A New Static Progressive Splint for Treatment of Knee and Elbow Flexion Contractures

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Background: *Knee and elbow flexion contractures are a frequent cause of ambulation and function problems that often require extensive rehabilitation. Traditional methods are of limited benefit in severe and fixed contracture. A new static progressive splint was developed from daily-use knee and elbow orthosis and a newly invented gradual telescopic rod, which is designed to provide low load, and gradual and prolonged stretching.*
Material and Method: *The splint was used in ten cases (11 knees) of knee flexion contracture and three cases of elbow flexion contracture. There were multiple etiologies of contracture such as burn scar contractures, intra-articular fractures, septic arthritis, juvenile rheumatoid arthritis, and immobilization. The average timing of the contracture before splinting was 14.6 months (range, 2 to 36) in the knee group and 16.7 months (range, 6 to 30) in the elbow group.*
Results: *The average initial extension was -53.6 degrees (range, -30 to -85) in the knee group and -70 degrees (range -65 to -80) in the elbow group. The average post treatment extension was -15 degrees (range, 0 to -30) in the knee group and -38.3 degrees (range, -30 to -45) in the elbow group. The average duration of treatment was 9.2 weeks (range, 4 to 16) in the knee group and 14 weeks (range, 11 to 20) in the elbow group. The most dramatic result was found in the patient who had burn scar flexion contractures of both knees for 20 months. The knee extensions increased from -60 and -85 degrees to full extension in four and 14 weeks after treatment, respectively. There were no recurrences or complications from the use of this splint. The patients were able to easily adjust the gradual telescopic rod themselves to provide the appropriate force for stretching.*
Conclusion: *The static progressive splint is a new, effective, and low cost method for treatment of knee and elbow flexion contracture from multiple etiologies. The excellent result was found in extra-articular contracture.*

Keywords: *Contracture, Knee, Elbow, Splint, Orthosis, Rehabilitation, Treatment*

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Knee and elbow flexion contractures are relatively common complications following trauma, inflammatory conditions, immobilization, burns, and congenital deformities. Severe knee flexion contracture can cause disabilities, decreased mobility and ambulation. Elbow flexion contracture causes impaired upper extremity function.

Treatments of knee and elbow flexion contractures have included non-surgical and surgical methods. The non-surgical method consists of passive stretching[1,2] with physical modalities, joint mobilization, traction and serial casting. Physical therapy needs experienced therapists and may fail in severe and fixed flexion contracture. Serial casting may result in pressure ulcers and stiffening of the joints[3,4]. It must be done by skilled personnel and requires re-casting every few days. Orthosis and splints were used to prevent deformities or maintain range of motion after stretching but not for increased motion. Surgical procedures such as soft tissue release, osteotomy and distraction with external fixator[5-8], increase range of motion and enhance function but they may cause complications. The complications were skin necrosis, tissue infection, knee subluxation, fracture, peroneal nerve palsy and recurrent[8,9].

A new static progressive splint (Fig. 1) was developed from daily-use knee and elbow orthosis and a newly invented gradual telescopic rod that

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was designed to provide low load and gradual and prolonged stretching.

Material and Method

The present study was performed between 2006 and 2009 with approval of the Ethics Committee of Maharat Nakhon Ratchasima Hospital. Thirteen patients with fixed flexion contracture of knee and elbow joints were treated with the new static progressive splints. Ten patients (eleven knees) had knee flexion contracture and three patients had elbow flexion contracture, all failed intensive physical therapy. Ten males and three females were included in the study. The average age was 35.2 years old (range 4 to 66) in the knee contracture group and 17 years old (range 11 to 25) in the elbow contracture group. The etiologies of knee and elbow flexion contracture were burn scar contracture, intra-articular fracture, trauma around knee joint, septic arthritis, juvenile rheumatoid arthritis, immobilization and heterotropic ossification (Table 1). Seven knees and three elbows received an operation before the study, depending on the cause of contracture.

The patients were instructed to wear the splint as much as possible or about 20 hours/day, including nighttime. The splint was taken off every 1 to 2 hours for range of motion exercises and hygiene care. The patients were taught to adjust the telescopic rod themselves for appropriate force for stretching to the point of discomfort, but not pain, four times a day.

