International Journal of Health Sciences and Research
Vol.10; Issue: 11; November 2020
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Effect of Proprioceptive Neuromuscular Facilitation Stretching and Theraband Exercises on Knee Joint in Patient with Post Operative Tibial Fracture

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ABSTRACT

Background: Fractures at tibia occur very frequently due to its subcutaneous position. A variety of Interlocking nails are available and most can be inserted using reamed or undreamed technique which reduces the hospitalization and other complications to great extent. PNF (proprioceptive neuromuscular facilitation) is most effective means to increase ROM (range of motion) by way of stretching, particularly in respect to short term gains in ROM. Contract relax and Hold relax stretching has been proved to increase the restricted ROM in knee joint following tibial fractures. Elastic bands (or Thera-bands) are instruments which are often used for resistance training for purpose of muscle strengthening and improvement of functional performance in orthopedic conditions.
Methods: All individuals with age between 17-64 years with tibial fractures operated with intramedullary interlocking nails were assessed after 4 weeks and were treated for 10 days. 30 subjects have been chosen and were treated with PNF stretching – Hold relax and Contract relax and Theraband exercises. Above methods were given 5 times a week for 2 weeks, the improvement was reassessed on 10th day.
Results: It was stated that PNF and Theraband produced consistent improvements in range of motion of knee joint and strengthening of knee flexors and extensors.
Conclusion: The study result shows that PNF stretching techniques and Theraband exercises proves to be effective in the in the post operative tibial fractures.

***Keywords*:** PNF stretching techniques, Theraband exercises, Knee joint, post operative tibial fractures.

INTRODUCTION

The Knee transmits loads, participates in motion, aids in conservation of momentum, and provides a force couple for activities involving the leg. The human knee, the largest and perhaps most complex joint in the body is a two joint structure composed of the tibiofemoral joint and the patellofemoral joint. The knee sustains high forces and moments and is situated between body's two longest lever arms (the femur and the tibia), making it more susceptible to injury. [1]

Fractures at tibia and fibula occur because of its subcutaneous position, tibia is more commonly fractured than fibula and more commonly sustains an open fracture, than any other long bone. A twisting force causes a spiral fracture of both bones at different levels; an angulatory force produces transverse or short oblique fractures usually at same level. Indirect injury is usually low energy with spiral or long oblique fracture. Direct injury crushes or splits the skin over the fracture; usually high energy lesion and most common cause is motorcycle accident. [2]

Tibia is the most commonly fractured long bone. Locked intramedullary nailing is currently considered the treatment

of choice for most type I, type II, type III A open and closed tibial shaft fractures. However, intramedullary nailing is not devoid of complications like, infection, delayed union, non union, malunion, knee stiffness, shortening, refracture of tibia. [3]

Treatment of diaphyseal fracture by techniques that require prolonged immobilization of the extremity has obvious disadvantage. Hospitalization, or convalescence, or both are prolonged, limitation of joint motion is common and malunion and non-union may occur. The unattainably perfect method of fracture treatment would safely fix the fracture so firmly that soft tissue and joint could be mobilized early continuously during healing and when applicable, ambulation with weight bearing could be permitted. A method closely approaching this perfection is medullary fixation of femoral shaft fracture and; to lesser extent, fracture of shafts of other long bones. [4]

Complication of tibial diaphyseal fracture: It is self evident that it is the degree of muscle damage that will largely dictate the extent and speed of muscle recovery after tibial fractures. [5] Gaston et al. (75) used a dynamometer to assess muscle recovering after isolated tibial diaphysis fracture. They excluded patient with multiple injuries or more than one fracture in limb and included only fractures treated with intermedullary nails to negate the effect of different treatment methods. They assessed muscle function in reciprocal muscles activity across knee, ankle and subtalar joints. In Quadriceps and Hamstrings, which were not affected by tibial fracture, the recovery is much slower and by 1year patient had only regained about 75% of normal quadriceps power on average. This study defines that quadriceps muscle atrophy quickly after tibial fracture and it takes considerable period before they return to reasonable function. [6]

Proprioceptive Neuromuscular Facilitation techniques fall into two fundamental categories, muscle strengthening and joint mobilizing techniques. The joint mobilizing technique helps in increasing the joint range of movement which is undertaken as a treatment strategy in this study. [7]

Therabands are the only resistive exercise bands endorsed by the American Physical Therapy Association (APTA). These 6" wide latex bands come in different, color-coded resistance levels, distinguished by the thickness of the band. The progressive resistance system provides at-a-glance feedback on your progress (also positive reinforcement). Resistance bands are in wide use throughout the world, and TheraBands in particular are endorsed by the American Physical Therapy Association (APTA). They are versatile, portable and easy-to-use (also inexpensive). [8]

