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The molded polythene splint for mallet finger deformities

Since 1970, 151 cases of mallet finger deformities with an average follow-up of 17 months have been treated with a molded polythene splint. Tendon injuries as well as fracture cases are included. This splint has been found to be highly effective, and open reduction of even major fracture fragments without subluxation of the distal phalanx has not been necessary. Although this splint was first described in 1969, detailed results and techniques have not been described previously. (J HAND SURG 9A:231-7, 1984.)

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The molded polythene splint was first mentioned by Stack.[1] He had developed and used this splint for the previous 12 years and advocated its use in the conservative management of mallet finger injuries. The splint was originally produced by the Pryor and Howard Company, England, and has subsequently been manufactured in Germany and is available in the United States through the Link Company, Link America, Inc., E. Hanover, N.J. Use of this splint has in-

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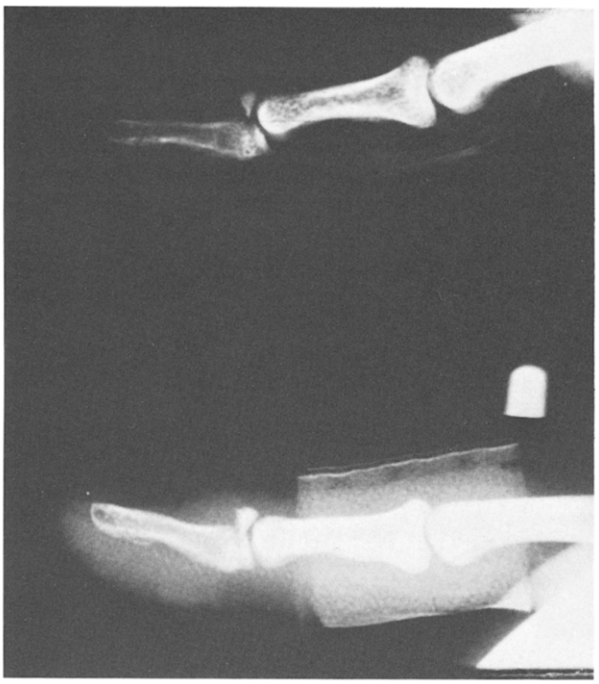

Fig. 1. *Top radiograph* shows the palmar subluxation of the shaft of the distal phalanx. *Lower radiograph* shows successful reduction of this subluxation after splint application with tape layering of the proximal palmar margin of the splint.

creased considerably.[2] This report discusses the proper method of application and potential difficulties with its use and results. This plastic splint is lightweight, comfortable, inexpensive, and effective. It allows for good digital use while in place, and it provides for good proximal interphalangeal (PIP) joint mobility. The current model is a superior splint without the previous and often uncomfortable irregularities that were due to mold wearing. This splint has replaced many of the previously described external splints,[3–20] internal splints,[21–24] and open techniques.[25] These previous reports often describe varying and generally disappointing results.

The encouraging results obtained with conservative treatment of fractures by the use of the molded polythene splint, even with relatively large fracture fragments, have led to my abandonment of open reduction and internal fixation except for those occasional cases with palmar subluxation of the shaft of the distal phalanx.

One hundred fity-one patients with an average follow-up of 17 months were available for examination, and they constitute the basis of this report. The minimum follow-up was 12 months.

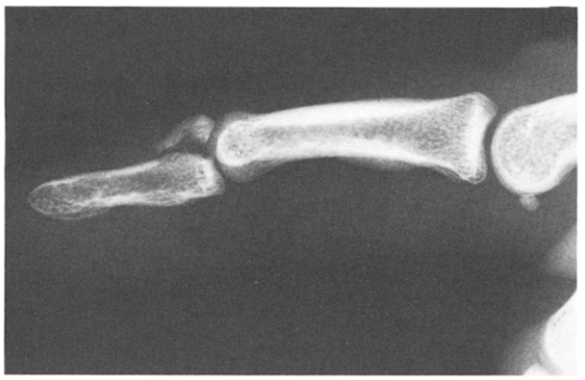

Fig. 2. The persistent subluxation of the shaft of the distal phalanx after an unsuccessful attempt at closed reduction. This injury was treated with an open reduction and Kirschner wire transfixion of the joint.