Results

Treatment with the static progressive splint was begun at an average of 14.6 months (range 2 to 36) in the knee group and 16.7 months (range 6 to 30) in the elbow group following the injury or other etiologies of the flexion contracture. All measurements were made with standard goniometers. The average extension before splinting was -53.6 degrees (range -30 to -85) in the knee group and -70 degrees (range -65 to -80) in the elbow group. The average post splinting extension was -15 degrees (range 0 to -30) in the knee group and -38.3 degrees (range -30 to -45) in the elbow group. The average arc of motion was improved from 52.8 to 97.7 degrees in the knee group and 26.7 to 65 degrees in the elbow group. The average duration of splinting was 9.2 weeks (range 4 to 16) in the knee group and 14 weeks (range 11 to 20) in the elbow group.

There was dramatic result in case 1 who had a history of 75% second and third degree burn. He developed burn scar contracture of both knees for 20 months and could not walk. An operation to release

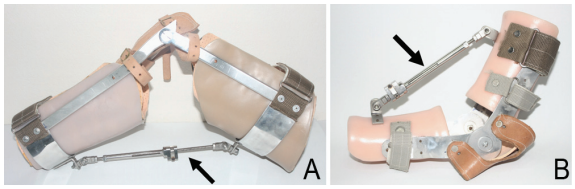

Fig. 1 The new static progressive splint for knee (A) and elbow (B) consist of daily-use orthosis and a newly invented gradual telescopic rod (arrow)

Fig. 2 Case 1 with right knee flexion contracture 60 degrees before splinting (A) and full knee extension after splinting (B)

Fig. 3 Case 1 with left knee flexion contracture 85 degrees before splinting (A) and full knee extension after splinting (B)

Table 1. Summary of clinical data

Case No.	Age/ Sex	Joint	Side	Etiologies	Procedures	Timing before splinting	Pre-splinting ROM			Post-splinting ROM			Duration of splinting
							Flex.	Ext.	Arc	Flex.	Ext.	Arc	
1	25/M	Knee	R+L	Burn scar	R: Release	20 months	135	-60	75	135	0	135	4 wk
					L: Non operation	21 months	135	-85	50	135	0	135	14 wk
2	53/M	Knee	L	Fracture intercondyle	1. ORIF adhesion 2. Arthrotomy + lysis	16 months	100	-45	55	100	-10	90	7 wk
3	35/M	Knee	R	Open fracture intercondyle and tibial plateau, ACL injury	1. ORIF 2. Debridement x 2	5 months	80	-30	50	100	0	100	8 wk
4	17/M	Knee	R	Open fracture medial condyle, ACL-PCL injury Infected screw	1. ORIF 2. Debridement x 4 3. Off screw	2 months	55	-45	10	80	-30	50	12 wk
5	35/M	Knee	R	Infected nail, Chronic osteomyelitis Septic arthritis	1. Debridement 2. Off nail	36 months	90	-55	35	90	-20	70	16 wk
6	50/M	Knee	L	Septic arthritis	Arthrotomy	5 months	105	-45	60	110	-30	80	6 wk
7	61/M	Knee	R	TB arthritis	Non operation	15 months	90	-45	45	110	-30	80	12 wk
8	4/F	Knee	R	Juvenile rheumatoid arthritis	Arthroscope + synovectomy	24 months	110	-55	55	110	-20	90	10 wk
9	66/F	Knee	L	Immobilization from hemiparesis	Non operation	9 months	135	-60	75	135	-25	110	8 wk
10	6/F	Knee	R	Burn scar	Non operation	8 months	135	-65	70	135	0	135	4 wk
Average	35.2	Knee				14.6 months	106.4	-53.6	52.8	112.7	-15	97.7	9.2 wk
11	25/M	Elbow	R	Open fracture intercondyle, tear radial nerve	1. ORIF 2. Debridement x 2	14 months	100	-65	35	100	-30	70	11 wk
12	15/M	Elbow	R	Fracture dislocation Heterotopic ossification	ORIF	6 months	100	-65	35	105	-45	60	20 wk
13	11/M	Elbow	L	Fracture lateral condyle	1. ORIF 2. Osteotomy + remove callus 3. Lysis adhesion	30 months	90	-80	10	105	-40	65	11 wk
Average	17	Elbow				16.7 months	96.7	-70	26.7	103.3	-38.3	65	14 wk