Therabands are colour-coded to identify the level of resistance. The colour band or tubing you use depends on the results you want to achieve with your strengthening routine. [28]

The rehabilitation protocol depends on the underlying mechanism of injury. For tibial fractures exercises with therabands can be given after 3 - 6 weeks of fracture reduction. [9]

The purpose of goniometry is to measure the angle of joint position or range of joint motion. Therefore, a valid goniometric measurement is one that truly represents the actual joint angle or the total ROM. [10]

Examination to determine muscle length and strength is essential before prescribing therapeutic exercises because most of these exercises are designed either to stretch short muscles or to strengthen weak muscles. Muscle length testing is done to determine whether the muscle length is limited or excessive, i.e., whether the muscle is too short to permit normal range of motion. When stretching is indicated, tight muscles should be stretched in a manner that is not injurious to the part or the body as a whole. Muscle strength testing is done to determine the capability of muscles or muscle groups to function in movement

and their ability to provide stability and support. [11]

Visual Analogue Scale (VAS) has properties consistent with a linear scale, at least for patients with mild-to moderate pain, and thus VAS scores can be treated as ratio data. This supports the notion that a change in the VAS score represents a relative change in the magnitude of pain sensation. This enhances its clinical application. [12] VAS is a methodologically sound instrument for quantitative assessment and for detecting clinically important changes in pain. [13]The aim of this treatment is to reduce pain and increase the ROM and muscle strength on knee. [14]

MATERIAL AND METHODS

Source of data:

Inpatient and outpatient of department of orthopaedics in Kempegowda Institute of Medical Science Hospital & Research Center Bangalore

Methods of collection of data:

Sample Size: 30 subjects

Study Design: An experimental study

Inclusion Criteria:

1. Age between 17 – 64 years [15]
2. Both the sexes are included
3. All simple fractures at proximal tibia.
4. Postoperative tibial fractures.
5. Gustilo- Anderson Gradings: [16]
   - Type I
   - Type II
   - Type III A
   - Type III B

Exclusion Criteria:

1. Old fractures of tibia and at knee
2. Pathological fractures of tibia and at knee
3. Any hip fractures
4. Any ankle fractures
5. Any hip, knee or ankle deformities

Methodology

- Check for inclusion and exclusion criteria.
- Explain the patient about the treatment.
- Patient informed consent form will be taken and assessed on Day 1, i.e. postoperatively after 4 weeks and on Day 10.

Assessment of Pain

The visual analog scale (VAS) is used to measure pain. A patient is asked to indicate his/her perceived pain intensity (most commonly) along a 100 mm horizontal line, and this rating is then measured from the left edge. "0" is marked on left end depicting 'no pain' and 10 at right end depicting 'maximum pain'.

Measurement of Knee Range of Motion (ROM)

The following procedure is recommended to be followed to improve reliability of goniometric measurements.

- Examiners should use consistent, well-defined testing positions and anatomical landmarks to align the arms of goniometer.
- During successive measurements of passive ROM, examiners should strive to apply the same amount of manual force to move the subject's body.
- During successive measurements of active ROM, the subject should be urged to exert same effort to perform a motion.

To reduce measurement variability, it is prudent to take repeated measurements on a subject with same type of measurement device. [17]

Knee Flexion:-The subject is placed in supine position with the knee in extension. Initially the hip is in 0 degrees of extension, abduction, and adduction, but as the knee begins to fled, the hip also flexes. Stabilize the femur to prevent rotation, abduction and adduction of hip. Center the fulcrum of the goniometer over the lateral epicondyle of femur. Align proximal arm with the lateral midline of the femur, using the greater trochanter for reference. Align the distal arm with lateral midline of the fibula, using the lateral malleolus and fibular head for reference. Normal knee flexion according to American Academy of Orthopaedic Surgeons is 0-135 degrees. [18]

Knee Extension:- The testing position and alignment are same as of knee flexion. Stabilize the femur to prevent rotation,

abduction and adduction of hip. The subject can be placed in prone position with 0 degrees of hip adduction or abduction, flexion, extension and rotation. Femur is stabilized in prone to prevent rotation, adduction, abduction, flexion or extension at hip. Goniometer alignment is same as in supine position.

Measurement of Muscle Strength: The muscle strength is assessed by the use of manual muscle test.

