Proceeding of the 1st World Disability & Rehabilitation Conference, Vol. 1, 2016, pp. 57-69

ISSN: 2513 - 2687 online
DOI: https://doi.org/10.17501/wdrc2016-1109

COMPARING HAMSTRING FLEXIBILITY BETWEEN THE TRANSTIBIAL PROSTHETIC WEARERS AND THE CONTROL SUBJECTS AND ASSESSING FACTORS ASSOCIATED WITH HAMSTRING FLEXIBILITY

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Abstract

Hamstring flexibility is necessary for mobility in transtibial prosthetic wearers. The aim of this study was to compare hamstring flexibility of transtibial prosthetic wearers and non-amputees and to assess factors associated with hamstring flexibility. A descriptive comparative study was carried out with participation of 50 male transtibial amputees who were prosthetic wearers and 50 male control subjects who were non-amputees. Study population mean age was 55.66 years (SD ±11.455) in transtibial prosthetic wearers while it was 51.28 years (SD ±10.784) in control subjects. Data related to amputation were collected by using an interview-administered questionnaire and hamstring flexibility was assessed using the back saver sit and reach test. Statistical analysis was done by using statistical package for social sciences 16.0 version. The study revealed that, hamstring flexibility has significant relationship (p=0.001) with transtibial prosthetic wearers and control subjects. Further, the younger age (p=0.002) and participation of prosthetic rehabilitation programme (p=0.005) have significant relationship with hamstring flexibility. whereas it has no significant relationship (p>0.05) with educational level, engaging in sports activity, reason for amputation, post prosthetic period, timing of wear the prosthesis and duration of participation of prosthetic rehabilitation programme. . It can be concluded that hamstring flexibility of transtibial prosthetic wearers is lower than non-amputees. In addition to that, age below fifty and Prosthetic rehabilitation programme was associated with better hamstring flexibility among transtibial prosthetic wearers.

Keywords: Hamstring, flexibility, transtibial amputee, prosthesis, age, rehabilitation.

INTRODUCTION

Flexibility is recognized as important components of physical fitness. Poor flexibility in the hamstrings and lower back are the causes of muscular pain in the lower back, gait limitation, poor posture and increased risk of falling in older adults. In lower limb amputation, it has been theorized that hamstring length is a critical component for maintenance of proper lumbar curvature. Tightness in the hamstring muscles can pull the pelvis into a posterior tilt, decreasing the lordosis of the lumbar spine, leading to poor attenuation of forces and an increase in anterior compression forces of the lumbar spine. Hamstring flexibility is necessary for mobility in trantibial prosthetic wearers.

There are some articles say: “Joint contractures are serious problem that might affect prosthetic fitting and proper gait, and also it will increase the energy needs during locomotion”. Just after post-operative period if the patient has not started the full range of motion, contracture can be developed in proximal to the amputation site (8). Amitabh J et al (53) report in this research, 19 days after transtibial amputation some patients had 15 degree of fixed flexion deformity at the knee. Also after prosthetic fitting, many patients ignore stretching after they start to walk again. As a result, hip and knee flexion

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contractures may develop (3). Severe knee flexion contractures cannot be reduced by exercise once they become fixed .Thus, developing contracture is serious complication of amputees (9). It will reduce their functional activities. Therefore, they will become depended people in the society. Maintaining hamstring flexibility is one of the most important to reduce their dependency. We can improve hamstring flexibility through proper rehabilitation programme. However, amputees give less attention to rehabilitation training or other special needs (3). Therefore, through this current study, we can improve the patient attention towards the rehabilitation programme.

To date there is no research about hamstring flexibility in transtibial prosthesis wearers. In Sri Lanka to date, there is no related literature, which supplies any evidence to prove hamstring flexibility between transtibial prosthetic wearers and control subjects. At this stage in Sri Lanka, there are many transtibial amputees due to war injuries resulting in increase of dependent people. It can affect the development of our country. There is need of research about hamstring flexibility in transtibial prosthetic wearers.

