TREATMENT OF MALLET FINGER – A REVIEW

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Disruption of the finger’s extensor apparatus at its terminal portion, causing inability to extend distal interphalangeal joint (abbreviation: DIP) and dropping of the distal phalanx, results with well known “mallet finger” deformity. This deformity can be caused by simple rupture of extensor apparatus, or avulsion fracture of the dorsal rim of the articular surface of distal phalanx. Sudden, forceful flexion of extended distal phalanx can easily damage thin terminal tendon inserted on the distal phalanx. The cause can be either direct blow to the distal phalanx, sharp or blunt injury to the distal interphalangeal joint (1). Swelling, tenderness and redness over the dorsal aspect of the DIP joint can accompany dropping and lack of active extension. Such inflammatory-like symptoms can develop in case of prolonged untreated injury. Lack of active extension can be either distinct or discrete (from few to several dozen degrees) respectively to complete or incomplete disruption of extensor apparatus or due to locking of avulsed fragment of the distal phalanx amid soft tissues.

Several classifications of this pathology can be found in the literature, including Doyle classification and Whebe-Schneider classification (2, 3). The former, new, more versatile, includes all possible patterns of injuries resulting with mallet finger deformity (tab. 1). The latter concerns bony mallet finger deformities (tab. 2). Another one, a Crawford classification, is used to classify outcomes of treatment (tab. 3) (4).

Table 1. Doyle’s classification of types of mallet fingers (2)

<table>
<thead>
<tr>
<th>Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>closed trauma, only tendon injury, or avulsion fracture with a small bony fragment</td>
</tr>
<tr>
<td>II</td>
<td>simple wound with extensor tendon division</td>
</tr>
<tr>
<td>III</td>
<td>deep wound with a skin and extensor tendon loss</td>
</tr>
<tr>
<td>IV</td>
<td>fracture of the dorsal rim of the distal phalanx, comprising an insertion of extensor tendon</td>
</tr>
<tr>
<td>IVa</td>
<td>pediatric fracture of the distal phalanx comprising growth plate with tendon insertion</td>
</tr>
<tr>
<td>IVb</td>
<td>fracture of the dorsal rim of the distal phalanx, involving 20-50% of the articular surface</td>
</tr>
<tr>
<td>IVc</td>
<td>fracture of the dorsal rim of the distal phalanx involving &gt;50% of the articular surface</td>
</tr>
</tbody>
</table>

Table 2. Wehbe-Schneider’s classification of types of mallet fractures (3)

<table>
<thead>
<tr>
<th>Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>non-displaced fracture of small dorsal rim fragment of distal phalanx</td>
</tr>
<tr>
<td>II</td>
<td>displaced fracture of small dorsal rim fragment of distal phalanx</td>
</tr>
<tr>
<td>III</td>
<td>fracture involving whole dorsal rim of distal phalanx</td>
</tr>
<tr>
<td></td>
<td>further characteristics of the fracture: subtypes:</td>
</tr>
<tr>
<td>A</td>
<td>bony fragment size &lt;1/3 of articular surface of the distal phalanx</td>
</tr>
<tr>
<td>B</td>
<td>bony fragment size &gt;1/3 but &lt;2/3 of articular surface of the distal phalanx</td>
</tr>
<tr>
<td>C</td>
<td>bony fragment size &gt;2/3 of articular surface of the distal phalanx</td>
</tr>
</tbody>
</table>
Mallet finger deformity is commonly neglected by patients and practitioners unless significant functional deficits or/and pain are present. But sometimes if such, it can cause tremendous impairment of the whole hand in everyday activities or work. Moreover, mallet finger deformity can develop and progress to swan-neck deformity with compensative hyperextension of proximal interphalangeal joint. Cosmetic concerns are more vital in women when it comes to decision of the course of the treatment. Dropping of the distal phalanx, and swan-neck deformity in particular, can cause unacceptable, distinctive cosmetic deficit. Most of surgeons agree that, because of all mentioned above, mallet finger deformity should be properly treated.

There are many usable techniques described. Those can be divided into two main groups: conservative and operative. Generally accepted indications for surgical repair are open injuries, avulsion fractures of more than 20-30% of articular surface of DIP joint or inveterate injuries. Acute, closed and tendinous (without fracture) injuries are generally treated nonoperatively. Several splints can be used to immobilize DIP joint in slight hyperextension, needed for bringing closer tendon ends (1, 5). Because of delicate structure and faint blood supply, the distal end of extensor apparatus needs long time to heal and to achieve durable scar. Thereby nonoperative treatment, apparently simple, is relatively handful. One must inform patients of long treatment, need of compliance, patience and uninterrupted splintage of DIP joint.