1) Grade 5 – Patient can hold the position against maximum resistance through complete range of motion.
2) Grade 4 – Patient can hold the position against strong to moderate resistance, has full range of motion.
3) Grade 3 – Patient can tolerate no resistance but can perform the movement through the full range of motion.
4) Grade 2 – Patient has all or partial range of motion in the gravity eliminated position.
5) Grade 1 – The muscle/muscles can be palpated while the patient is performing the action in gravity eliminated position.
6) Grade 0 – No contractile activity can be felt in gravity eliminated position. [19]

PNF for post operativetibial fractures

1) Contract Relax – The therapist takes the part passively or resists the active movement of the part to the point where further movement into the agonist pattern is limited by tension in antagonist group. Then the therapist changes the grip to that used for antagonist pattern and instructs the patient to 'pull' or 'push'. The process can be repeated at point where resistance to further movement is experienced.
2) Hold Relax – As for contract relax, for hold relax the therapist takes the limb to the point where further movement into the agonist pattern is prevented by tension in the antagonists. The movement may be passive or active. The therapist smoothly changes to the grip for the antagonist pattern and instructs the patient to 'hold' slowly; by concentrating on the rotary component, the therapist builds up the resistance until the patient is contracting his muscles maximally. The therapist must never break or overcome the patient's maximal isometric contraction. The patient is instructed to 'relax' and the sequence is completed as for the contract relax technique. [20]

Frequency:- The above methods are given one session per day for 5 days in a week. The improvement is reassessed on 10^{th} day

Theraband exercises for post operativetibial fractures:-

1. Squats:- Begin with center of band under feet. Grasp ends of bands with hands by sides. Keep tension in band with elbow straight. Keeping elbow straight, slowly bend the knees while leaning forward slightly at the hips. Slowly return to starting position.
2. Hamstring curls:- Stabilize one end of a short band under the foot. Loop the other end around the opposite ankle. Bend the knee on the side opposite the foot with the band under it, pulling theankle against the band. Hold and slowly return. [20]

Frequency:- The above methods are given one session per day for 5 days in a week. The improvement is reassessed on 10^{th} day.

RESULTS

Statistical Methods: Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance. The following assumptions on data are made, **Assumptions: 1.**Dependent variables should be normally distributed, 2.Samples drawn from the population should be random, and Cases of the samples should be independent.

Student t test (two tailed, dependent) has been used to find the significance of study

parameters on continuous scale within each group.

Effect size has been computed to find the effect due to Cohen

Sample Size estimation

Mean Known Population size

$n = \{ z^2 * \sigma^2 * [N / (N - 1)] \} / \{ ME^2 + [z^2 * \sigma^2 / (N - 1)] \}$

Mean Unknown population size

$n = (z^2 * \sigma^2) / ME^2$

ME: is the margin of error, measure of precision.

and Z is 1.96 as critical value at 95%CI

N: population size

n: Sample size

σ: Standard deviation

z: Critical value based on Normal distribution at 95% Confidence Interval

Standard deviation: $SD = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$

Student t-test for paired comparisons

Definition: Used to compare means on the same or related subject over time or in differing circumstances.

Assumptions: The observed data are from the same subject or from a matched subject and are drawn from a population with a normal distribution.

Characteristics: Subjects are often tested in a before-after situation (across time, with some intervention occurring such as a diet), or subjects are paired such as with twins, or with subject as alike as possible.

Test: The paired t-test is actually a test that the differences between the two observations are 0. So, if D represents the difference between observations, the hypotheses are:

H_o: D = 0 (the difference between the two observations is 0)

H_a: D 0 (the difference is not 0)

The test statistic is t with n-1 degrees of freedom. If the p-value associated with t is low (< 0.05), there is evidence to reject the null hypothesis. Thus, you would have evidence that there is a difference in means across the paired observations.

$$t = \frac{(\bar{x}1 - \bar{x}2)}{s / \sqrt{n}},$$

where $s = \sqrt{\sum (di - \bar{d})^2 / n - 1}$,

and di is the difference formed for each pair of observations

3.Effect Size

$$d = \frac{mean1 - Mean2}{PooledSD}$$

No effect (N)	d<0.20
Small effect (S)	0.20 <d<0.50
Moderate effect (M)	0.50 <d<0.80
Large effect (L)	0.80<d<1.20
Very large effect (VL)	d>1.20

4.Significant figures

+ Suggestive significance (P value: 0.05<P<0.10)

* Moderately significant (P value:0.01<P ≤ 0.05)

** Strongly significant (P value : P≤0.01)

Statistical software: The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1 ,Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

Table 1: Age distribution of patients studied

Age in years	Number of patients	%
18-20	4	13.3
21-30	8	26.7
31-40	6	20.0
41-50	4	13.3
51-60	4	13.3
61-70	4	13.3
Total	30	100.0

Mean ± SD: 38.50±16.08

The above table shows the age distribution of the patients studied. It shows that there are 13.3% patients in age group 18-20, 26.7% in age group 21-30, 20.0% in age group 31-40, 13.3% in age group 41-50, 13.3% in age group 51-60 and 13.3% in age group 61-70. The total mean and standard deviation is 38.50±16.08. The graph is presented below.

