The spiral oblique retinacular ligament (SORL)

A procedure is described for reconstruction of the oblique retinacular ligament using a small tendon graft in a spiral fashion to act as a dynamic tenodesis to restore distal interphalangeal extension and to restrain proximal interphalangeal hyperextension. The method has been uniformly successful in the treatment of post-traumatic "swan-neck" or "mallet" deformity. Although the concept is simple, the procedure demands thorough understanding of digital anatomy for successful completion.


Lack of voluntary distal interphalangeal (DIP) extension ("mallet finger") with or without proximal interphalangeal (PIP) hyperextension ("swan neck") represents a serious disruption of finger function.

The causes of these deformities are many, but they can be reduced to three general categories: (1) disruption of the terminal extensor mechanism with or without resultant PIP hyperextension; (2) disruption or laxity of the volar plate, flexor digitorum superficialis (FDS), or vertical retinacular fibers at the PIP joint, resulting in PIP hyperextension followed by compensatory DIP flexion; and (3) intrinsic muscle contracture or spasticity from systemic diseases or central nervous system dysfunction (Fig. 1).

Reversal of these deformities depends on correction of the primary factory causing imbalance. However, in many cases the compensatory joint deformity becomes as important as the original insult. Therefore, surgical correction often requires stabilization of the volar structures of the PIP joint with an attempt to provide active and full DIP extension.

Though the fascinating oblique retinacular ligament (ORL) has been elusive to many anatomists, this structure was described by Weitbrecht and later was studied independently by Landsmeer and Haines. Kaplan, Milford, and Shrewsbury and Johnson more recently have analyzed the ORL. The ORL originates volar to the PIP axis of rotation from the proximal phalanx and flexor sheath and passes dorsally and distally to join the terminal extensor tendon. Some authors feel that the ORL acts as a dynamic tenodesis, extending the DIP joint as the PIP joint is extended and relaxing with PIP flexion to allow full DIP flexion. Others believe ORL function is static, acting to centralize the extensor mechanism and to reinforce lateral stability of the PIP joint. Regardless of the function of the anatomic ORL, PIP and DIP motion are interdependent, and lack or excess of extension in either joint will reciprocally affect the other (Fig. 1).

Many operative procedures have been described to correct swan neck posturing by checkreining PIP hyperextension in an attempt to recreate balanced digital function. Littler described use of an intact lateral band for ORL reconstruction by releasing it proximally and rerouting it volar to the axis of PIP rotation, securing it to the flexor tendon sheath. By recreating an ORL, PIP hyperextension was checked and distal joint extension was obtained through the dynamic tenodesis (Fig. 3). This procedure and its various modifications have been reasonably successful in treatment of swan-neck deformity. However, this procedure depends upon an intact terminal extensor insertion and therefore cannot be used in deformities secondary to rupture of the extensor (mallet finger). Also, the proximal juncture of the transposed lateral band to another structure (flexor sheath, extensor tendon) occasionally has failed, resulting in recurrence of the deformity.

This report describes a dynamic tenodesis that can be utilized for correction of DIP extension deficit (mallet finger) with or without associated PIP hyperextension (swan neck).

All patients treated had established deformities.
enodesis, extended DIP flexion to compensate lateral tension of the metacarpophalangeal (MCP) joint, and PIP hyperextension, or loss of volar stabilizing structures of the PIP joint flexor digitorum superficialis, volar plate, and adjacent retinacular fibers) causing PIP hyperextension followed by compensatory DIP flexion. (E.g., extrinsic extensors, l. interossi, l. lumbrical, 0, absence of volar PIP structures or terminal DIP extensor, +, intact flexor digitorum profundus acting on distal phalanx or intact extensor digitorium communis exerting all extensor forces on middle phalanx.)

Fig. 2. Weitbrecht described the "retinaculum tendini longi" in 1742 (translated by Kaplan in 1969).

either from failure of treatment of rupture of the terminal tendon, old dorsal dislocation of PIP joint, or from a lateral ligament of or because of excision of the superficialis tendon. All joints were roentgenographically normal and had full passive range of motion.

Technique

An angular dorsal incision is used to expose the distal phalanx, and short mid-axial incisions are necessary to gain access to the radial side of the PIP joint and ulnar side of the proximal phalanx (Fig. 4). Using a small sharp gouge, a vertical hole is made between the terminal extensor insertion and the germinal nail matrix (Figs. 4, B, and 5, A).

A subcutaneous passage for the new ligament is created using gentle dissection proximally along the middle phalanx over the path of the lateral band (Fig. 5, B) dorsal to Cleland's ligament to PIP level, there spiralling volarly between the neurovascular bundles.

Fig. 3. Illustration of a dynamic tenodesis fixed volar to proximal interphalangeal (PIP) axis and dorsal to distal interphalangeal (DIP) axis. PIP extension tightens "R+" causing DIP extension, PIP flexion relaxes "RO" allowing DIP flexion.