Therefore, this research aims at assessing whether there is a difference in hamstring flexibility between transtibial prosthetic wearers and control subjects. In addition, assessing factors associated with hamstring flexibility. This study would be helpful to Sri Lankan society.

Research Objectives

General objective

- To compare hamstring flexibility between transtibial prosthetic wearers and control subject and assessing factors associated with hamstring flexibility.

Specific objectives

- To assess hamstring flexibility in transtibial prosthetic wearers using back saver sit and reach test
- To assess hamstring flexibility in control subject using back saver sit and reach test.
- To compare hamstring flexibility between below knee amputees with prosthetic leg and control subjects.
- To assess the factors affecting the level of hamstring flexibility of the transtibial prosthetic wearers

METHODOLOGY

This section illustrates the details about study design, study setting, study population with inclusion and exclusion criteria, sample size and study materials. Later part of the chapter consists of data collecting procedure along with a short description regarding data analysis.

Study Design

This study was a descriptive comparative study and the study was conducted between February 2013 and June 2013 during 9am to 12pm

Study Setting

Both transtibial prosthetic wearers and control subject were selected from Colombo Friend-in –need Society, Colombo 2.

Sampling Method

A convenient sampling method was used for selecting the participants. In this method, all the eligible study units and controls were included in the study in a consecutive manner. The researcher did not previously know the participants.

Study Sample

The study was conducted in two groups: Lower limb amputees who were transtibial prosthetic wearers and a group of non-amputees males as the control group.

Inclusion criteria specified for transtibial amputees who are prosthetic wearers:

- Age between 23-73 male who used prosthesis for more than 1 year.
- No history of fracture in either lower limb

- No history of injury in hamstring muscles (either lower limb)

Exclusion criteria specified for transtibial amputees who are prosthetic wearers:

- Mental illness and serious illness
- Professional Dancers
- Deformity in both lower limb
- Neurological deficits and musculoskeletal disorders which affect hamstring flexibility

Inclusion criteria specified for controls who are non-amputees:

- Age between 23-73 male
- No history of fracture in both lower limb
- No history of injury in hamstring muscles (both lower limb)

Exclusion criteria specified for control who are non-amputees:

- Mental illness and serious illness
- Professional Dancers
- Deformity in both lower limb
- Normal subjects who have neurological deficits and musculoskeletal disorders, which affect hamstring flexibility.

Sample Size

The study subjects were 50 transtibial prosthetic wearers who have worn prosthesis more than one year and 50 control subjects. The total sample was 100 participants (n=100)

Data Collection Instruments

Data was collected in two methods, which are administering a questionnaire and doing measurements.

1. Interview administered questionnaire:

Socio demographic data was included as first part of questionnaire.

Information related to amputation like level of amputation, reason for amputation, duration of amputation , how long have they used prosthesis, whether they were using/used walking aids, how many hours have they wear prosthesis, did they participate rehabilitation programme were included as last part of questionnaire.

2. Measurements:

Measuring device was used to measure muscular flexibility. This test is called as back saver sit and reach test. This equipment was prepared according to the standard methods (55).

Following is a description of how the measurements were done. Participants was advised to remove the shoes and sit facing the flexibility measuring device with fully extended one knee and foot flat against the end of box .Then they were advised to bend the other knee so that sole of the foot flat on the floor and 7-10 cm to the side of the extended knee and hands put on top of each other(tips of the middle fingers even), with their palms down .When performing test participant were asked to reach as far as forward, while sliding their hands along the box scale as far as possible. They were instructed to hold the position of maximum reach for about two second and the distance of maximum reach was recorded to the nearest centimeters. Average of three trials on each limb was recorded for analysis.

Participants had to perform the exercise two times. Warm up exercises, stretching and relaxing exercises had been carried at the beginning and at the end of the performing back saver sit and reach test.

Data Collection Procedure

The data collection was carried out at the above study setting. Prior to administering of the information sheet, eligible study unit were educated about the study. Written informed consent was taken from participants after reading the distributed information sheet, which included the purpose, the nature of the study and the potential benefits of the research. Then, the principal investigator according to their answers filled the interviewer-administered questionnaire. The principal investigator did all the measurements by her. She provided specific instruction to these individuals on how to complete the back saver sit and

reach test and measured the hamstring flexibility. Transtibial amputees were asked to wear prosthesis during measures. These measurements were taken at a time convenient to the participants. Each measurement was taken three times using the same measuring equipment. The mean of three values were taken for the accuracy of data.

