

# Progressive Stretch-Load is a Principle Step in the Surgical Treatment of Burned Knee Contracture

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## Abstract

A prospective study which includes 36 patients who presented with 43 post burn knee contractures was conducted over the period of three years from Oct.2003-Oct.2006.

Their mean age incidence was 17 years. Patients with right sided contractures were 16, left sided 13 and bilateral contractures were present in 7. The F/M ratio was 1:2.2. The mean time elapse from the burn injury to the development of contracture was 2.3 years. The mean healing time was 72 days .The degree of the flexion contractures were classified according to range of joint motion limitations into mild (less than 60° ) moderate (60-90°) and sever (more then 90°).

The surgical release procedures involved two stages; (1) Incising of the contracted scar with subsequent application of progressive stretch load (PSL) to the limb through incremental weight traction over extended period of time, until the knee joint is fully extended. (2) To cover the created defect by Split Skin Graft (SSG). The weight traction range was 2.25-8.50 kilograms. The mean duration of PSL application was 7 days. The mean hospital stays was 11.5 days .The mean follow-up period was 14 months. The complication rate was five (13.88 %), three patients (8.33%) showed partial (10-15°) recurrence in the contracture angle. Two patients (5.55 %) developed popliteal ulcerating graft which required excision and skin graft in six months period. By using the PSL method 31 patients (86.11 %) had full range of movements in the knee joint, and resumed their work in 3 -4 months during post operative periods.

## INTRODUCTION

Deep partial or full-thickness burns if untreated, neglected, infected or managed conservatively can develop severe deformity and scar contracture in the joint with significant reduction in patient activities (<sub>1,2</sub>). Treatment strategy in burns is prevention of contractures rather than their management. Despite the advances in burn management protocols, there are many data supporting high incidence of joints contractures. Schneider et al examined prospectively the incidence of large joint contractures after burn trauma in 985 cases during the period 1993 to 2002, 381 (38.7%) developed at least one contracture at their time of discharge with the mean of three contractures per person; the knee joint was involved in (22%) of them (<sub>3</sub>).

Post burn knee contracture primarily affect the skin while secondary contracture also involve the capsule, ligaments, tendons, muscles, and the neurovascular bundle across the joint .In a long standing contracture, the articulating bones can be subluxated or dislocated as evident clinically by joint deformity and radiologically by forward sliding of lower femoral end on tibial condyle. Additionally, the local bones

showed radiological evidences of osteoporotic changes.

The management of joint contractures presents a great challenge both for the orthopaedic and the plastic surgeons. Aggressive physiotherapy, manipulation, splinting and various surgical methods; including scar release, tendon lengthening and osteotomies with skin graft , have been described for the treatment of joint contractures, with almost protracted morbidity in most of the cases(<sub>4,5</sub>).

The objective of the study was to use the concept of stretch to the shortened structures in a contracture by applying Progressive Stretch Load (PSL) for extended period of time. This will lead to tissue relaxation with subsequent tissue lengthening of the involved structures. This can only be done after dividing the unyielding scar tissue, which gives a way for the traction forces to exert its effect.

## MATERIALS AND METHODS

During the three years period from Oct. 2003-Oct.2006, a prospective study of 36 patients, with the age incidence ranging from 7-45 years with a mean of 17, and the age distribution (shown in Table I) was conducted

**Figure 1**

Table 1: Age Group Distribution of 36 Patients

Age group	No of cases	%
1 - 10 years	9	25.01
11-20 years	15	41.67
21-30 years	8	22.22
31-40 years	3	8.33
41-50 years	1	2.77
Total	36	100

16 of these patients had right sided and 13 had left side contractures, while seven patients had bilateral knee contractures. 11 of the patients were female and 25 were male, distribution of 43 contractures is shown in Table II.

**Figure 4**

Figure 2: Mark two points on either side of knee contracture. Dotted line was the proposed incision of the scar tissue.

Degree of Post Burn Knee Contracture	Male	Female	No. of Patients	No of Patients with Bilateral Contracture	No. of Knee Contracture	% Contracture Categories
Mild (60° and below)	7	3	10	2	12	27.90
Moderate (61-90°)	13	7	20	4	24	55.81
Severe (above 91°)	5	1	6	1	7	16.27
Total	25	11	36	7	43	99.98

The F/M ratio was 1: 2.2. The time elapse from the burn injury was 1-5 years with the mean of 2.3 years. Healing time duration was 40-120 days with a mean of 72 days.

The exclusion criteria for this study were subluxation/dislocation in the knee joint, radiological features of osteoporotic changes in the local bones and joint stiffness following trial of 4 weeks of pre-operative physiotherapy.

The degree of the contractures was classified according to the range of the joint motion limitation as shown in table II.

**Figure 3**

Figure 1: Mild Post Burn Knee Contracture one year after the injury



## SURGICAL RECONSTRUCTION

In considering cases with bilateral knee contractures, staged release of either limb is the rule; the preference to start with is either dominant, or the mildly contracted limb.