Material and methods

Since 1970, this splint has been used in the nonoperative management of 166 cases of mallet finger deformities, whether these resulted from extensor tendon rupture, laceration, small avulsion fractures of the base of the distal phalanx, or the more significant dorsal intra-articular fracture involving up to 50% of the joint surface. Additionally, in the first 3 years, the splint was used often as an adjunct to open fracture reduction or secondary tendon repair; these cases are not included in this report. In 159 of the 166 patients, this splint was used as the initial treatment, although its application was begun as long as 2½ months after the injury. In seven of the 166 patients, the splint replaced different types of splints or casts applied by other physicians, and two of these seven patients had open tendon injuries. In all seven patients, these other forms of immobilization had been applied for more than 2 weeks, and these cases are also excluded from this report. Eight other patients were lost to follow-up. Also excluded were all cases of severe crushing loss of extensor tendon substance, with or without fractures of the middle or distal phalanx.

This splint is available in eight sizes and is applied to mallet finger injuries with tendon rupture or laceration for a total of 8 weeks. The splint is applied for an additional 2 weeks at night.

When a fracture is present, the splint is applied until there is radiographic evidence of bony union. In several cases of a very small avulsion fracture, use of the splint was stopped at the 9- to 10-week mark in the absence of radiographic evidence of bony healing. In these cases, sufficient fibrous tissue existed between the shaft of the

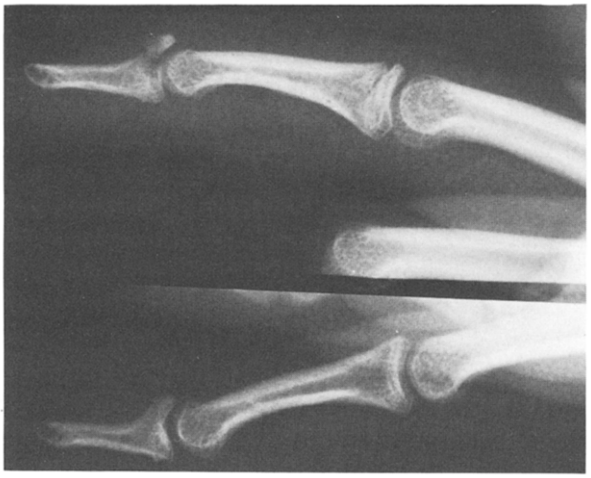

Fig. 3. *Top radiograph* shows the displaced fracture at the dorsal base of the distal phalanx. *Bottom radiograph* shows the remodeling of the articular surface. This patient has a full range of motion without pain.

phalanx and the tendon for normal extensor tendon function.

When more than 30% of the articular surface was fractured, a lateral x-ray film was taken of the digit with the splint applied at weekly intervals for the first 3 weeks to rule out palmar subluxation of the distal phalanx.

Results

The injury occurred in 85 male patients and 65 female patients. The dominant hand was involved in 90 of 151 cases (60%). The index finger was involved in 16 patients (11%), the long finger in 55 patients (36%), the ring finger in 46 patients (30%), and the small finger in 34 patients (23%).

The following classification system was used: *excellent*—full distal joint extension, full flexion, and no pain; *good*—0° to 10° of extension deficit with full flexion and no pain; *fair*—10° to 25° of extension deficit, any flexion loss, and no pain; and *poor*—more than 25° of extension deficit. Any patient with persistent pain at follow-up was classified as having a poor result.

Closed tendon injuries. These injuries occurred in 62 patients. Very small fracture fragments comprising less than 20% of the joint surface were placed in this group.

Time of injury to splinting:	*Cases:*
0 to 10 days	35
11 to 30 days	15
1 to 2 months	11
2 plus months	1

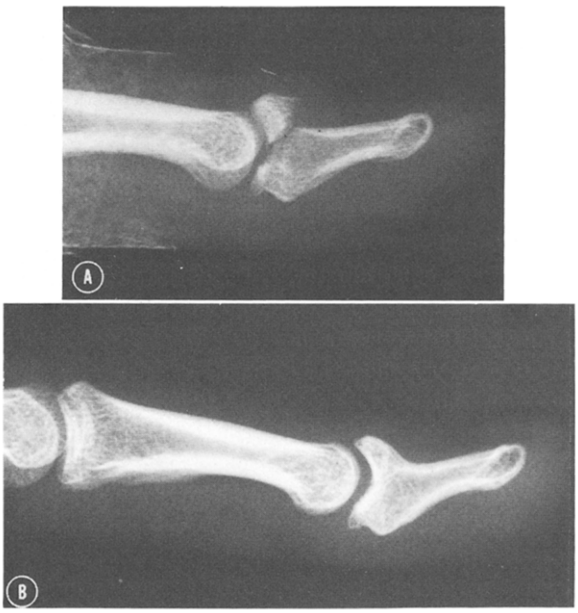

Fig. 4. A, The displacement of the large articular fracture fragment with the splint applied. **B,** The remodeling of the articular surface 1 year after injury.