Data Validation

The principal investigator according to their answers filled all questionnaires. She used simple language without medical terms and it was understandable to the participant's educational state. For the unclear parts further explanation was provided

The same measuring equipment was used to take the measurements and the principal investigator took all the measurements. To ensure the accuracy all the measurements were taken for three times.

Data Analysis

Data was analyzed by the principal investigator with help of supervisor using the SPSS (Statistical Package for Social Sciences) version 17.0 software on a personal computer.

The socio-demographic characteristics of the study population were described using frequency distributions and the mean age of the two groups were calculated. In addition, information related to amputation was described using frequency distribution.

Mean values of hamstring flexibility of transtibial prosthetic wearers and control subject were calculated. The independent sample test was used for comparisons between the two groups. Paired sample test was used for comparisons within the group. A p value of 0.05 was be used to determine the significance.

Factors were cross tabulated to the two different levels of hamstring flexibility and their associations were assessed using the chi square test. Age, educational level, sports activity, reason for amputation, post-prosthetic period, timing of wear the prosthesis, participation of prosthetic rehabilitation programme and duration of participation of prosthetic rehabilitation programme were the factors which were assessed for its association with hamstring flexibility.

The participants with a measurement of 20.33cm or more were categorized as having above average hamstring flexibility while those with a measurement 20.32 or below categorized as having below average hamstring flexibility (29,47,48). This cut off mark was decided prior to analysis of data in consultation with supervisor.

RESULTS AND ANALYSIS

Table 1 shows the frequency distribution of the basic characteristics of study population

Table 1: Frequency distribution of basic characteristics of study population

Demographic information of study population	Transtibial prosthetic wearers	Control subject
Mean age	55.66	51.28
Civil Status		
Single	7 (14)	2 (4)
Married	43(86)	48(96)
Educational level		
No schooling	1 (2)	2(4)
Grade 1-5	11 (22)	16 (32)
Grade 6-11	19 (38)	16 (32)
G.C.E O/L	12 (24)	7 (14)
G.C.E A/L	6 (12)	5 (10)
Graduate	0(0)	3 (6)
Vocationally trained	1(2)	1 (2)
Sports Activity		
Not participated	47 (94)	48 (96)
Cricket	2 (4)	2 (4)
Karate	1 (2)	0 (0)

Table 2: Frequency distribution of information related to amputation among transtibial prosthetic wearers

Information related to amputation among the transtibial prosthetic wearers	No (Percentage)
Amputation periods (years)	
1.5-6.4	30 (6)
6.5-11.4	5(10)
11.5-16.4	4(8)
16.5-21.4	5(10)
21.5-26.4	4(8)
≥ 26.5	2(4)
Reason for amputation	
Vascular disease	8 (16)
Diabetes	12(24)
Trauma	30(60)
Amputation level between the knee and ankle	
Upper	30
Middle	16
Lower	4
post prosthetic period (years)	
1-5	31 (62)
6-10	5 (10)
11-15	4 (8)
16-20	7(14)
21-25	1 (2)
≥26	2 (4)
Hours of wearing the prosthesis at home (per day)	
3	2
4	1
5	9
6	6
7	2
8	11
9	3
10	8
11	2
12	6
Participate any prosthetic rehabilitation programme	
Yes	27
No	23

Table 3: Frequency distribution of different categories of hamstring flexibility (average of both legs) between transtibial prosthetic wearers and control subjects

Hamstring flexibility categories (cm)	Transtibial prosthetic wearers		Control subjects		Independent sample test
	No.	Percentage	No.	Percentage	
1-5.50	3	6	1	2	
5.51-10.01	11	22	3	6	
10.02-14.52	10	20	8	16	t= -3.500
14.53-19.03	13	26	7	14	
19.04-23.54	5	10	20	40	
23.55-28.05	7	14	6	12	
≥28.06	1	2	5	10	df=98
					p=0.001
Total	50	100	50	100	

Minimum value for hamstring flexibility in the group of transtibial prosthetic wearers was 1.12 cm and the maxium was 43.50cm with a meanvalue of 15.1913cm (SD ±6.70752). Minimum value of hamstring flexibility in the group of control subject was 3.85cm and maximum was 32.55cm with a mean value of 19.7740cm (SD ±6.38178). The mean value of hamstring flexibility in control subject was significantly higher than the transtibial prosthetic wearers (t= -3.500; df=98; p=0.001).