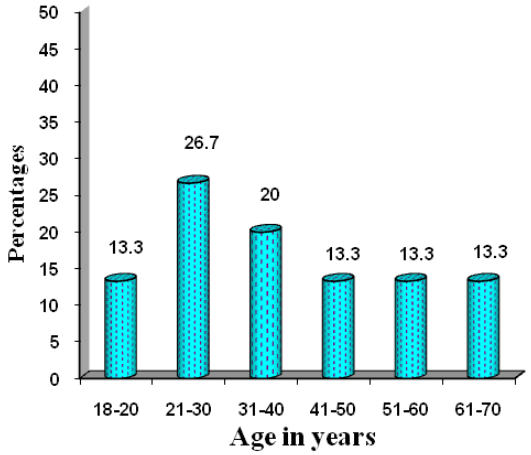

Fig 1: Age distribution

Table 2: Gender distribution of patients studied

Gender	Number of patients	%
Male	25	83.3
Female	5	16.7
Total	30	100.0

The above table shows the gender distribution of the patients studied. It shows that there were 83.3% males and 16.7% females in the study. The graph is presented below.

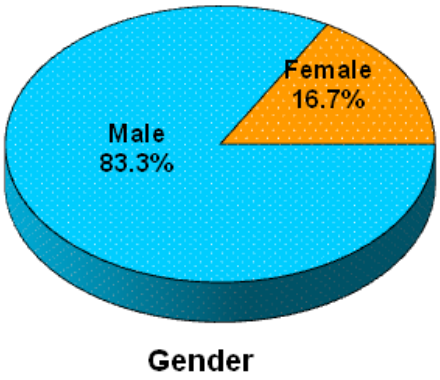

Fig 2: Gender distribution

Table 3: Evaluation based on VAS, ROM,and MMT

	Day 1	Day 10	Difference	95%CI	P value
VAS	7.60±0.93	3.13±1.79	4.96	3.92-5.01	<0.001**
ROM					
Knee Flexion	97.63±17.79	114.56±18.49	16.93	13.94-19.93	<0.001**
Knee Extension	2.07±3.15	0.43±1.35	1.63	0.79-2.47	<0.001**
MMT					
Knee Flexors	3.33±0.48	4.47±0.73	1.13	0.89-1.37	<0.001**
Knee Extensors	3.73±0.58	4.50±0.63	0.77	0.61-0.93	<0.001**

Results are presented in Mean ± SD

The above table shows the evaluation based on

VAS, ROM and MMT.

On Day 1 the VAS is 7.60±0.93 and on day 10 the VAS is 3.13±1.79.

On Day 1 the ROM of Knee flexion is 97.63±17.79 and on day 10 is 114.56±18.49.

On Day 1 the ROM of Knee extension is 2.07±3.15and on day 10 is 0.43±1.35.

On Day 1 the MMT of Knee flexors is 3.33±0.48 and on day 10 is 4.47±0.73.

On Day 1 the MMT of Knee extensors is 3.73±0.58 and on day 10 is 4.50±0.63.

The graphs are presented below for VAS, ROM and MMT.