Of the 35 patients treated within the initial 10 days, 23 achieved excellent results. Seven results were judged good, and five were judged fair. No poor results were encountered. In those 15 patients treated in the 11- to 30-day interval after injury, 11 were judged to have had an excellent result, three were classified as having a good result, and one had a poor result. When treatment was begun between 1 and 2 months after the injury, two were judged to have excellent results, and three were considered to have good results. There were four fair and two poor results. One patient with a 2½-month-old injury had a poor result.

Since 1977, four patients with a fair result and one with a poor result subsequent to the initial 8 weeks of splinting were splinted for an additional 8 weeks. Three excellent, one good, and one fair result were achieved with this longer splinting time. The initial poor result improved to fair and was so classified because of a persisting flexion loss 20 months after the repeat splinting athough full extension was achieved.

Fracture fragment cases. Eighty-nine patients had fracture fragments comprising 20% to 50% of the joint surface. These injuries tended to be seen earlier than the closed tendon injuries, possibly because of increased swelling or pain.

Fig. 5. Serial films showing improvement of the fracture reduction with use of the splint. **A,** The injury. **B,** The fracture position 1 week after splint applicaton. **C,** The fracture healed in an improved position at 7 weeks.

Time of injury to splinting:	*Cases:*
0 to 10 days	64
11 to 30 days	11
1 to 2 months	14
>2 months	0

Eleven patients had palmar subluxation of the distal phalanx. Eight of these were seen at the time of initial evaluation, and three developed subsequent to splint application. Four of these eight patients with initial subluxation were treated successfully with the mallet finger splint by digital block anesthetic, manipulation of the shaft of the phalanx, and tape layering of the proximal palmar margin of the splint to produce an upward force on the shaft of the distal phalanx (Fig. 1). This method of reduction was tried in all eight of these patients. Recurring subluxations in the four cases of successful results did not occur, and the fractures healed with excellent results. The other four patients with initial subluxation and failed reduction attempts (Fig. 2) required open reduction of the fracture fragment and Kirschner wire fixation of the distal joint in the reduced position. Subluxation occurred in three patients after splint application and similar open reductions were done.

Of the 64 patients treated within the first 10 days, there were 47 excellent results, six good results, four fair results, and seven poor results. Three of the four fair results were so classified because of some flexion loss, although they had good extension. Of the seven poor results, three were so classified because of pain. Three others were felt to be the result of poor patient compliance; they had removed the splint and tape to allow flexion of the distal joint.

Of the nine patients treated from 11 to 30 days after injury, six were classified as having an excellent result, two good, and one fair. For the 14 patients treated between 1 and 2 months after the injury, there were eight with an excellent result, two good, three fair, and one poor.

Patients with palmar subluxation of the distal phalanx tended to have large fracture fragments. Six of the 11 patients with subluxation of the distal phalanx had fractures passing through the midline of the articular surface. All three patients who developed palmar subluxation after splint application were in this large fragment group. The remaining five patients had fracture fragments in the 20% to 50% size range.

In this series, no case of PIP joint stiffness was encountered. One patient developed a contact dermatitis requiring the use of a different type of splint. No case of dorsal skin necrosis occurred, presumably because the achieved hyperextension of the distal joint is so slight. Skin maceration has become much less of a problem because of my increased willingness to allow patients to remove their splints for digital and splint cleansing and drying.

Discussion

The results with the use of this splint have been most satisfying. Many of the fair and poor results encountered were felt to be the result of improper splint wearing or splint changing by the patient. In my experience as well as that of others,[20] splinting results for tendon injuries of 3 weeks to 2 months' duration exceed those that have been encountered after secondary tendon repairs. Even in fair or poor results, repeat splinting should be attempted before open tendon repairs. Because of the results obtained with resplinting, I concur with Doyle[2] that secondary repairs probably should not be attempted before 6 months after injury since splinting before this time may be worthwhile.

Since 1974, I have not felt the need for open reduction of fracture fragments without phalangeal subluxation since excellent remodeling of the articular surface

