INTRODUCTION

Amputation is actually a preventive type of surgery. Patients, their families and care givers must be aware of the realistic outcomes and expectations of amputation. The level of amputation, stump length and the age of patients directly affect the outcome. A comprehensive rehabilitation program is required to improve the functional outcome of patients after amputation. Gait training is the key of ambulation and main focus was given to improve the symmetry, gait velocity, cadence, and step length of person with amputation. Precise and intensive physical training is provided to measure the physical and functional performance in gait training according to International Classification of Functioning, Disability and Health (ICF) category of body structure of functioning. Biofeedback and postural gait training program is also provided in rehabilitation protocol for improving the ambulation of person with amputation and also comparing the energy consumption ratio. Proprioceptive facilitation with appropriate biofeedback is provided to improve the dynamic balance and overall mobility of patients but gait training part is missing with proper feedback. The main focus of this study was to provide appropriate and precise proprioceptive facilitation approaches in improving the gait performance, parameters and ambulation of patients.

The said technique integrates manual contacts, verbal commands and vision to carry out, refine and improve muscle functioning and gait. Approximation is used to facilitate the extensor or stabilizing muscle contraction and its stability. Excluding the biomechanical explanation, the latest outlook recommends that proprioceptive neuromuscular facilitation stretching technique impacts the area at which stretch is tolerated. The mechanisms which are supporting change in tolerance or stretch perception are unknown, but pain modulation has been advised.

The objective of this study was to determine the effectiveness of proprioceptive neuromuscular facilitation (PNF) techniques as compared to traditional prosthetic strength training, in improving ambulatory function in people with transtibial amputation.

METHODOLOGY

This was a randomized controlled trial conducted from July to December, 2014. The criteria to include participants were unilateral transtibial amputation, lack of contracture, first time or old prosthetic user and one-third stump length. Patients who presented with wet wounds, phantom pain, neuroma, swelling, contractures or bilateral lower extremity amputations, were excluded from the study.

ABSTRACT

Objective: To determine the effects of proprioceptive neuromuscular facilitation (PNF) techniques as compared with the traditional prosthetic strength training (TPT), in improving ambulatory function in subjects with transtibial amputation.

Study Design: Randomized control trial.

Place and Duration of Study: Artificial Limb Centre of Fauji Foundation Hospital, Rawalpindi, from July to December 2014.

Methodology: Patients with lower-limb amputation was selected through purposive sampling and randomly assigned into PNF group (n=31) and traditional group (n=32). The baseline and follow-up of 04 weeks treatment session was provided and measurement was noted through the locomotor capabilities index.

Results: The locomotor capabilities index abilities had significant difference in both groups. The mean index was 23.93 for PNF and 18.18 for TPT (p > 0.05), and the knee muscle strength was also significantly different (p > 0.05). There was no significant difference in gait parameters.

Conclusion: Proprioceptive neuromuscular facilitation technique is better in improving the locomotor abilities and knee muscle strength as compared to traditional training. The basic gait parameters have same effect in both groups.

Key Words: Proprioceptive neuromuscular facilitation. Trans-tibial amputation. Locomotor capabilities index. Gait parameters.
Patients were randomly divided into PNF group (n=31) and traditional strength training group (n=32). The traditional group was subjected to 30 minutes session of weight bearing, weight shifting, balance exercise, single limb loading, stepping, and strength training through sand bag. The PNF group underwent 30 minutes session of weight bearing, weight shifting, balance exercise, single limb loading, and stepping. The PNF principal (e.g. manual contact, verbal command, vision, and timing for emphasis, resistance, approximation, stretch, slow reversal, and rhythmic stabilization) were applied to this group.

The measured gait parameters included step width, step length, cadence, stride length, and the locomotor capabilities index (LCI).

The patients were told to walk comfortably on the powdered mat between parallel bars; the readings were taken from their footprints. Cadence was accessed as the maximum number of comfortable steps taken per minute during walk. The distance between two uninterrupted footprints of the same foot was measured as stride length. The distance between two successive footprints, i.e., sound heel to the amputated heel, and amputated heel to the sound heel was measured as step length. The distance between the centres of 2 heels was measured as step width. Six footprints consisting of 3 consecutive left and 3 consecutive right footprints were analyzed. Three measurements of step length, step width and stride length were averaged for statistical analysis.

The locomotor capabilities index contains 14 items which measure one universal construct, the locomotor capabilities with prosthesis. Each of these items is further graded on a four-point ordinal scale, i.e. 0 means unable to do; 1 means ability with the help of a person; 2 indicates ability to do under supervision; 3 designates ability to execute the task or activity independently. The total locomotors capabilities index is the sum of item scores and can range from 0 (worst) to 42 (best). The measured gait parameters included step width, step length, cadence, stride length, and the locomotor capabilities index (LCI).

The descriptive analysis includes the frequency, mean and standard deviation of variables. In inferential analysis, independent t-test, and paired t-test, was used to compare the two groups and within groups, respectively. The alpha value is 0.05 and the SPSS version 21 was used for analysis.

RESULTS

Patients with unilateral transtibial amputation (n=63) were randomly assigned into PNF training group (n=31), and TPT group (n=32). Twenty-six patients had right sided amputation, whereas 37 were amputated from the left side. Twenty-seven percent patients had no co-morbidity, 17.5% had diabetes mellitus, 11.1% had hypertension, and 44.4% had both diabetes mellitus and hypertension.