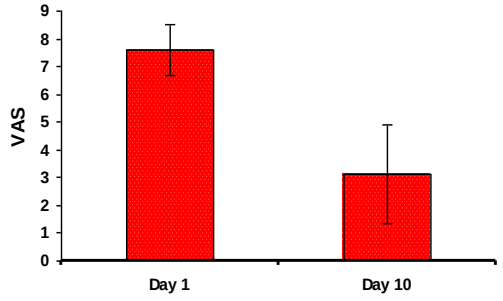

Fig 3: Evaluation of VAS on Day 1 and Day 10

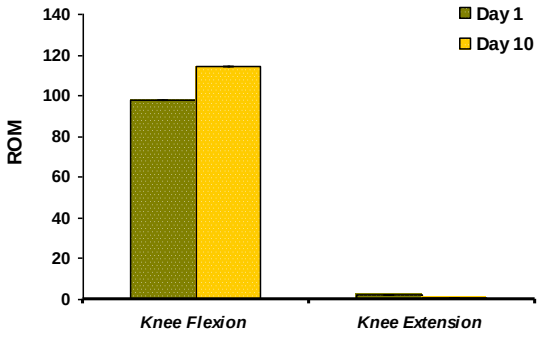

Fig 4: Evaluation of ROM on Day 1 and Day 10

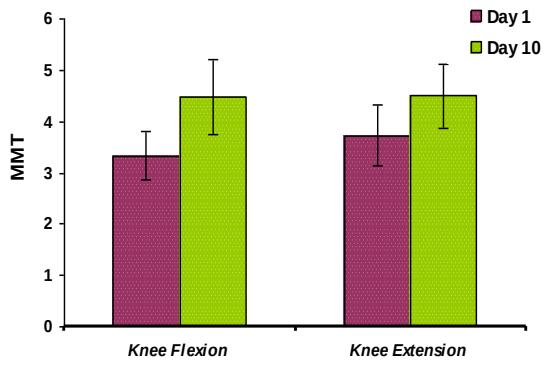

Fig 5: Evaluation of MMT on Day 1 and Day 10

DISCUSSION

The Knee transmits loads and participates in the activities of daily living. The knee sustains high forces and moments and is situated between body's two longest lever arms i.e. Tibia and Fibula, making it more susceptible for injury. Fractures at tibia occur because of its subcutaneous position. Tibia is more commonly fractured bone than any other long bones. According to a study, the high energy trauma (as from motor accidents) is the most common cause for tibia fracture. The tibia shaft is vulnerable not only to blunt trauma from vehicular accidents but also to shear torsional forces from sports and simply from falls. Locked intramedullary nailing is currently considered the treatment of choice for most type of tibial fractures. The intramedullary interlocking nailing has proved effective in reducing the hospital stay and many other complications like infections, malalignment, varus or valgus angulation and return to work. Weight bearing is restricted until early callus occurs i.e. 4 to 6 weeks. It becomes self evident that the degree of muscle damage will largely dictate the extent and speed of muscle recovery after tibial fractures.

The PNF stretching techniques are more efficacious treatment for increasing the ROM amongst which Hold-relax and Contract-relax are extensively used for knee problems. Purpose of contract relax is that it utilizes the development of muscle tension through a concentric or maintained contraction to facilitate relaxation and stretching of the intrinsic connective tissue elements of that muscle. Purpose of hold relax is that it is used to facilitate relaxation and increase range, utilizing an isometric rather than an isotonic contraction.

Tubes and bands of elastic material are instruments which are often used for resistance training, for the purpose of muscle strengthening and the improvement of functional performance of sports player, for rehabilitation in orthopedic diseases and for prevention of muscle strength decline. Elastic bands or Therabands produce significant increases in the strength of muscles. They are versatile, portable and easy to used and also inexpensive.

In this study, the goniometric measurements have been used to measure the range of motion of knee flexion as well as extension.

The Manual muscle testing has been used to assess the strength of knee flexors and extensors.

The VAS scale is used to measure the intensity of the pain perceived by the patient.

In this study, the PNF stretching and Theraband exercises both showed great improvements in increasing ROM and MMT of knee flexors and extensors along with reduction of pain. Thus, the PNF stretching and Theraband exercises can be used in post operative tibial fractures for increasing the range of motion and strengthening of knee.

Limitation

- Sample size of this study is 30 which is small. In future studies a larger population can be included so that results can be generalized for clinical application.
- Studies can be done in different age groups.
- Studies can be restricted to only males or females.
- Studies can be done in tibial condyle fractures to know the effect of the same treatment.
- Studies can be done to know the effects on ankle or hip.

Recommendation

- In future studies a larger population can be included so that results can be generalized for clinical application.
- Study can be done in only male or female groups.
- A Pain algometer can be used instead of VAS scale for more accurate results.
- Dynamometer can be used instead of MMT for more accurate results.

CONCLUSION

Based on the statistical analysis performed and the test of significance it is seen that there is significant improvement in the subjects when treated with PNF stretching (contract relax and hold relax techniques) and Theraband exercises in reducing pain and strengthening of the knee flexors and extensors. This can be noted with statistically significant improvement in Visual analogue scale, Range of Motion and Manual Muscle Testing.

Thus PNF stretching techniques and Theraband exercises proves to be effective in the in the post operative tibial fractures.

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How to cite this article: Shridhar S, Harish SP, Ravish. VN. Effect of proprioceptive neuromuscular facilitation stretching and theraband exercises on knee joint in patient with post operative tibial fracture. Int J Health Sci Res. 2020; 10(11):75-83.

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