Table 4: Frequency distribution of hamstring flexibility between amputated leg and non-amputated leg in transtibial prosthetic wearers

Hamstring flexibility categories (cm)	Amputated leg		Non amputated leg		Paired sample test
	No.	Percentage	No.	Percentage	
1-5.50	2	4	4	8	
5.51-10.01	7	14	10	20	
10.02-14.52	16	32	10	20	
14.53-19.03	9	18	14	28	
19.04-23.54	10	20	4	8	t= 1.706
23.55-28.05	5	10	7	14	
≥28.06	1	2	1	2	
					df=49
					p=0.094
Total	50	100	50	100	

Minimum value for hamstring flexibility in the group of transtibial prosthetic leg was 1.17 cm and the maxium was 31.73cm with a mean value of 15.5253cm (SD ±6.69873). Minimum value of hamstring flexibility in the group of non amputee leg was 1.07cm and maximum was 31.47cm with a mean value of 14.8573cm (SD ±6.99598).

The mean value of hamstring flexibility in transtibial prosthetic leg was higher than the non amputee leg. However, this difference was statistically not significant (t= 1.706; df=49; p=0.094).

Table 5: Frequency distribution of affecting factors and hamstring flexibility

Factors	Below average hamstring flexibility (≤ 20.32 cm)		Above average hamstring flexibility (≥ 20.33cm)		Significance
	No.	%	No.	%	
Age group					x2 = 9.426
≤ 50	9	23.1	8	72.7	df=1
≥51	30	76.9	3	27.3	p=0.002
Educational level					
G.C.E.O/L not complete and lower					
G.C.E.O/L completed and higher	26	66.7	5	45.5	x2 = 1.639
					df=1
	13	33.3	6	54.5	p=0.201
Sports activity (before amputation)					
Yes					x2 = 0.239
No	2	5.1	1	9.1	df=1
	37	94.9	10	90.9	p=0.625
Reason for amputation					x2 = 0.952
Non traumatic	17	43.6	3	27.3	df=1
Traumatic	22	56.4	8	72.7	p=0.329
Post prosthetic periods(years)					x2 = 0.466
1-15.5	32	82.1	8	72.7	df=1
15.6-30.1	7	17.9	3	27.3	p=0.495
Timing of wear prosthesis (hours)					
1-7	15	38.5	5	45.5	x2 = 0.175
8-12	24	61.5	6	54.5	df=1
					p=0.676
Participate any prosthetic rehabilitation programme.					x2 = 7.734
Yes	17	43.6	10	90.9	df=1
No	22	56.4	1	9.1	p=0.005
Period of participate in prosthetic rehabilitation programme. (weeks)					x2 =3.038
1-3	6	35.3	7	70	df=1
4-48	11	64.7	3	30	p=0.081

Younger age (p=0.002) and participation of prosthetic rehabilitation programme (p=0.005) were found to be significantly associated with having an above average hamstring flexibility. Educational level, engaging in sports activity, reason for amputation, post prosthetic period, timing of wear the prosthesis and duration of participation of prosthetic rehabilitation programme were not found to be significantly associated with a having an above average hamstring flexibility.

DISCUSSION

This chapter consists of an evaluation of the results and research findings in respect to existing literature.

In current study, hamstring flexibility was assessed in both legs in transtibial prosthetic wearers and control subjects. Hennessey et al (54) has done a study about flexibility and posture assessment in relation to hamstring injury by using injured and non-injured athletes. In that study, they compared mean (SD) of both legs between the injured and non-injured groups. Results indicated no difference in flexibility between the injured and non-injured groups. Thus, in current study also mean value of both legs was compared between the transtibial prosthetic wearers and control subjects.