Fig. 4. a, Complete overview of completed spiral oblique retinacular ligament (SORL), including skin fixation of free tendon graft (g) with a button and/or metal clip, (1) Dorsal incision (i) exposing base of distal phalanx. (2) Distal fixation of graft (g) through distal phalanx. (3) Integrity of the volar plate (v.p.) of the DIP joint is important for it is upon this structure that the dynamic tension of the SORL will be exerted.) c, (1) Cross-section of the proximal interphalangeal level illustrating spiral path of SORL between neurovascular bundles and flexor tendon sheath. (c.t., central tendon). (2) Cross-section at base of proximal phalanx illustrating proximal tendon-bone fixation by transverse hole through phalanx. Note lateral bands retracted dorsally.
Fig. 5. Surgical technique for spiral oblique retinacular ligament (SORL). A, Vertical hole in distal phalanx, guide wire passed with straight needle. B, Subcutaneous passage for SORL along lateral band dorsal to Cleland’s ligament. C, Spiral path of SORL (F, flexor tendon sheath, neurovascular bundles retracted volarly). D, Transverse hole in proximal phalanx. Lateral band retracted dorsally. E, Correction of deformity with tension on SORL. F, Skin fixation with button and/or metal clip. G, Passive extension of the proximal interphalangeal joint (PIP) results in distal interphalangeal (DIP) extension. H, Full passive PIP and DIP flexion possible.
and the flexor sheath and exiting through the ulnar incision (Fig. 5, C). A second hole is made transversely at the base of the proximal phalanx, beneath the lateral bands (Figs. 4, C, and 5, D).

A small gauge stainless steel wire, placed through the gouge holes and along the spiralling tunnel, is used to guide a small caliber, free tendon graft into position. A palmaris longus tendon is preferred, as the donor and may be split longitudinally for correction of multiple fingers if desired. Plantaris tendons also have been used. Longitudinal tension on the graft will straighten both the DIP and PIP joints (Fig. 5, E). Graft tension is adjusted with both the PIP and DIP joints at neutral extension by securing the free ends with a button and/or hemoclips (Fig. 5, F). The effect of the tenodesis should be tested with passive flexion and extension of the PIP joint. Passive extension of the PIP joint should be accompanied by full extension of the DIP joint. (Fig. 5, G and H). The tension adjustment is critical, and particular effort must be made to avoid excess pull, which will cause PIP flexion and DIP extension ("boutonniere").

A conforming dressing is applied with metacarpophalangeal flexion and full PIP and DIP extension maintained with a plaster shell. The dressing is removed after 3 weeks and active motion is begun.

Results

Table I summarizes the results of the spiral oblique retinacular ligament (SORL) procedure. There has been no difficulty with exit sites of the grafts. One patient (D. P.) required a dynamic splint to achieve full PIP extension postoperatively. One patient (C. P.), done early in the series after two previous surgical efforts, developed hyperextension of the DIP joint which was corrected with slight lengthening of the graft proximally. There have been neither significant PIP flexion contractures not alterations in the preoperative range of motion of this joint (Fig. 6).

Discussion

Many procedures have been described for the correction of PIP hyperextension or lack of DIP extension. However, the most effective procedures designed to correct DIP extension lag with or without PIP hyperextension are those which employ the principle of a dynamic ORL. The functional significance of the ORL in a normal finger has been the subject of mild controversy for several years, but the principle of DIP extension resulting from increased tension along a linear, nonelastic structure fixed dorsal to the DIP axis and volar to the PIP axis is sound. Thus DIP extension is a product of PIP movement through the construction of a dynamic tenodesis (Figs. 3 and 6, B and C).

Restoration of active flexion/extension of the DIP joint following damage to the extensor mechanism over the middle phalanx is difficult. Procedures have been described which involve reinsertion of the extensor mechanism into the distal phalanx. Unfortunately in many instances following such procedures, DIP extension may be improved, but full DIP flexion is lost. Also, vital PIP flexion may be restricted by increased tension on the extensor mechanism or adherence of the extensor over the middle phalanx.

The procedure described here is a direct extension of
the idea of surgical substitution of ORL function by a lateral band. The use of a free tendon of small caliber as a spiral oblique retinacular ligament (SORL) has several advantages: (1) the operation can be used after rupture of the terminal extensor and corrects DIP extension deficit and PIP hyperextension simultaneously; (2) terminal extension can be restored without altering the extensor mechanism, thereby avoiding restriction of DIP and PIP flexion; (3) the procedure does not involve sacrifice of any portion of the existing extensor mechanism; (4) the graft is anchored to bone both proximally and distally for the most positive biologic anchor, obviating problems (adhesion formation or laxity of fixation) resulting from suture to other tendinous or fibrous structures within the digit; and (5) the tension can be adjusted accurately through tension or relaxation on the tendon graft after all skin wounds are closed by observation of the neutral extended joint position.

The disadvantages of the procedure are the need for a free tendon graft, but no problems have resulted from use of the palmaris longus or plantaris tendons. Also, several digital incisions are necessary, but these are not a significant esthetic consideration. The operation demands precise understanding of normal digital anatomy and proper placement of a free tendon in relation to the extensor mechanism, neurovascular bundles, and flexor sheath. Two exactly placed holes in the distal and proximal phalanges are necessary. There have been no complications involving any of the structures. The tension adjustment using a button and/or external clips is critical, as illustrated by the one case that required revision for DIP hyperextension. This also illustrates the importance of the integrity of the DIP volar plate and check ligament, for it is upon these structures that the final dynamic tension of the SORL is imposed, not the insertion site of the graft into the terminal phalanx (Figs. 2 and 4, B).
The procedure provides a predictable method for correcting loss of DIP extension and/or PIP hyperextension.

REFERENCES