The inferential statistics shows the p-value of knee flexors and extensors and hip extensors (p=0.322). This shows there is no significant difference in muscular strength in both the PNF and traditional group (Table I). The mean locomotor capability index was 23.93 ±4.24 in PNF group and 18.18 ±7.78 in traditional group (p < 0.001). The changes in gait parameter was noted within group and results showed significant difference in step length and cadence (p < 0.001) at baseline and after 04 weeks in the PNF group. There was no significant difference in the step width (p=0.023, Table II).

DISCUSSION

According to the results of this study, there is a significant increase of muscle strength of hip flexors, hip extensors, knee flexors and knee extensors of residual limbs of unilateral amputees of the group which received proprioceptive neuromuscular facilitation technique (PNF). The individual's locomotor capabilities index, who received PNF training, demonstrated significant independence in basic and advanced activities of daily living as compared to the traditional strength training group. There is no significant difference in the step length, step width and cadence of people having transtibial amputation in experimental PNF and control (traditional strength training) group.

**Table I:** Inferential statistics of knee and hip muscles.

<table>
<thead>
<tr>
<th>Variables</th>
<th>PNF Mean (±SD)</th>
<th>TPT Mean (±SD)</th>
<th>p-value (Independent Samples Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMT knee flexors</td>
<td>4.96 (±1.79)</td>
<td>4.75 (±4.39)</td>
<td>0.013</td>
</tr>
<tr>
<td>MMT knee extensors</td>
<td>4.96 (±1.79)</td>
<td>4.75 (±4.39)</td>
<td>0.013</td>
</tr>
<tr>
<td>MMT hip extensors</td>
<td>4.96 (±1.79)</td>
<td>4.90 (±2.96)</td>
<td>0.322</td>
</tr>
</tbody>
</table>

The Table shows mean and standard deviation of knee flexors and extensors and hip extensors.

**Table II:** Gait parameter of PNF group.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Baseline Mean (±SD)</th>
<th>After 04 weeks Mean (±SD)</th>
<th>p-value (Paired t-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step length</td>
<td>27.06 ±9.39</td>
<td>31.74 ±8.04</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Step width</td>
<td>18.09 ±4.66</td>
<td>16.29 ±2.08</td>
<td>0.023</td>
</tr>
<tr>
<td>Cadence</td>
<td>50.70 ±23.76</td>
<td>63.64 ±18.73</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

The Table shows mean and standard deviation with p-value of locomotor capability index.

**Table III:** Inferential statistics of locomotor capability index.

<table>
<thead>
<tr>
<th>Variables</th>
<th>PNF Mean (±SD)</th>
<th>TPT Mean (±SD)</th>
<th>p-value (Independent Samples Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCI basic activities</td>
<td>23.93 ±4.24</td>
<td>18.18 ±7.78</td>
<td>0.001</td>
</tr>
</tbody>
</table>

The Table shows the mean and standard deviation with p-value of locomotor capability index.
Yigiter compared the gait parameters in PNF and TST groups. There was a significant improvement in proprioceptive neuromuscular facilitation group in terms of weight bearing and gait parameters as compared to the traditional strength training group. These findings are similar to the results of this study. A case report described the usage of virtual reality-based gait training programme by providing feedbacks in order to increase the physiological and biomechanical performance in people with transfemoral amputation. Training for the transfemoral amputee to exercise the residual limb’s musculature, should be mandatory for routine physical therapy protocol because biofeedback has proven to be an advantageous tool for the re-education of stump. Donachy determined the strength and endurance training of people with left upper and lower extremity amputations. The results of their study indicated that strength and endurance training regimen compensated for the extremity losses and it allows amputees to participate in physically challenging activities which were previously might not available for them. Pezzin observed the long-term outcomes of people who went through trauma related amputations and explored the factors which were influencing their physical, social and psychological health.

Many improvements and advancements have occurred in the functional outcomes of patients who received proper rehabilitation care. Rau compared the effectiveness of precise and intensive physical therapy programme with usual care in ambulation on functional performance of people with lower limb amputations. He demonstrated that physical therapy is effective in successful outcome of functional performance and hence it has a worth in total rehabilitation programme. Halsne demonstrated that people with transfemoral amputation are comparatively more variable. Their findings indicated that step activity is useful for illustrating aspects of prosthetic users - measurement of steps and mobility over brief periods is not indicative of long-term habitual patterns.

Liu reported that progressive resistance training is an effective intervention for improving physical function in geriatrics by improving strength and performance of simple and complex activities. Howe concluded that exercise therapy appeared to have significantly beneficial effects on the balance ability. Brandalize reported that functional exercise, strength training, and stretching has positive effects in improving the performance of gait. Rau reported that physical therapy plays a crucial role in enhancing functional performance of people with lower extremity amputations. Hence it has its scope in every rehabilitation center.

**CONCLUSION**

Proprioceptive neuromuscular facilitation technique was better in improving locomotion and functional status of people with transtibial amputation as compared to the traditional prosthetic strength training. The techniques were equally effective for improving step length, step width, and cadence in trans-tibial amputees.

**REFERENCES**

17. Pezzin LE, Dillingham TR, MacKenzie EJ. Rehabilitation and the long-term outcomes of persons with trauma-