The finding indicated that transtibial prosthetic wearers had significantly lower hamstring flexibility than control subject (t= -3.500; df=98; p=0.001).This may be due to the fact that physically active people have better flexibility than those who are not (34). In current study, after amputation, a majority (70%, n=35) of transtibial prosthetic wearers who were employed before were not employed. Only 8% (n=4) of control subjects were not employed. Also, as indicated earlier, most of the transtibial prosthetic wearers neglect the streching programme once begin to walk, resulting in hamstring contracture(3). Furthermore, " Tidy's physiotherapy " by Ann (50) shows that postoperatively there is a tendency to develop the knee flexor contracture in below knee amputees.The literature to date does not conclusively support this result between the transtibial prosthetic wearers and control subject .There is no related literture about hamstring flexibility between trantibial prosthetic wearers and control subject.More investigations are clearly needed on this aspect in the future studies.

Hennessey et al (54) concluded that, no difference was observed between the injured limp hamstring flexibility and the non-injured limp hamstring flexibility for injured subjects. In current study also , statistical analysis of hamstring flexibiity between the amputated leg and and non-amputated leg in transtibial prosthetic wearers was not found to be significantly different. However,the mean value of hamstring flexibility in amputated leg was higher than the non amputated leg. This may be due to the fact that amputees put more stress on their intact limp during mobility and daily activities (16). Thus, this tendency can cause degenerative changes in their intact limb (16), resulting it can affect the flexibility of intact limb muscles. Furthermore ,contractures can develop intact limb hip flexors, knee flexors and plantar flexors in lower limb amputees due to prolonged bed rest in the comfortable semi-Fowler position(3).

Jiabei (49) has done a study about physical fitness performance of young adults with or without cognitive impairment by using 75 young adults including 41 without disbilities and 34 with mild cognitive impairements. It showed young adults with cognitive impairments have significantly poorer flexibility than the young adults without disabilities. Another study on physical fitness of lower limb amputees by Chin (7) using 31 amputees and 18 abled bodies. In that study had shown that the VO2max, AT,and maximum workload for the amputees were 18.8 ± 4.9 ml/kg/min, 12.8 ±2.0 ml/kg/min, and 67.6 ± 20.2 W,respectively. The equivalent figures for the able-bodied group were 23.5 ± 3.2 ml/kg/min, 14.3 ± 1.6 ml/kg/min,and102.4 ± 33.6 W. The values of the amputees has significantly lower than the abled bodies ($p<0.005$). This indicates that more comparative studies are needed to study the flexibility of transtibial prosthetic wearers.

The book "The Brockport Physical Fitness Test Manual "By Joseph (29) had shown that youngsters with amputation and youngsters without disabilities has same level of flexibility between the non amputated leg in amputee person and youngsters without disabilities.In contrast to this ,the current study showed that mean value of hamstring flexibility in control subject was higher than the non amputated leg in transtibial prosthetic wearers. According to the

statistical analysis this difference between the two groups were shown a significant relationship. (t= -3.671; df=98; p=0.000). This may be due to the fact that the present studies included persons who are age between the 23 to 73. Whereas the present study had not only youngsters but also elders.

Factors Affecting the Level of Hamstring Flexibility of the Transtibial Prosthetic Wearers

In the current study, age, educational level, sports activity, reason for amputation, post prosthetic period, timing of wear the prosthesis, participation of prosthetic rehabilitation programme and duration of participation of prosthetic rehabilitation programme were the factors, which were assessed for its association with hamstring flexibility.

Of these factors, a higher proportion of transtibial prosthetic wearers below 50 years of age had above average hamstring flexibility. In present study, being younger was found to be significantly associated with above average hamstring flexibility. The literature to date does not conclusively support this result in transtibial prosthetic wearers. As indicated earlier, physical fitness is highly important of mobility in lower limb amputees (7) and flexibility is recognized as an important component of physical fitness. Thus, flexibility may directly or indirectly affect mobility in transtibial prosthetic wearers.

