discharge. The other forty were re-examined four to thirty-six months after operation.

Results

There were five failures for which reoperation was performed, three of them in patients whose ruptured collateral ligament was resutured more than three weeks after the original injury. These three patients were successfully treated, two by transfer of the extensor indicis proprius, as previously reported, and one by arthrodesis. The other two had tendon grafts for reconstruction of a ruptured ulnar collateral ligament by the technique described. In one of them, the graft had ruptured six months after operation when stability was tested by an "insurance doctor"; in the other, the graft gradually stretched over a period of about six months, causing recurrent pain when the patient returned to his original job lifting heavy boxes. Both of
Figs. 8-A through 8-D: This eighteen-year-old man ruptured the radial collateral ligament of the right thumb when it was caught in a helmet while he was playing football four months previously.

Fig. 8-A: A preoperative photograph shows volar subluxation of the proximal phalanx.

Fig. 8-B: Marked radial instability is demonstrated by adduction stress.

Fig. 8-C: Four months after tendon graft (opposite palmaris longus) to replace the ruptured radial collateral ligament, subluxation is corrected and metacarpophalangeal-joint flexion is equal to that of the opposite thumb.

Fig. 8-D: Lateral stability is restored so that ulnar deviation of the proximal phalanx under stress is equal to that of the opposite thumb.

These patients were successfully treated by arthrodesis at reoperation.

The remaining sixty-four surgically treated patients all regained excellent stability. None had more than a 15-degree excess of laxity in the involved thumb compared with the normal thumb. The stability was assessed by measuring the amount of radial deviation of the proximal phalanx while the patient exerted maximum pinch pressure with the ulnar side of the thumb against the tip of the index finger and by measuring the radial or ulnar deviation caused when the examiner exerted a radial or ulnar deviating force on the distal phalanx while the first metacarpal was held firmly. Stability was tested in both extension and flexion of the metacarpophalangeal joint. One patient complained of persistent dorsal hypesthesia, apparently due to injury to a sensory branch of the radial nerve. Two patients with a tendon-graft reconstruction complained of a small, painless lump at the site of the graft, but this was not disabling. One patient with excellent stability and an excellent range of motion complained of continued aching pain during heavy work and used a splint intermittently. In no case did severe subluxation (more than three millimeters) or rotatory deformity persist (Figs. 8-A through 9-C).

For forty of the sixty-five patients who were operated on for ligament repair or reconstruction and did not require secondary surgery, data were available that permitted comparison of the ranges of motion of the metacarpophalangeal and interphalangeal joints of the injured and uninjured thumbs. In the fifteen patients treated by primary repair, the metacarpophalangeal joint showed an average loss of 4 degrees of extension (maximum, 30 degrees) and of 17 degrees of flexion (maximum, 50 degrees); the interphalangeal joint showed an average loss of 5 degrees of extension (maximum, 45 degrees) and of 18 degrees of flexion (maximum, 45 degrees). In the twenty-five patients who had secondary repair with a tendon graft, the average loss at the metacarpophalangeal joint was 8 degrees of extension (maximum, 30 degrees)
and 11 degrees of flexion (maximum, 40 degrees). With the exception of the patients requiring secondary surgery, almost all patients were able to return to full activity, including manual labor and athletics, within three months of surgery; none sought further care either for late stretching or rupture of the repaired ligament, or for late recurrence of the deformity.

Discussion

Although chronic post-traumatic instability of the thumb metacarpophalangeal joint is relatively common and often quite disabling, controversy persists as to the mechanism of injury, the exact nature of the lesion, the treatment, and the prognosis.

Campbell concluded that so-called gamekeeper’s thumb is due to gradual stretching of the ulnar collateral ligament. All of his patients had subjected their thumbs to repetitive abduction maneuvers over a long period of time. None had had an acute injury. Moberg 6,7 and Stener 3,11,13 described avulsion of the collateral ligament with its distal end often displaced proximal to the intact adductor-dorsal expansion, but almost all of their patients were operated on within three weeks of an acute injury. Kaplan found in two patients that the adductor-dorsal expansion had stretched, with radial dislocation of the extensor pollicis longus, but that the ulnar collateral ligament was intact. However, both of his patients had been operated on previously, some months after the original injury, and their collateral ligaments had been resutured. The adductor-dorsal expansion therefore may have been injured at the time of the original surgery. Neviaser and associates also called attention to the stabilizing influence of the adductor-dorsal expansion and recommended its repair in cases of ulnar instability.