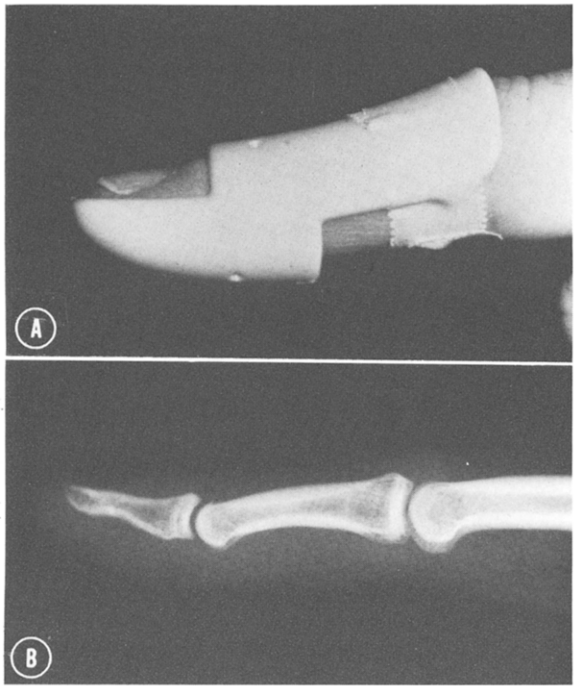

Fig. 6. A, Correct application of the splint with the pulp placed distally into the splint and the proximal portion of the splint taped securely to the digit. **B,** Same finger with proper splint application. Note slight hyperextension at the DIP joint.

often occurs (Figs. 3 and 4, *A* and *B*). Since osteoarthritis commonly involves the distal interphalangeal (DIP) joint and only occasionally produces discomfort, the claims for needed accurate open reduction of these large fractures has seemed excessive. In addition, less than precise open reductions are achieved too often. I believe slight restrictions in flexion are more likely to occur after open reduction, possibly because of the increased scarring combined with the frequent use of a transarticular Kirschner wire. Since very good functional results occurred in most of the patients after splint application, I now reserve open reduction for only those fractures with associated subluxation of the distal phalanx.

Fracture position was often improved after inducing digital block anesthesia, manipulative reduction, and splint application. X-ray films were taken at weekly intervals when phalangeal subluxation was felt possible because of the large fracture fragment. Slight improvement in the fracture position was often seen (Fig. 5). This observation has led to a less frequent use of digital block anesthetic and closed manipulative reduction, but these are still used for large displaced fractures.

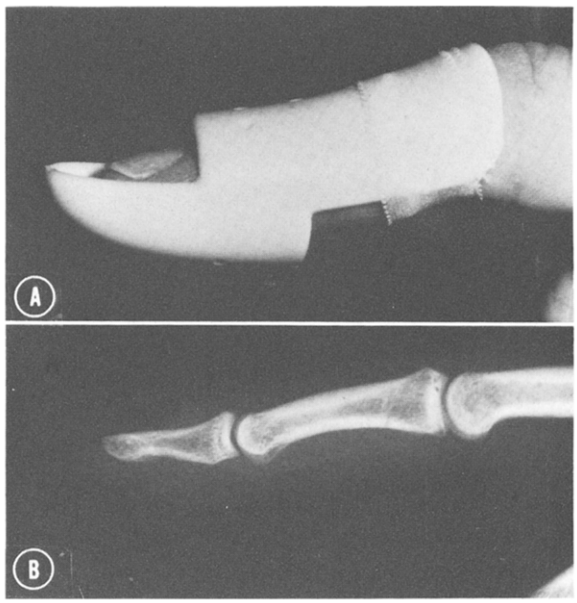

Fig. 7. A, Improper splint application with a gap between the tip of the digit and the end of the splint. **B,** Loss of DIP joint hyperextension.

There are many details of proper splint application that have not been described previously. Accurate taping of the splint to the digit cannot be done by the patient since two hands are required. The proximal portion of the splint must remain in direct contact with the dorsum of the digit. The circumference of the proximal portion of the splint always exceeds the circumference of the finger. Rigid taping of the splint to the digit to avoid movement in the anteroposterior plane is often impossible because of this difference in circumference. To correct this difference, the splint must be compressed laterally against the digit while nonelastic tape is applied proximally. If this is not done, the splint will ride dorsal to the middle phalanx, particularly when the PIP is flexed. This can result in slight flexion of the distal joint. The digit must be well placed within the splint, and the tip of the pulp must be in contact with the end of the splint (Fig. 6). There is a tendency for a gap to exist in this interval, and the patient is advised to force the finger frequently into the splint. This digital advancement is usually required at least several times daily. If a gap is allowed, the distal joint hyperextension will be lost (Fig. 7). If the combination of lax proximal taping and careless positioning of the pulp of the digit is allowed, even more flexion at the distal joint occurs (Fig. 8), and the functional results can be compromised.