Both the present age of patient and the age at amputation were not found to be factors associated with the outcome of success in rehabilitation among the amputee in the study conducted by Chan et al in the Department of Geriatrics Medicine, Tan Tock Seng Hospital, Singapore (51) but mobility rates of these amputees after one year of prosthetic fitting had worsened with increasing age at amputation in the study conducted by Davies et al in Northern General Hospital, Sheffield, England (45).

In present study, participation of prosthetic rehabilitation programme was found to be significantly associated with having an above average hamstring flexibility. The literature to date does not conclusively support this result in transtibial prosthetic wearers.

In present study, educational level, sports activity, reason for amputation, post prosthetic period, timing of wear the prosthesis and duration of participation of prosthetic rehabilitation programme were not found to be significantly associated with a having an above average hamstring flexibility. Even this result is not conclusively supported by the literature on studies among transtibial prosthetic wearers.

The study to compare the lower body flexibility, strength and knee stability between 9 karate athletes and 15 non-athletes. Results indicated that this group of karate athletes demonstrated significantly greater hamstring flexibility (39). In contrast to this, current study indicated that participating in sports activity was not associated with a having a above average hamstring flexibility. However, it should be noted that the current study included transtibial prosthetic wearers and only few of them (n=3) are participated in sports activity. Thus, it can be reason for contrast results of two studies.

The study conducted by Johnson et al in United States Of America (46) comparing pre and post amputations mobility and the influence of age and associated medical problems among 120 male patients who undergone unilateral transtibial amputations. They found that, either cardiac disease or diabetes mellitus lowered post amputation mobility score and peripheral vascular disease lowered pre amputation mobility score. However, they also found that cause of amputation did not influence the mobility scores. Physically active people were found to have better flexibility than those who are not (34). As indicated earlier, mobility may directly or indirectly affect the flexibility in transtibial prosthetic wearers. In current study also, the cause of amputation was not found to be significantly associated with a having an above average hamstring flexibility.

Miller et al (35) reported that those who underwent lower limb amputation long before reported relatively higher level of balance confidence. In contrast to this, in current study, post prosthetic period was not found to be significantly associated with hamstring flexibility. This may be due to the fact that varies with age at amputation, education level, included were not only youngsters but also elders and paricipation of rehabilitation programme. More investigations are clearly needed on this aspect in the future studies.

CONCLUSIONS

- Hamstring flexibility of transtibial prosthetic wearers is lower than non-amputees.
- Age below fifty and Prosthetic rehabilitation programme was associated with better hamstring flexibility among transtibial prosthetic wearers.
- Educational level, engaging in sports activity, reason for amputation, post prosthetic period, timing of wear the prosthesis and duration of participation of prosthetic rehabilitation programme were not found to be associated with an above average hamstring flexibility.

RECOMMANDATIONS

- Prosthetic rehabilitation programme is recommended to all transtibial prosthetic wearers to improve hamstring flexibility.
- More extensive studies to assess hamstring flexibility among transtibial prosthetic wearers are recommended to fully understand the issues among transtibial prosthetic wearers.
- As study setting and the sample size is limited in the current study, it is highly recommended to conduct a similar study among a large population of transtibial prosthetic wearers in Sri Lanka.
- More extensive studies to need for increasing the validity of back saver sit and reach test among the transtibial prosthetic wearers.

LIMITATIONS

Compared with other studies sample size of this study was small and contains only male subjects within the particular age group. Another limitation was the selection of study population. The study sample was selected only from one setting. Thus, the finding results may not representative the entire transtibial prosthetic wearers and control subject. Current study did not include an assessment of different type of prosthetic device, which is affecting the mobility of the amputees. Thus, this may directly or indirectly affect flexibility in transtibial prosthetic wearers.

ACKNOWLEDGEMENT

My sincere heartfelt gratitude goes out to all the participants who participated in this research, without them this dissertation would not have been a reality.

I am also grateful to my supervisor Dr.(Mrs.) N.S. Gunawardene for her great support during the study. Last but not leased to my family for providing precious support during the study period.

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