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Effects of serial casting in the treatment of flexion contractures of proximal interphalangeal joints in patients with rheumatoid arthritis and juvenile idiopathic arthritis: A retrospective study

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ABSTRACT

Aim: To analyze the effects of serial casting (SC) in the treatment of proximal interphalangeal (PIP) joint flexion contractures in patients with rheumatoid arthritis and juvenile idiopathic arthritis.
Study design: Retrospective case-series.
Methods: The data of 18 patients treated with SC were obtained from their patient records. The angular changes in the finger joints were analyzed and compared statistically using t-tests.
Results: A total of 49 fingers were serially casted with plaster of Paris over a 14-year period. The SC resulted in significant (26.8°; $p < 0.001$) reduction in the PIP joint extension loss. Small, but statistically significant, losses in flexion were associated with these gains. ($p < 0.001$). Angular changes were also observed in the other finger joints. The magnitude of the initial extension loss was the only factor to explain the amount of motion gained ($p < 0.001$; $R2 = 0.38$).
Conclusion: SC is an effective method to correct flexion contractures in PIP joints in selected patients with arthritis. The gain is partially related to the magnitude of initial extension loss.

Introduction

Rheumatoid arthritis (RA) and juvenile idiopathic arthritis (JIA) are the most common types of autoimmune connective tissue disorders among adults and children respectively.[1] Long-term inflammation of the synovial tissue may lead to weakening of the supporting structures and corruption of the delicate biomechanical balance of the joint in both disorders.[2,3] The balance of the forces acting on the joints gradually deteriorates as joint deformities or instability develops. Deformities tend to progress if no external forces are provided in the opposite direction.[4] The development of flexion contractures in proximal interphalangeal (PIP) joints is a common sequela to this process in both disorders and a common cause of referral to hand clinics.[5–7] Structural changes inside the joint or surrounding soft tissues may lead to a progressive lack of extension, hampering the ability to grasp medium to large objects.[8] In addition, patients may have difficulty in some activities of daily living such as placing their hands into a narrow space and washing one's face. Improper immobilization also contributes to this situation and may lead to additional soft-tissue changes in the joint.[9]

Flexion contractures of the PIP joints are generally challenging problems for hand therapists. Exercises and orthoses are common conservative methods to deal with this problem.[9] However, treatment protocols may differ depending on the nature and severity of the underlying pathology. There are some studies in the literature reporting the sole or combined effects of these methods.[10,11] In most of these studies, patients have orthopedic problems. However, RA and JIA are chronic disorders in nature and disease pathomechanisms in the joint differ from those of acute injuries. Various types of orthoses have been proposed for treatment of the problem.[12,13] Static or elastic traction orthoses may be preferred depending on the characteristics of the joint involvement. Static ones have been demonstrated to be effective in alleviating active joint disease and pain by resting the inflamed joints,[14,15] but the number of studies reporting the value of them in preventing or correcting finger deformities is limited.[16] Although elastic traction orthoses have proven to be effective in most orthopedic conditions, they are used cautiously in patients with RA due to fear that the force created by stretching may result in further damage to the joint structures.[17] This concern further increases in the active phase of the joint disease when inflammatory synovium forms a pannus.

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Pannus is an invasive tissue and grows over the surfaces of the joint cartilage, into and around the tendons, and into the ligament attachments. This invasion may result in loosening of ligaments, destruction of joint surfaces, and functional disability of tendons.[18] In the active phase of the disease, weakened and loose periarticular tissues may not function properly to resist or transmit the dynamic forces even with appropriate parameters and may be further damaged when exposed to them.

Tissue elongation provided by serial casting is another method to correct flexion contractures.[19,20] It provides low load to shortened periarticular tissues over a prolonged period of time.[21] Gentle, slow repositioning of the deformed joints via serial casting allows contracted soft tissues to resume their original length.[4]

The idea of using serial casting to regain extension in interphalangeal joints was first introduced by Dr. Brand.[22] His experiences with leprosy patients, paved the way for this method for a wide variety of conditions that are associated with joint contractures in the hand. Serial casting provides a gentler and more precise means of tissue remodeling compared to that provided by elastic traction or static progressive orthoses. The response to continual positioning with serial casting is plastic deformation. When a contracted tissue is held under constant tension, a permanent change will occur due to reorientation of the collagen network.[4,23–25] In addition to the realignment of collagen fibers, Brand postulated the idea of the addition of new cells during continual positioning.[24,25] However, the idea of lengthening by adding cells has not been proven.

