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Static progressive stretch for the treatment of knee stiffness

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Abstract

Persistent knee stiffness is common after knee arthroplasties, cruciate ligament repairs, and trauma. Static progressive stretch protocols have shown success in treating contractures of the elbow, ankle, and knee in case reports and small case series. This study evaluated static progressive stretch as a treatment method for patients who had refractory knee stiffness, and compared the outcomes to published results of other therapeutic modalities. Forty-one patients who had knee stiffness and who had not improved with conventional physical therapy modalities were treated with a patient-directed orthosis that utilized the principles of static progressive stretch. After a mean of 9 weeks of use (range, 3 to 27 weeks), the total arc of motion increased by a mean of 33° (range, 0 to 85°). Forty of 41 patients had increased motion at a mean final follow-up time of 1 year (range, 6 months to 2 years), and 93% were satisfied with the results. The outcomes were comparable to other nonoperative treatments reported in the literature, but the results in the present study occurred in a shorter mean treatment time. An orthosis that utilizes the principles of static progressive stretch may be a successful treatment for improving the range of motion and satisfaction of patients who have knee contractures.

Keywords: Splint; Static progressive stretch; Knee contracture; Knee stiffness; Knee rehabilitation

1. Introduction

Arthrofibrosis of the knee joint can occur following knee surgery, trauma, or immobilization. This can severely impact gait, mobility, function, and overall quality of life. The reported prevalence of knee contractures after total knee arthroplasty varies due to differing diagnostic criteria, and has ranged from 1.3% to 15% [1–4]. It is usually treated successfully with mobilization, stretching, strengthening, and gait training [5–7]. However, stiffness and pain can persist despite these therapeutic modalities and can cause severe dysfunction.

When functional problems caused by knee stiffness continue despite aggressive physical therapy, various other nonoperative techniques can be utilized in an attempt to improve symptoms, including various orthoses [7–11] and serial casting [12,13]. Operative treatments for knee stiffness include manipulation under anesthesia [4,14,15], lysis of adhesions and/or soft tissue release [16–20], external fixators [20,21], as well as revision arthroplasty [2,22]. These procedures have success rates ranging from 66% to 94%. Despite the success rates of some surgical treatments for knee stiffness, nonsurgical options should be attempted prior to considering these more invasive procedures. This may reduce complications, decrease costs, and increase patient satisfaction.

Of the nonsurgical protocols for treating knee stiffness, stretching has led to variable results [7,11,23]. Serial casting may improve symptoms, but it involves multiple visits and may cause skin as well as damage [12,13].

Various orthoses have been developed for improving knee stiffness, and such devices generally use either creep or stress relaxation principles to stretch the soft tissues. Creep loading involves the use of spring tension to apply a constant force to the

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Fig. 1. The device used in the study consists of a metal brace with a padded thigh cuff and two padded leg cuffs. Velcro straps are used to secure the device, and the knob on the brace adjusts the degree of flexion or extension.

joint as the displacement gradually increases [10,11]. In stress relaxation, the joint is maintained at a constant displacement near the end range of motion, and the resistance of the soft tissue to the stretch gradually decreases. Static progressive stretch is a technique in which stress relaxation is applied to a joint, but the displacement is periodically increased as the soft tissue fibers remodel and the tissue lengthens [24]. This is the principle behind serial casting. Static progressive stretch has been successful in treating patients who have stiff knees [8,9]. It has also shown success in treating elbow [25,26] and ankle contractures [27].

The present study assessed the use of an orthosis that utilized the principles of static progressive stretch to treat a large cohort of patients who had knee stiffness and who had failed other nonoperative techniques. We evaluated the duration of treatment, range of motion, patient compliance, and overall satisfaction. We also compared these results to other treatments for knee stiffness reported in the literature.

2. Materials and methods

Forty-one consecutive patients who had knee stiffness and had failed other therapeutic modalities were treated with a patient-directed, bidirectional orthosis that utilized the principles of static progressive stretch. For the purpose of this study, knee stiffness was defined as a total arc of motion of less than 90° or a flexion contracture that impaired quality of life. Patients who had heterotopic ossification or other osseous deformities that were limiting motion were excluded. At the completion of the study, the duration of treatment, range of motion, compliance, satisfaction, and complications were recorded for each patient. The range of motion at final follow-up was evaluated and compared to published studies of other techniques. This study had full Institutional Review Board approval.