The experimental defects created by stress on the metacarpophalangeal joints in cadaveria, as reported in the literature, have varied. The variability of these findings may have been due to the differences in the experimental models, some studies having been performed on fresh specimens 3,13, others on embalmed specimens 5,10, and still others on specimens preserved in formalin. The method by which the injury was produced also differed in these studies. In some the proximal phalanx was stressed radially 9 and in others, dorsally 12. Some were subjected to impact, while others were tested after serial transection of pararticular tissues 3,8,13.

In many patients in this series, the instability was produced by a force on the thumb directed ulnarly or radially and dorsally. Stener’s observation that both the collateral and the accessory collateral ligament prevent excessive hyperextension of the metacarpophalangeal joint would suggest that these ligaments may rupture when the proximal phalanx is forced dorsally (and dorsoradially) and that the sudden development of ulnar instability after acute trauma may be the result of a radial hyperextension injury. In all ten patients in this series with a large fracture fragment, the fracture involved only the volar ulnar margin of the base of the proximal phalanx. Most likely, a portion of the volar plate was also ruptured adjacent to its attachment to the fracture fragment.

Ulnar instability of the thumb following ski injuries is often produced by a ski-pole strap 9. Most ski instructors recommend passing the fingers through the loop of the strap, grasping the pole with the strap in the palm. When the skier falls with the ski pole caught in the snow, the strap pulls across the palm, rupturing the supporting structures on the ulnar and volar side of the metacarpophalangeal joint. If the strap is allowed to dangle at the wrist, and the pole is grasped without the strap in the palm, a fall is less likely to cause thumb injury since the strap will not entangle or twist the thumb (Figs. 10-A and 10-B). Recent changes in design of the ski pole and strap may decrease the incidence of these injuries.

Fourteen patients in this series were treated by immobilization in a plaster cast for more than three weeks and subsequently had continued complaints necessitating surgery. Although retraction of the avulsed collateral ligament proximal to the dorsal expansion, as described by Stener, may be a factor, it seems likely that if there is complete rupture of the collateral ligament, it will not heal with conservative treatment even if the ligament is only mildly displaced.

The collateral ligaments of the thumb have two principle functions: one, to provide lateral stability and the other, which is equally important, to provide dorsal support for the proximal phalanx 10. Volar subluxation of the metacarpophalangeal joints of the fingers due to attrition of the collateral ligaments caused by rheumatoid disease is well known. In the thumb, the collateral ligaments, which pass distally and volarly, are of great importance for the dorsal support of the proximal phalanx. If the collateral ligaments do not provide sufficient support, the thumb flexors, rather than flexing the phalanx about an axis, translocate it toward the palm, causing volar subluxation of the metacarpophalangeal joint (Fig. 11). If one collateral ligament is ruptured, the opposite collateral ligament continues to support the proximal phalanx on the uninjured
proximal phalanx anteriorly (top). With rupture of a collateral ligament, the intrinsic and extrinsic flexors of the thumb which tend to subluxate the thumb hold the proximal phalanx dorsally, resisting the force of the intact radial collateral ligament, the intact radial ligament (bottom).

The collateral ligaments of the metacarpophalangeal joint of the thumb hold the proximal phalanx dorsally, resisting the force of the intrinsic and extrinsic flexors of the thumb which tend to subluxate the proximal phalanx anteriorly (top). With rupture of a collateral ligament, the proximal phalanx is free to subluxate volarly, rotating around the opposite, intact collateral ligament (bottom).