Preoperative range of joint movement within the contracted scar is assessed and trial of preoperative physiotherapy for 4 weeks is required to compensate for the prolonged post-operative immobilization. This further improves the joint mobility and bone density. The surgical steps taken are:

1. Per-operative preparation for (PSL): Following proper surgical preparation, a point is marked on each side of the knee joint. Then these two points are joined on top of scar crest as shown in Figure (2). The release procedure is done by incising the contracted scar tissue to the depth of normal soft pliable tissue. Then with gentle gauze dissection wound edges are separated apart as accessible, followed by soft dressing to the open wound. The skin traction kit is attached to the contracted limb subsequently.

**Figure 5**

Figure 3: Per Operative View, covering the created defect by SSG



2. Post-operative application of (PSL): With patient under adequate analgesia, the limb is placed in Bohler Braun Frame and weight traction is used with 1-1.5 kilograms to be re-evaluated every 12 hours. The weight is increases gradually as the patient condition permits. This continues until the knee joint become fully extended. The maximum allowed traction load is 8-12 % of the total body weight. The key deciding points in the progressive stretching are proper patient selection, adequate analgesia and patient compliance. Change of the dressing whenever it become spotty, wet or smelly is mandatory.

3. Split Skin Graft (SSG): Patient is re-operated to cover the created skin defect by SSG as shown in Figure 3. A soft dressing is applied followed by “Above the knee Plaster of Paris” (POP) cylinder in extended position.

**Figure 6**

Figure 4: post operative view of released knee by PSL method



4. Post-operative follow up is essential to check for “Compartmental leg syndrome”, by monitoring pain and the colour changes of the exposed toes. After POP becomes dried a window opening at the popliteal fossa is performed to nurse the SSG. The POP cylinder is applied for 3-4 weeks. All patients are recommended to wear elastic stocking for three months following the removal of the POP cylinder. Figure 4 shows the post operative result following PSL method in burn knee contracture.

**Figure 7**

Figure 5: Post-Burn Knee Contracture, following release and traction using PSL method for 5 days. Full extension was achieved and the wound was ready for SSG.



Figure 5 shows the immediate results following PSL in another patient, ready for SSG covering.

{image:7}

## RESULTS

The weight traction used in this study was 2.25-8.50 kilograms as the maximum weight used in (PSL) method.

The PSL was required for 3-10 (mean=7) days to achieve the releasing effect of the contracted knee joints into full extension.

The hospital stays during the reconstruction procedure lasted 8-17 (mean=11.5) days. The follow-up period extended 12-18 (mean=14) months.

The incidence of the complication in this study was five in 43 contractures (11.62 %) seen in 36 patients (13.88%). Three patients (8.33%) showed partial 10-15° recurrence in the contracture angle. Two patients (5.55 %) developed popliteal unstable tight graft with occasional break up into small longitudinal ulcer, which ultimately required excision and skin graft in six months period post-operatively.

By using the PSL method, thirty one patients had restored full range of movements in the knee region (86.11 %). They resumed their work in 3 -4 months periods post-operatively.

## DISCUSSION

The purpose of reconstructive operation in post burn knee contractures is the removal of scarring, the elimination of contractures, and the restoration of full movement of a joint without the relapse of a contracture<sup>(6)</sup>. The contracture anatomy involves the skin envelope which is the main tissue affected by scarring process and the connective tissue around the joint with shrinkage in the peri-articular and intra-articular tissues.

Despite extensive literature review we were not able to find identical work to compare with, but there is evidence that the concept of PSL was used by many authors to deal with joints contractures <sup>(7,8)</sup>. There is concomitantly a progressive lengthening of all soft tissues including vessels and nerves. Ullmann et al was able to successfully treat six patients with joint contractures by the Ilizarov Technique which is originally designed to treat bone gaps based on theory of distraction histogenesis. In this method, following gradual stretching, expansion was achieved with significant improvement in the range of joint movement <sup>(9,10,11,12,13)</sup>. Other devices developed in the field of rehabilitation based

on the same concept of PSL were used as low-load prolonged stretch or static progressive stretch. The end goal of using these devices is to cause elongation of connective tissue, tendons, ligaments, or muscles in order to improve range of joint movement <sup>(13,14,15)</sup>.

Teresa M. et al had used the Dynasplint System successfully in 28 nursing home residents with 10° or more of knee flexion contracture by low or high load prolonged stretch concept <sup>(16)</sup>.

Tissue expander is one of the clinical applications that stretch the enveloping tissues by the same idea of progressive stretching load from within <sup>(17)</sup>.

Other studies revealed that mechanical signals received by the cell in the form of stretching or compression are transduced through trans-membrane receptors and led to initiation of elongation of smooth muscle fibres of the bladder, intestine or cardiac muscle through changes in the gene expression <sup>(18,19)</sup>.

The basic drawback of this method is partial lysis and shrinkage of the skin graft <sup>(20)</sup> which led to partial recurrence of the contracture in three patients. This tendency of split skin grafted area was reported by many authors <sup>(20, 21)</sup>, and continuous splinting and massage for 3-6 months were suggested to alleviate these drawbacks <sup>(20)</sup>. The generation of scar tissue beneath the graft and development of unstable graft can explain the occurrence of ulceration in two patients.

## CONCLUSION

1. PSL application is the simple, convenient, safe and easily reproduced method.
2. The overall result of using (PSL) are promising suggesting low morbidity, reduced number and duration of surgical interventions, early convalescence, good functional restoration and short hospital stay.

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