Mallet finger deformity is a common problem, treated usually in outpatients departments. Generally choice of treatment is based on preferences rather than reasonable factors. As usually there is not one established method of treatment. The objective of this paper is a review of possible treatment methods – considering actual state of knowledge – and to remind of rules of conservative treatment and operative techniques used to deal with “mallet finger” deformity.

Conservative treatment

As mentioned above, this treatment is indicated for acute cases (up to 2 weeks from injury), closed injuries, isolated disruption of extensor apparatus, or small fragment fracture (less than 1/3 of articular surface). Immobilization in slight extension of DIP joint is obtained by usage of short splints. Most popular one was introduced in 50s of the last century Stack splint (fig. 1). Previously used splinting with proximal interphalangeal joint flexed in 90° and DIP joint in full extension is not necessary, because freeing proximal interphalangeal joint does not influence the distal end of extensor apparatus (6). Immobilization of DIP joint alone is sufficient treatment. Conservative treatment can be effective in delayed cases, up to 2 months even, as described in literature (7). Hygiene of finger can be difficult. Splintage gets dirty and skin underneath can be easily macerated. These most common problems can push patient to remove the splint. If distal phalanx drops during cleansing the treatment course starts over. Nevertheless non operative treatment is most frequently advocated in acute cases (1, 5, 8).

As previously mentioned Stack splint is mostly recognized and accessible in the market devise for treatment of mallet finger deformity. It is not perfect after all. In the long course of treatment, apart from maceration,
Treatment of mallet finger – a review

Skin over dorsal aspect of DIP joint can be easily compromised by pressure exerted by the distal rim of the splint causing even pressure-sore. According to the one of the older publications complication rate is up to 45% of total number of treated fingers (9). Institutional clinical experience of authors of this article does not confirm so high complication rate and risk of Stack splint usage. There are many other devises maintaining DIP joint in extension. Most of them are made of foam padded aluminum Zimmer splint. It can be either applied as simple dorsal short splint, almost in the same manner as described by Kleinert with foam padding excised over DIP joint or Mexican-hut modeled (fig. 2 and 3) (5, 8, 10, 11). Time of maintenance is equal. Theoretical advantage over Stack splint is decreased pressure exerted to the skin on the dorsal aspect of the DIP joint, and so it better blood supply. Tuttle et al. describe effective treatment with simple dorsal Zimmer splint removable for the time of cleansing. Patients were informed to not let the distal phalanx drop (1). Keeping finger flexed in MCP and PIP joint, and other fingers in full extension is useful advice. This maneuver releases tension of FDP of injured finger and prevents involuntary DIP joint flexion. Beside dorsally placed splints there are several palmarly placed, made of aluminum or plastofit (fig. 4 and 5).

Conservative treatment of mallet finger deformities is considered effective. The outcomes are satisfactory in 80-90% of cases. It means no flexion deficit and up to 10°of extension lag (5, 11-14). Some authors suggest type IVb and IVc fractures, with relatively large bony fragment, can be treated conservatively with satisfactory results. Our experience elucidate possibility of types I, II, IVb effective non operative treatment, using every presented method if one obeys few simple rules. These are:

1. DIP joint should be immobilized in full extension or slight hyperextension. Excessive hyperextension promotes complications and

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Fig. 2. Dorsal aluminium splint with sponge deficit above DIP joint (8)

Fig. 3. „Sombrero” dorsal aluminium splint

Fig. 4. Palmar aluminium splint

Fig. 5. Custom-made plastofit splint
incomplete extension compromises outcome.

2. Splint must not exert pressure to the skin over dorsal aspect of DIP joint, so not to compromise blood supply to healing site and to avoid pressure-sore.

3. When managing type IV injury in Doyle classification, after splintage one should confirm accurate fracture reduction and DIP joint sub-luxation reduced. If these goals are impossible to achieve it is better to choose operative management.

4. One should inform patient 2 months continuous splintage is a mandatory in case of simple disruption of extensor apparatus and 1.5 month when dealing with type IV injuries. Patient should know safe splint removal technique for the time of cleansing. X-ray control should be performed 2 and 4 weeks afterwards.

There are about 40 mallet fingers treated in authors’ Department every year. There is not only one method preferred and splintage technique depends mostly on personal experience of surgeon. Most frequently used are plastofit splints, Stack splints, simple dorsal Zimmer splints (fig. 1, 2, 5). We have not observed any significant complications of non operative treatment in our practice but the results were, so far, not scientifically assessed.

