Distraction Histiogenesis for Correction of Long Standing Flexion Deformities of the Proximal Interphalangeal (PIP) Joint of the Hand

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ABSTRACT

Reconstruction of long standing flexion deformities of the PIP joint carries the risk of neurovascular compromise. Gradual soft tissue distraction (distraction histiogenesis) was used to treat 12 fingers with long standing flexion contractures of the PIP joint. The deformity was due to post-burn contracture in 10 fingers and congenital contracture (camptodactyly) in 2 fingers. Two distractors were applied for each finger. Full extension was achieved in all fingers. Physiotherapy after the distraction program was required for significant improvement of range of motion (ROM). Mild relapse complicated 3 fingers.

In this study, gradual soft tissue distraction proved to be an excellent modality for treating long standing flexion deformities of the PIP joint. There was no need for other reconstructive procedures.

INTRODUCTION

Long standing flexion deformity of the PIP joint of different etiologies is usually complicated by shortening of volar soft tissues and joint contracture [1,2]. Traditional reconstruction includes staged extensive releases, tendon work, capsulotomy, arthroplasty or arthrodesis, soft tissue coverage and physiotherapy [1]. However, these techniques are not applicable in all situations and have their own limitations and drawbacks.

Distraction lengthening was firstly introduced for limb lengthening in skeletally deficient patients [3]. It is found to provide an optimal environment for soft tissue adaptation and subsequent elongation [4]. Slow distraction of soft tissue contractures alone such as those encountered in a burn [5,6,7] or in a radial clubhand [8] was reported. Soft tissue distraction of PIP joint flexion contracture was used by Grishkevich as a preparatory operation for treatment of post burn boutonniere deformity [9]. Its role was only to stretch scarred and contracted volar soft tissues and open the PIP joint space maximizing its passive movements before extensor tendon grafting.

In this study, long standing PIP joint flexion contracture due to burn or camptodactyly was corrected by soft tissue distraction to evaluate its usefullness as a modality of treatment of such cases.

PATIENTS AND METHODS

This study was conducted on 12 fingers with long standing PIP joint flexion deformity of 7 patients. The patients were presented either with post burn contracted fingers (10 fingers of 5 patients), or camptodactyly (2 fingers of 2 patients). The study was held in 2 years, starting from October 2003. Etiology, age, sex, affected fingers, angle of contracture (Fig. 1) and ROM are shown in Table (1).

Surgery: The aim of the procedure was to achieve lengthening of the contracted volar tissues through soft tissue distraction. Local ring anaesthesia was used in all cases. Two K-wires of 2mm diameter were introduced blindly in the bones of proximal and middle phalanges. They were applied in a transverse manner proximal and distal to the affected PIP joint, as far as possible away from the joint (Figs. 2). No surgical incisions nor osteotomies were needed. Then, the distractors were fitted on the K-wires. We used custom-made devices (Fig. 3), exactly similar to the Molinaextraoral unidirectional baby distractor, that are used for infant mandibular distraction. Two distractors for each deformed finger were applied, one along each side (radial and ulnar) leaving 1/2 cm of clearance for potential swelling. The devices were put longitudinally corresponding to the base of a triangle having its apex at the PIP joint (apex of the deformity) and its sides along the long axes of the proximal and middle phalanges. On activation of the device, the distraction vector would elongate the contracted volar tissues. The purpose of using two devices was to have equal elongation on both sides, when they are equally activated to avoid deviation and articular surfaces compression.

The 1st patient with camptodactyly affecting the little finger of both hands (Fig. 4A) had soft tissue distraction of the left little finger compared against traditional release of the right little finger (Fig. 4B,C). The right little finger was operated upon by skin release (Z plasty), flexor superficialis release, lumbrical insertion release and capsulotomy of the PIP joint.

The ring finger of the 2nd patient resisted distraction because of extensive volar tissue loss and subsequent scarring. There was adhesion between volar surfaces of middle phalynx distally and proximal phalynx and palm proximally (Fig. 5A). Removal of distractors, scar excision and minimal release were done. Neurovascular bundles were stretched and attempts of more release led to vascular compromize. Raw area was covered with full thickness skin graft (FTSG). The distractors were reapplied 1 month post-operatively (Fig. 5E).

Postoperative care: Antibiotic ointment was applied to the sites of K-wires. The finger was put in a light cotton padding and wrapped lightly. Prophylactic systemic antibiotic and oral analgesic were prescribed. The patient was discharged at the same day of surgery. The patient was trained to activate the devices at home performing 1mm distraction/day bilaterally starting 3 days postoperatively (as a period of rest). Weekly clinic visits were necessary to check neurologic status and judge the straight lengthening. The patient was instructed to inform about any colour changes or intolerable pain at once. The rate of distraction was reduced to 0.5mm/day when pain was intolerable and back again to the usual rate when possible. On achieving full extension, distractors were left as retainers for 4 weeks and then removed as an outpatient procedure. Physiotherapy started by that time.