The patients included 20 men and 21 women who had a mean age of 56 years (range, 23 to 78 years). The reasons for the knee stiffness and pain included total or unicompartmental knee arthroplasty (21 patients), cruciate ligament injury/reconstruction (nine patients), distal femur fracture (two patients), and chronic knee stiffness secondary to multiple prior surgeries, including arthroscopic explorations and debridements (nine patients). Five of the patients who had chronic knee stiffness secondary to multiple prior surgeries also had chronic pain, and two of those patients had been diagnosed with complex regional pain syndrome. Twenty-five of the patients who were studied had previously undergone manipulation under anesthesia to treat the arthrofibrosis, but continued to have knee stiffness following the procedure. None of the patients underwent operative exploration to treat the stiffness. All patients were evaluated radiographically to ensure that there were no bony deformities that were interfering with motion. Each patient had undergone standard physical therapy for a mean of 10 weeks (range, 6 to 26 weeks), which included stretching, range of motion therapy, strengthening exercises, gait training, and ultrasound. In each case, the physical therapist determined that the patient's stiffness would not improve using these techniques, so the patient began using the orthosis. The mean interval between the onset of stiffness and the initiation of treatment with the orthotic device was 17 weeks (range, 6 to 57 weeks).

The orthosis used in the study was the JAS Knee device (Joint Active Systems, Effingham, Illinois) (Fig. 1). The device consists of a metal brace that has two padded cuffs attached which wrap around the thigh and leg, respectively, and are secured with straps. The angle can be adjusted by turning a knob on the brace. The brace can be adjusted to various angles between 160° of flexion and −21° of hyperextension by turning a knob at the distal end. To apply the orthosis, the brace is adjusted to a position matching the angle of the contracture. The orthosis is then positioned over the knee, with the center of the brace placed over the patella, and the straps are fastened. Neoprene wraps are placed between the cuff and skin to assist with containment of tissue in the cuff area and to ensure that maximal cuff/skin contact was maintained throughout the therapy sessions.

Instructions and demonstrations regarding the use of the orthosis were given to all patients. The patients were shown how to place the orthosis on the extremity and to adjust the angle until they felt a gentle stretch. This position was maintained for 5 min. At that time, the intensity of the stretch was subjectively assessed, and if it had decreased, the angle of the device was adjusted until the gentle stretch was attained again. This assessment and readjustment was continued every 5 min for the entire 30-minute treatment session. If the patient required increases in both flexion and extension, then he or she allocated 30 min for each movement, for a total of 1 h per session. Patients underwent one treatment session per day for the first 5 days, and then increased the frequency as tolerated to a maximum of three sessions per day. They continued treatment until they felt that no further improvements were being achieved for at least 1 week. None of the patients received any other therapy or operative treatment for their knee stiffness between the start of the study and the final follow-up.

Patients were followed in the office throughout the course of the treatment, and were seen for final follow-up at a mean of 1 year (range, 6 months to 2 years) after cessation of treatment. At each visit, the range of motion was measured with a goniometer by a physical therapist and the lower extremity was examined for injuries or other lesions. The same physical therapist evaluated and recorded all range of motion measurements for each patient. At the final follow-up, each patient answered questions regarding compliance, satisfaction, and complications with the device. They rated overall satisfaction using the Likert scale [28], which ranged from 0 to 10 points, with 0 points indicating complete dissatisfaction and 10 points indicating complete satisfaction. A score of 0 to 5 points was considered dissatisfied.

Table 1
Range of motion values before and after treatment with the device

	Pretreatment visit	Final follow-up visit	*p*-value
Total active arc of motion in degrees (range)	69 (21 to 100)	102 (55 to 130)	<0.001
Extension	−15 (−65 to −3)	−6 (−45 to 0)	<0.001
Flexion	84 (30 to 110)	108 (65 to 135)	<0.001