The extensor pollicis brevis also provide support for the proximal phalanx, limiting volar displacement. The extensor pollicis brevis inserts into the base of the proximal phalanx and the dorsal capsule of the metacarpophalangeal joint, and is unlikely to be displaced or ruptured in ulnar or radial injuries of the thumb with or without hyperextension. The extensor pollicis longus inserts onto the base of the distal phalanx. It is held in the midline of the dorsum of the metacarpophalangeal joint by radial and ulnar sagittal bands, both of which attach to the volar plate, and by the dorsal expansion of the adductor pollicis and abductor pollicis brevis. As a result of radial or ulnar stress, the dorsal expansion of the adductor or abductor may be stretched, allowing the extensor pollicis longus to subluxate from the dorsum of the metacarpophalangeal joint. Imbrication and suture of the torn or stretched adductor expansion in cases of ulnar instability, or of the abductor expansion in cases of radial instability, will usually relocate the extensor pollicis longus in the midline of the dorsal aspect of the metacarpophalangeal joint so that it once again contributes to the dorsal stability of the proximal phalanx of the thumb. Extensor indicis proprius transfer, as described by Kaplan, can also be used to reinforce the ulnar dorsal expansion of the adductor pollicis and to hold a displaced extensor pollicis longus in the midline of the dorsum of the joint.

The majority of injuries to the collateral ligament can be successfully treated conservatively. If the ligament is partially ruptured, a plaster-of-Paris splint or cast or an Orthoplast splint worn for three weeks may restore normal stability to the joint. In this series, many of the patients were referred for treatment either because of gross joint laxity following relatively severe trauma or because of persistent complaints following either conservative care or no care at all. The many thousands of patients with so-called sprained thumbs who are successfully treated in ski areas, emergency rooms, and private offices throughout the country attest to the efficacy of conservative therapy for these incomplete collateral ligament injuries. Surgery would appear to be indicated in patients who have evidence of complete collateral ligament disruption, a displaced fracture of the volar part of the base of the proximal phalanx, or volar subluxation of the proximal phalanx, as well as in patients who have persistent disability several months after collateral ligament injury. If gentle stress applied on the proximal phalanx, with or without local anesthesia at the site of injury, reveals deviation which exceeds that of the uninjured thumb by more than 45 degrees, complete disruption of the collateral ligament can be assumed. Stability should be tested with the metacarpophalangeal joint both in flexion and in extension. Stress roentgenograms are often helpful in evaluating these injuries.

Arthrodesis is an alternative to soft-tissue reconstruction for lateral instability of the thumb metacarpophalangeal joint. Soft-tissue reconstruction results in an average loss of 20 to 30 degrees of motion of the metacarpophalangeal and interphalangeal joints of the thumb, a result that would appear to be preferable to the complete loss after fusion. Arthrodesis of the metacarpophalangeal joint limits the versatility of the thumb, especially in young and active patients. Arthrodesis should probably be reserved for those who have painful or osteoarthritic joints, or for the few who have persistent complaints after soft-tissue reconstruction.

Conclusions

1. Post-traumatic radial or ulnar instability of the metacarpophalangeal joint of the thumb is usually due to rupture of a collateral ligament or to avulsion or fracture of its bone insertion.

2. Instability of the metacarpophalangeal joint of the
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thumb may be due to hyperextension combined with either radial or ulnar stress on the proximal phalanx, causing injury not only to the collateral ligament but also to the volar soft-tissue structures about the thumb.

3. Loss of either collateral ligament of the thumb may result in volar subluxation or rotation of the proximal phalanx.

4. With post-traumatic radial or ulnar instability of the thumb metacarpophalangeal joint, early surgery is indicated if:
   a. Lateral deviation of the stressed thumb in either flexion or extension is 45 degrees more than that on the normal side.
   b. There is a displaced articular fracture of the proximal phalanx.
   c. There is volar subluxation of the proximal phalanx.

   In all other cases, the thumb should be immobilized for three weeks with a plaster thumb-spica gauntlet cast.

   Surgical treatment of an acute injury should include resuturing the collateral ligaments, if ruptured, or replacing the avulsed fracture fragment. The intrinsic dorsal apparatus may also require repair.

5. With persistent lateral instability or volar subluxation of the metacarpophalangeal joint of the thumb present for more than one month after injury, surgical reconstruction of the collateral ligaments should be performed. The intrinsic aponeurosis should also be tightened if it appears attenuated. The metacarpophalangeal joint of the thumb may be arthrodesed in the presence of persistent pain or symptomatic osteoarthritis, or after failure of soft-tissue reconstruction.

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References