Operative treatment

Operative management is not limited only to the cases inappropriate to conservative treatment. Surgeons who prefer operative management in acute cases do not advocate better efficiency but convenience for the patients for whom external splintage usually is uncomfortable. Some author suggest possibility of earlier DIP joint mobilization after operative management (17). There are many methods of operative mallet finger management described in literature, starting from most simple DIP joint arthrodesis with single K-wire in slight hyperextension, up to more sophisticated techniques like tendon suture, tendon reinsertion, K-wire or mini screw osteosynthesis of fracture fragment and double K-wire extension block or tenodermodesis. We provide detailed description of several, interesting, viable techniques and the outcomes below.

Bauze et al. used two PDS 2/0 sutures to attach fracture fragment of distal phalanx in type IV Doyle classification mallet fingers. Each suture was anchored to the end of extensor apparatus and pulled through finger pulp sided to the bone and then backwards but it was not pierced through the bone. DIP joint arthrodesis was performed just after, sutures were tightened and tied so to obtain reduction of fracture fragment. K-wire was removed after two months. Authors assessed outcomes of the treatment of 10 patients operated at a mean of 2 months after injury (range 1-16 weeks). At a mean of 17 months follow-up (range 5-29), an average DIP joint active and passive ranges of motion were of 38° and 54° respectively (51% and 60% of the range of motion of the contralateral DIP joint). Two-point pinch with using treated finger was 3.8 kG (81% of strength in healthy hand), and total grip strength was 38 kG (95% of strength in healthy hand). All patient returned to their previous work. In half of patients, after 17 months, control X-ray showed DIP joint narrowing and mild degenerative changes. Complications occurred in half of the patients: nail deformation, K-wire track infection and skin draw on the pulp (18).

Ishiguro et al. proposed interesting way of stabilizing fracture bony fragment of distal phalanx with two K-wires, none of them piercing through it (fig. 6). Differently to other techniques distal phalanx was immobilized in slight flexion about 30° to 40°. Wires were removed after 4 to 6 weeks (19). Pegoli et al. presented treatment results of in 65 type IV mallet fingers in Doyle classification with modified Ishiguro’s technique (fig. 7). At a mean of 1.5 year follow-up (range 0.5 to 11) the authors obtained 51 good and very good results (78%), 13 moderate (20%) and 1 poor result (2%). They observed one complication of K-wire track infection. Before K-wire removal patient wore plastofit splint for protection, and one third of patient splinted fingers during night for one month more additionally to achieve full correction in case of incomplete active extension of distal phalanx (20). Original Ishiguro’s technique, and it’s modifications are considered effective and are frequently utilized in type IV in Doyle classification mallet finger treatment.

Ulusoy et al. showed results of treatment in 19 patients with mallet finger deformity. Long finger was most frequently involved – 7 cases (43%), 11 cases were type I and II in Doyle clas-
Classification (without fracture), 8 cases were type IV – fracture involving 20% and more of articular surface. All cases were neglected and operated at a mean of 2 months after tendon injury (range 1-5) and at a mean of 2 weeks after avulsion fracture (range 1-4). Ring finger was most frequently involved – 7 cases (43%). Reattachment of extensor apparatus to distal phalanx was performed with suture piercing throughout bone of distal phalanx (fig. 8). DIP joint was immobilized with single K-wire for 1.5 month. Results assessed at a mean of 16 months, revealed full extension in all cases, with average flexion 74° (range 60°-90°), were considered very good in 14 and good in 5 cases according to Crawford criteria. No complications were observed, but 6 patients (31%) developed DIP joint narrowing and mild degenerative changes in X-ray examination (23).

Rocchi et al. used original technique percutaneous osteosynthesis with single K-wire advanced from dorsal to palmar direction, throughout avulsed fracture fragment, basis of distal phalanx and throughout pulp. Dorsal end of K-wire was consecutively bent and – through small dorsally placed incision – drawn in tissues to stabilize reduction. The pulp was secured with small thermoplastic splint but not to immobilize DIP joint. Palmarly protruding 1 cm end of K wire was advanced through the splint. This end was drawn through the small fragment of plastic tube and subsequently bent (fig. 9). Such stable construction maintained reduction of the fracture fragment in anatomical position. In this method DIP joint was left free enabling flexion of distal phalanx without losing reduction. K-wire was removed after 1.5 months average. Authors treated 48 type IV Doyle classification mallet fingers this way, and achieved 11 very good, 35 good and 2 poor results according to Crawford classification at a mean of 12 months follow-up. Complication included one K-wire track infection. K-wire was removed after 2 weeks and treatment finished with DIP joint splintage (24).