In patients with short fingers, the proximal edge of

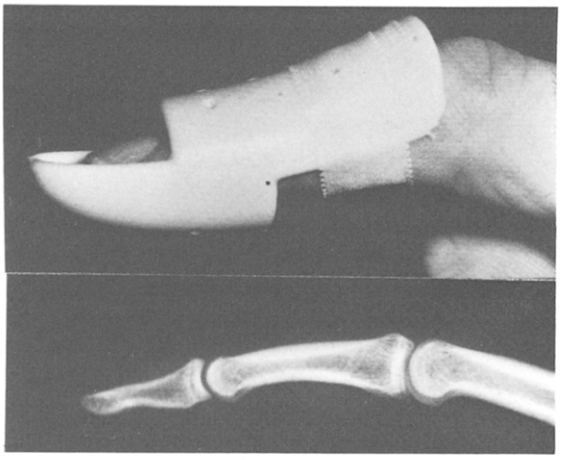

Fig. 8. Top, Lax proximal taping combined with a gap between the tip of the digit and the end of the splint. **Bottom,** Slight flexion at the DIP joint.

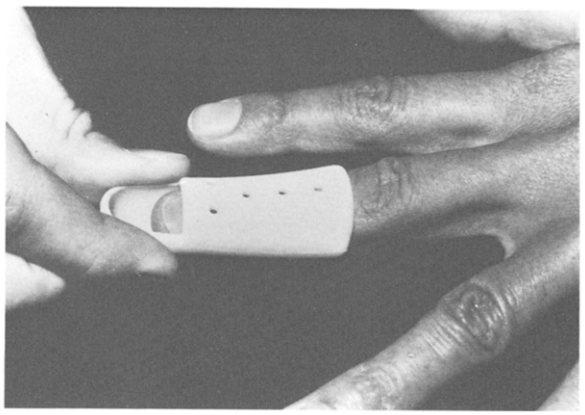

Fig. 9. Technique for splint removal or reapplication. Contact must be maintained at all times between the proximal dorsal margin of the splint and the skin on the dorsum of the finger. During removal the finger must be pressed down against a firm surface to avoid flexion at the DIP joint.

the splint is often proximal to the axis of rotation of the PIP joint. Nonetheless, the tape is applied as far proximally as possible to maintain the proximal portion of the splint against the digit. This can restrict somewhat PIP joint flexion but has not led to any permanent loss in PIP joint mobility. I believe this taping technique to maintain the very slight degree of distal joint hyperextension is more important than allowing complete mobility of the PIP joint.

In closed tendon injuries, patients are allowed occasionally to remove the splint. More frequent yet proper removal has ended the problem of skin maceration seen in the earlier years of the series and has not compromised the results. With the finger firmly pressed down against a counter, the splint is removed, maintaining the dorsal proximal edge against the dorsum of the digit at all times (Fig. 9). If this proximal edge is not kept in contact with the dorsal skin, the joint can be levered into flexion. Then the splint and the finger may be cleansed and the splint reapplied, maintaining contact of the dorsal proximal edge of the splint with the dorsal skin. Proper snug taping of the finger fully within the splint is performed then.

Fig. 10. A, A fracture with subluxation of the distal phalanx after wearing of the splint. This was treated with open reduction and a single Kirschner wire used to transfix the joint. The fracture fragment lay easily in its proper position and was therefore not transfixed. **B,** The fracture healed and excellent function was obtained.

I believe that in some cases of the large fracture fragments, this splint increases the potential for palmar subluxation of the distal phalanx (Fig. 10). Therefore, with fracture fragments involving 35% to 50% of the joint surface, I purposely have not had the digit fully inserted within the splint. A 3 to 4 mm gap is allowed, and this reduces to some degree the tendency for hyperextension of the distal phalanx. Full digital insertion in the splint in those cases can encourage palmar subluxation of the phalanx by hyperextending the joint. In such situations, the profundus tendon can pull the intact articular surface of the distal phalanx beneath the condyles of the middle phalanx. In these fractures, splint removal for digital cleansing before 2 weeks has not been allowed.

Occasionally, a splint of intermediate size would seem desirable. This is achieved best by taking the smaller of the two closest sizes and cutting the splint longitudinally in the midline dorsally. This splitting allows comfortable splint application. With the sub-

sequent taping, fixation is secure, and as swelling subsides, a splint of similar size without the dorsal cut is substituted.

This splint is useful for many other injuries. It provides good pulp protection for painful lacerations and amputation revisions. It is also adequate for many other fractures of the distal phalanx and the distal portion of the middle phalanx. For fractures distal to the middle third of the distal phalanx, the digit should not be inserted fully since the phalanx may heal with some angulation. Here, also, a gap of 3 to 4 mm is allowed to prevent hyperextension at the fracture site. I have found that such protection of fingertip injuries often allows early work resumption, and I prefer this protection to other types of splints or finger guards when digital use is required in spite of pain.

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