ORIF = open reduction internal fixation; ACL = anterior cruciate ligament; PCL = posterior cruciate ligament

the scar was performed in the right knee. It increased knee extension from -90 degrees to -60 degrees before splinting. The knee flexion contracture was improved from 60 degrees to full extension after four weeks of splinting (Fig. 2). In the left knee, the flexion contracture was reduced from 85 degrees to full extension after 14 weeks of splinting (Fig. 3). There were no skin complications or recurrence at 31 and 13 weeks follow-up. Plain film of both knees showed no posterior subluxation of the tibia. The patient can walk normally without gait aid.

All patients can ambulate with the splint and they can easily adjust the telescopic rod.

Four patients had minimum correction of the contractures. Two patients (Case 6 and 7), had histories of septic arthritis, presented with knee flexion contracture 45 degrees for 5 and 15 months. Plain film of their knees showed severe intra-articular damage. Their contractures were reduced by only 15 degrees after the use of the splint.

Case 4, a 17-year-old boy, had been treated with open reduction and internal fixation with screw for open fracture of medial condyle and knee ligament injury. Multiple debridement (4 times) and screw removal were performed because of infection. He was treated with splinting program two months after surgery. The knee flexion contracture was improved by only 15 degrees after 12 weeks period of splinting. Plain film of his knee revealed severe intra-articular lesion. He could walk and returned to school.

A 15-year-old boy (Case 12) was presented six months after open reduction and internal fixation for fracture and dislocation of the right elbow. Severe intra-articular damage and heterotropic ossification around the elbow joint were seen in the plain film of his elbow. The splinting program improved elbow flexion contracture by 20 degrees and increased the arc of motion by 25 degrees. The duration of splinting was 20 weeks. No further improvement was found after this period. He was able to do daily activities.

Discussion

The static progressive splint is a new, locally made, simple to fabricate and can be reused. It is effective for correcting knee and elbow flexion contractures from multiple etiologies without the need of percutaneous pin fixation or other surgeries. When compare to a previous study that used distraction with external fixator in same degree of burn scar knee flexion contracture[5], the results were better without the need of surgery. The force of tissue stretching is controlled by the patient. The compliance of splint use is good. The patients can tolerate the pressure and be a part of the active treatment program. They can ambulate and do daily activities with the splint. Admission to hospital is not necessary in most cases except for the patients with learning or cognitive problems.

This splint is the first locally made static progressive splint in Thailand although it is not a new idea. There have been many designs of the splints, which differ from the one we have used[10-18]. However, it was identical in principle, low load, gradual and slow distraction as in Ilizarov principle[7].

The results depend on severity of the intra-articular damage, age of the patient, timing of the contracture, surgical procedure before the treatment, and other causes of mechanical obstruction in or around the joint. The most dramatic result was found in extra-articular contracture even though in severe flexion contracture such as 85 degrees flexion contracture in case 1. However, severe intra-articular damage (Case 2, 4, 6, 7, 11, 12 and 13), prolonged contracture (Case1, 5, 7, 8, 11 and 13) and patients with fixed deformity also gained some benefit from the use of this splint.

It is important to instruct the patient to take the splint off regularly for range of motion exercises, especially flexion motion. There were decreases in flexion in the patients who wore the splint for a long time without range of motion exercise that could be improved after appropriate instruction. Overall, there was an average of 6 degrees increase in knee and elbow flexion.

The total time of using the splint per day varied among the patients. There were many reasons why the patients did not follow the instructions such as discomfort from improper splint fitting, skin allergy to the material of the splint, rather heavy weight of the splint in the patient with weakness, embarrassment, and some activities in the water or a dirty environment.

Conclusion

The static progressive splint is a new, effective, and low cost method for treatment of knee and elbow flexion contracture from multiple etiologies. Excellent results were found in extra-articular contracture.