Nakamura et al. used operative management to treat type I and II Doyle classification mallet fingers (without fracture) in order of...
early finger mobilization. Proximal end of ruptured tendon was reattached with thin wire advanced through distal phalanx and subsequently tied. Additionally tendon was sutured and DIP joint immobilized with K wire only for 3 weeks. DIP joint was mobilized just afterwards. Using this technique in 15 patients authors achieved 58° of DIP joint range of motion and 6° extension lag at a mean of one year follow-up (17).

Simple temporary arthrodesis of DIP joint with single K-wire is used in treatment of acute mallet finger deformities (25). This is called internal splintage in contrast to external splintage described previously in conservative treatment. This can be used in isolated tendon injuries and with bony fragments. Advantage of this technique is simplicity and convenience to the patient, who does not have to wear uncomfortable splintage throughout course of treatment. If inflammatory response in vicinity of K-wire does not occur; this technique allows patient to work during course of the treatment, and one of the authors experienced this on his own. End of K-wire sunk beneath the skin did not disturb hand preparation before operations, but special attention had to be paid when full strength grip was involved, like fracture reduction, K wires cutting, screw placement in bones. Inflammatory reaction in vicinity of K-wires appears in about 10% of cases and mostly, if noticed early enough, can be easily treated with oral antibiotics (e.g. amoxicillin) and treatment can be continued. In case of symptomatic infection or no improvement despite antibiotics K-wire should be removed and treatment continued conservatively. Effectiveness of temporary DIP joint arthrodesis with K-wire is equal to conservative treatment (14).

The neglected cases constitute different problem. These comprises conservative treatment failures. In Doyle type IV injuries one of previously described methods is used, resembling refreshment of fracture site before reduction and final stabilization. In old Doyle type I and II cases, after refreshment and mobilization two parted ends of extensor apparatus are sutured together with double continuous PDS II 5.0. Subsequently DIP joint single K-wire arthrodesis in slight extension is performed, provided that they can be brought together. The wire is kept for 2 months. After removal cautious mobilization is started and protective splintage is maintained for the following month when performing activities involving full strength grasping. This technique is preferred in authors department, though rarely utilized due to little number of inveterate cases, about 10-15 a year.

When two ends of extensor apparatus are too distant, one of viable, but seldom used is Fowler’s method – cutting off and advancement distally central slip of extensor apparatus to bring ends together and suture directly (26). If distal part of tendon is not long enough to put firm suture, proximal end must be attached to distal phalanx using one of methods mentioned (2, 18, 23). To avoid more complicated operation of reattachment of distal end of the extensor apparatus to the bone of distal phalanx, suture en block skin and tendon end after scar, and dorsal fragment of articular DIP joint capsule excision was proposed (tenodermodesis). Before 3-4 sutures are tied, the DIP joint is immobilized in slight extension with K-wire (5). Sorene et al. described results of such treatment in 16 patients, suffering from mallet finger deformity caused by simple tendon injury, lasting average 6 months and with extension lag average 50°. At a mean of 3 years
Treatment of mallet finger – a review

follow-up, they observed very good result according to Crawford criteria in half of the patients, good in six patients and poor in two patients. All patients obtained extension lag correction, but average range of motion in DIP joint was only 30°. Even though authors stated no difficulty to the patients – such significant limitation of DIP joint range of motion must be considered as disadvantage of this technique (27).

Previously described methods does not cover all possible situations. Authors observed rare failures after two or even three attempts of operative management, and the main problem in those cases were nagging pain of the DIP joint while moving and painful and hyper-sensitive swelling over DIP joint. An X-ray examination often reveals joint space narrowing and degenerative changes. If one faces such problem DIP joint definitive arthrodesis seems to be reasonable and effective salvage. Pain relief compensate lack of DIP joint, and so limited range of motion.

Lets look at a Cochrane meta-analysis of mallet fingers treatment (14). Of numerous studies concerning treatment of this injury, only four met the criteria of scientific evidence, and the results were based on total number of 283 treated fingers. Three of which comparing two different methods of splintage and one comparing splintage with DIP joint arthrodesis with K-wire. Results of those analysis does not permit decision which method of splintage is the one most effective and safest, does arthrodesis with K-wire is better than simple splintage or even to decide if treatment is better than doing nothing. Taking into consideration all publications authors of the mentioned meta-analysis suggest that external splintage of DIP joint using multiple options of immobilization is the only scientifically justified way of mallet finger treatment (14). Such ambiguous conclusion indicates mean quality of previous studies concerning treatment of this injury, esp. regarding operative management.

Presented opinions about mallet finger treatment are based on author’s experience and review of literature. We hope that readers of this article will find them helpful in dealing with such injuries, and illustrations of operative techniques will support their armamentarium.

REFERENCES

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