RESULTS

Soft tissue distraction was performed to correct long standing flexion deformity of PIP joint of 12 fingers in 7 patients. The deformity was due to burn in 10 fingers (5 patients) and congenital (camptodactyly) in 2 fingers (2 patients). Full extension was accomplished in all patients (Figs. 4,5). The time needed differed according to the severity of the deformity. There was minimal improvement of ROM (10-30 degrees) after removal of the distractors. Extensive physiotherapy (3 visits/week for 6-12 weeks) was needed to significantly improve the ROM. No capsulotomy, tenolysis, or arthroplasty were indicated in any of the patients.

Pain was controlled easily by oral analgesics. The ring finger that needed pre-distraction release and grafting was the only finger that expressed no pain during distraction with preservation of normal sensation.

Wire site inflammation and mild infection occurred in 5 fingers and controlled by local antiseptics (povidone-iodine solution) and antibiotics (fusidic acid ointment).

Extrinsic finger flexor tightness was a transient sequel in 8 fingers. Improvement was evidenced during post-distraction splinting period and completed after physiotherapy.

Numbness was almost a constant complaint during distraction of all fingers. Return of normal sensation started gradually from the 2nd week of splinting.

Mild relapse was found in 3 fingers, 8 weeks after removal of the distractors.

DISCUSSION

Distraction histiogenesis is a biological process of soft tissue active adaptation to gradual stretching [10]. This soft tissue response is either secondary to bone lengthening or primary if distraction is applied across a joint. Distraction histiogenesis may be used for the slow distraction of soft tissue contractures due to burn [5,6,7] or in congenital radial club hand [8].

In the vast majority of burned hands the initial thermal injury is limited to the skin alone; the underlying tendons, vessels and joints are usually spared. Prolonged wound healing with its attended edema, infection, fibrosis, poor positioning and prolonged immobilization can lead to adhesion of gliding tissues and joint contractures. Many palmar burns that heal spontaneously during the acute period, develop significant contractures. Flexion contracture of the PIP joint is a common deformity in palmar burns [1].



Fig. (1): Measuring the angle of contracture using the goniometer.



Fig. (4-A): Preoperative view of bilateral camptodactyly of little fingers.



Fig. (2): K-wires transversally applied.



Fig. (4-B): Post-distraction of the Lt little finger (dorsal view), the Rt little finger was traditionally released.



Fig. (3): The two distractors in place.



Fig. (4-C): Post-distraction of the Lt little finger (palmar view).



Fig. (5-A): Preoperative view of post-burn contracted PIP joints of the index, middle, ring and little fingers.



Fig. (5-C): Distractors were removed.



Fig. (5-B): Distraction of the index and little fingers was completed.



Fig. (5-D): Distraction of the middle finger.

Table (1)





Fig. (5-E): Distraction of the ring finger after its release and grafting.

On the other hand, the etiology of the congenital flexion deformity of the PIP joint (camptodactyly) is confusing, and vertualy every structure surrounding the PIP joint has been implicated in its pathogenesis [11]. Most authors emphasise the dynamic imbalance caused by abnormal intrinsic muscle anatomy as the primary cause of these flexion

contractures and the capsular and ligamentous changes are secondary events [2].

Long standing flexion deformity of the PIP joints of different etiologies is a challenging problem that needs staged release and reconstruction to avoid neurovascular compromise. Gradual soft tissue distraction has offered an additional and still evolving management tool for the treatment of soft tissue contractures given the proper indications. It was used to lengthen post burn contractures of the foot [5], the PIP joint in boutonniere deformity [9], the first web space [6] and the wrist [7]. Congenital soft tissue contractures were also distracted successfully in radial club hands for centeralization of the wrist joint [8].

In this study, 12 fingers with long standing flexion contractures of the PIP joint (10 post burn-2 camptodactyly) were treated with gradual soft tissue distraction. Full extension in all fingers was reached by the end of the distraction program.

The use of 2 distractors for each finger prevented deviation or articular surfaces compression, but limited the possibility to distract 2 adjacent fingers at the same time. Infrequent wire site infection, flexor tightness and insignificant improvement of ROM were controlable drawbacks of the technique. Local care, enough splinting time and physiotherapy solved these problems. Better ROM could be achieved if physiotherapy was held during the distraction program. The future plan includes: Removal of the distractors while leaving the K wires followed by passive and active mobilization of the PIP joint. This will be done during the weekly clinic visits.

At the beginning of this study, relapse was expected to be a significant drawback of scarred tissue distraction. Mild relapse was estimated in only 3 fingers of post-burn etiology denoting that scarred tissue can be distracted safely and successfully. This could be explained by the electron microscopic examination of the distracted postburn contracted scar that was performed by El-Deeb, [7]. It showed the collagen fibers that were intact at the beginning of the distraction to be fragmented with signs of immaturity and increased mitosis at the end. Although this finding described scarred tissue reaction to distraction, it is comparable to normal tissues' reaction to continuous stretch (distraction) that has been claimed by Dyachkova and Utenkin, [12] who stated that: There are two predominant mechanisms at play: Reorganization of collagen and neo-histiogenesis.

In conclusion, soft tissue distraction histiogenesis is an excellent modality for treating long standing flexion deformities of the PIP joint. It provides safer and predictable gradual stretch of the contracted tissues. In addition it eliminates the need for staged procedures that still carry the risk of neuro-vascular compromise.

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