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อุปกรณ์ยึดข้อแบบปรับได้แบบใหม่สำหรับรักษาข้อเข่าและข้อศอกติดแข็งในท่างอ

รัชวรรณ สุขเสถียร, ยิ่งยง สุขเสถียร

ภูมิหลัง: *ข้อเข่าและข้อศอกติดแข็งในท่างอเป็นสาเหตุของปัญหาการเคลื่อนไหว และจำกัดการทำงานของร่างกายที่พบบ่อย ซึ่งต้องอาศัยการฟื้นฟูอย่างมาก วิธีรักษาแบบอนุรักษนิยมที่ใช้ในปัจจุบันมักไม่ได้ผลในผู้ป่วยที่ข้อติดแข็งที่เป็นมากและเป็นมานาน อุปกรณ์ยึดข้อแบบปรับได้แบบใหม่จึงถูกประดิษฐ์คิดค้นขึ้นจากกายอุปกรณ์เสริมของเข่าและข้อศอกที่มีใช้อยู่ที่โรงพยาบาล ร่วมกับแกนยึดข้อที่ประดิษฐ์ขึ้นใหม่โดยอาศัยหลักการยืดข้อโดยใช้แรงน้อยค่อยเป็นค่อยไป และนานพอ*

วัสดุและวิธีการ: *อุปกรณ์ยึดข้อแบบปรับได้แบบใหม่ถูกใช้ในการรักษาผู้ป่วยข้อเข่าติดแข็ง 10 ราย (11 เข่า) และผู้ป่วยข้อศอกติดแข็ง 3 ราย ซึ่งข้อติดแข็งจากหลายสาเหตุเช่น แผลเป็นหดรั้งจากไฟไหม้ กระดูกแตกเข้าข้อ ข้อติดเชื้อ ข้ออักเสบ ข้อติดจากภาวะไม่เคลื่อนไหว ระยะเวลาข้อติดแข็งก่อนการรักษาเฉลี่ย 14.6 เดือน (2 ถึง 36 เดือน) ในกลุ่มข้อเข่าติดแข็งและเฉลี่ย 16.7 เดือน (6 ถึง 30 เดือน) ในกลุ่มข้อศอกติดแข็ง*

ผลการศึกษา: *ก่อนการรักษาข้อเข่าและข้อศอกติดในท่างอเฉลี่ย 53.6 องศา (30 ถึง 85 องศา) และ 70 องศา (65 ถึง 80 องศา) ก่อนการรักษาตามลำดับ หลังการรักษาพบว่าข้อเข่าและข้อศอกติดในท่างอเฉลี่ย 15 องศา (0 ถึง 30 องศา) และ 38.3 องศา (30 ถึง 45 องศา) ตามลำดับ ระยะเวลาในการรักษาเฉลี่ย 9.2 สัปดาห์ (4 ถึง 16 สัปดาห์) ในกลุ่มข้อเข่าติดแข็งและ 14 สัปดาห์ (11 ถึง 20 สัปดาห์) ในกลุ่มข้อศอกติดแข็ง ผลการรักษาที่ดีมากพบในผู้ป่วยที่ข้อเข่าทั้งสองข้างติดแข็งจากแผลเป็นหดรั้งซึ่งเป็นผลจากไฟไหม้มา 20 เดือน ข้อเข่าที่ติดในท่างอ 60 และ 85 องศา สามารถเหยียดตรงได้หลังการรักษา 4 และ 14 สัปดาห์ ตามลำดับ โดยไม่พบการกลับเป็นซ้ำและภาวะแทรกซ้อนจากการรักษา ผู้ป่วยสามารถหมุนเหยียดแกนยึดข้อด้วยตัวเองจนได้แรงตึงที่เหมาะสมสำหรับการยืดข้อ*

สรุป: *อุปกรณ์ยึดข้อแบบปรับได้นี้ถือเป็นอุปกรณ์ใหม่ที่มีประสิทธิภาพ ราคาถูกสำหรับการรักษาข้อเข่าและข้อศอกติดแข็งจากสาเหตุต่าง ๆ โดยผลการรักษาที่ดีมากพบในกรณีข้อติดแข็งแบบ extra-articular*