Digital serial casting can be accomplished with various materials including Plaster of Paris (POP), thermoplastic tapes such as Orficast™ and fiberglass fabric coated with a kind of temperature-sensitive polymer (QuickCast™).[26] Among them, POP is the oldest, and the most versatile material. It is also readily available, cheap, conforms to body parts and is skin-friendly.[4,27,28] Although serial casting is mentioned as an effective method for correcting flexion deformities in many resources,[23,26,29] there are only a few studies reporting its effectiveness for this problem.[30–32] None of these studies use the serial casting for the correction of PIP joint flexion contractures in patients with RA or JIA.

Another concern is the effects of PIP joint immobilization on the neighboring joints. This is a concern for all static orthoses.[19] Immobilization of a joint may lead to increased forces and angular demands on the adjacent joints. This can be an even more important concern when serial casting fragile joints patients with RA or JIA.

The main aim of this study was to retrospectively analyze the effects of serial casting applications in a group of patients with PIP joint flexion contractures associated with RA or JIA. We also aimed to elicit patient- and disease-related factors that might have an effect on the result of treatment.

Method

This study was conducted in the Rheumatology Department of Cerrahpaşa Medical Faculty at İstanbul University. The approval for the study was obtained from the Ethics Committee of İstanbul Bilim University. The study design was retrospective. The data of patients treated with serial casting to correct flexion contractures of the PIP joints were determined from the patient treatment records. A total of 49 fingers of 18 patients were identified that underwent serial casting during the 14-year interval from which records were reviewed. These patients with RA or JIA were identified from those admitted to the outpatient clinic of a rheumatology department during the period between the years 1996 and 2009. Thirteen of them had a diagnosis of RA and the others had JIA. All patients, except one with JIA, were female.

Data collection

In addition to active range of motion (ROM) data of all joints in the casted fingers, demographic information, treatment and disease durations, and number of casting repetitions were obtained from the treatment records of patients. All measurements and treatment interventions in the unit were conducted by one of the authors of this study. He was the only therapist working in this clinic during the study interval.

Active ROMs were measured in all finger joints. A wire-tracing method was used to measure ROM. In the study by Ellis et al,[33] repeatability coefficients for the same observer and different observers were found to be 10.9 and 12.3° respectively for the PIP joints measured with a wire-tracing method. The corresponding values obtained with finger goniometry were 4.7 and 7.2° for the same joint. Although, a finger in healthy subjects, goniometer was shown to be a more reliable instrument in healthy subjects, wire tracing was the preferred method for patients with finger involvement in our therapy unit. The fact that the arms of a finger goniometer could not be strictly placed over the phalanges because of surface irregularities on the bones and soft tissues associated with arthritic changes was the major factor in this preference. ROM measurements were taken at the beginning of the therapy session during the first visit. At the following visits, they were taken immediately after cast removal. Before the measurements, patients were instructed to actively move their joint(s) to be measured until the limit of motion in the test direction. ROM measurements of PIP and DIP joints were taken together. Throughout the measurements of these two joints, the wrist was supported in the neutral position. The loss of extension in PIP and DIP joints was measured in combined while the MCP joint of the same finger was held about 45° of flexion to eliminate the tightness of intrinsic hand muscles. While maintaining the prescribed positions of MCP and wrist joints, patients were requested to actively extend their interphalangeal joints. During the flexion measurements of these joints, the MCP joint was positioned in neutral, and the patient was requested to actively flex his or her finger to be measured into a hook position. For the ROM measurements in MCP joints, PIP and DIP joints were held in the relaxed position and the wrist joint was supported in neutral.

Before the ROM measurements, a piece of solder wire was cut in accordance with the length of the segment to be measured. For the measurements of interphalangeal joints, the wire was laid on the midline of the finger dorsum. For the MCP joint movements, solder wire was placed on the proximal phalanx and the associated metacarpal bone of the finger to be measured. The wire was placed on the finger only after the joint being measured had reached its angular limit in one direction. At this point, the solder wire was carefully shaped with the angulation of the measured segment. Then, the wire taking the shape of the segment was carefully removed, while the patient preserved the end position(s) of the joint(s), and put on a sheet of paper divided into squares for each joint movement. During this transfer process, maximum care was taken to preserve the form of the wire. The shape of the wire was directly projected onto the paper via a pen while slightly pressing down the ends of the wire with the tips of the index and middle fingers of the other hand. Joint locations were marked on the projected line. After the axis of the goniometer was placed on the point corresponding to movement axis of a finger joint, its arms were held parallel to the linear parts of the proximal and distal lines at each side of this point. After making sure that the goniometer was correctly positioned on the paper, the degrees of angle on the scale was read and recorded below the tracing. For the follow-up of changes in the extension range, the amount of extension lack was recorded. The maximum flexion angle was documented to track the