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Body image perception, compliance with a prosthesis and cognitive performance in transfemoral amputees

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ABSTRACT

Objective: The aim of the study was to assess mutual associations of body image perception, compliance with the prosthesis and cognitive performance in transfemoral amputees.
Methods: Fourty transfemoral amputee (30 male and 10 female), who had a traumatic and unilateral amputation were included in this study. The mean age of the patients at the time of study was 37 ± 9.9 and the mean age at amputation was 12.6 ± 9.4 years. Patients's body image perception and compliance with the prosthesis paramaters were evaluated with Amputee Body Image Scale (ABIS) and Trinity Amputation and Prosthesis Experience Scales (TAPES). MoCA (The Montreal Cognitive Assessment) has been used to determine the cognitive ability of the participant. All tests has been administered by dual task method during ambulation. Patients who had neurologic or cognitive deficit were excluded from the study.
Results: There was a statistically significant relationship between an individual's body image perception and cognitive performance. Body image perception was significantly and negatively correlated with the MoCA score ($r = -0.514$, $p < 0.001$). There was a statistically significant positive correlation between psychosocial adjustment, prosthesis satisfaction and MoCA scores ($r = 0.550$, $p < 0.001$).
Conclusions: Body image satisfaction, psychosocial adjustment, lack of activity restriction, and satisfaction with prosthesis are positively associated with cognitive performance of transfemoral amputees. Before beginning the amputee rehabilitation programs, we recommend to include not only physical functions, but also consider body image and cognitive functions as assessment parameters.
Level of evidence: Level IV, Diagnostic Study.
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Introduction

Lower limb amputation is a traumatic and life changing surgical procedure affecting an individual's functional, psychological and social aspects.[1] The use of prosthesis following an amputation has a positive influence on an individual's psychosocial status and quality of life.[2]

Body image refers to the mental picture that a person forms of his or her body and its appearance. The body image is a reflection of prior experiences and the perception of current body diagram which is arranged in the sensory cortex of the cerebrum. Body image is affected by various factors such as optic and tactile senses, emotional experiences and the relative effects of these experiences on body image perception, the impressions of others about our physical appearance and our reactions to these impressions, and our attitudes and values regarding our own body when comparing it to others. An alteration in an individual's body image will set up a series of emotional, physiological and psychological reactions.[3]

Abbreviations: ABIS, The Amputee Body Image Scale; TAPES, The Trinity Amputation and Prosthesis Experience Scales; MoCA, The Montreal Cognitive Assessment; MMT, Mini Mental Test.

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The loss of a limb by amputation affects body image perception dramatically. As the amputation level increases the discomfort of the amputee from his/her own image increases.[4] The discomfort from body image affects negatively an amputees quality of life.[5]

Several studies have been carried out to better understand the relationship between prosthesis satisfaction and body image. The main idea focused on by these studies was that the higher levels of overall satisfaction with prosthesis were correlated with lower levels of body image disturbance.[6,7] For instance, Murray et al[6] found that proper fitting of prosthetic limbs and adequate ambulation with prosthesis will also enhance body image satisfaction. Following amputation, using a prosthesis has significant impact on mobility, participation and psychosocial well-being/adjustment. Successful prosthetic users perceive their overall well-being more positively and their quality of life increase in time.[8–10] M. Asano et al[11] surveyed people with lower limb amputations to examine predictors of quality of life among individuals. A significant correlation was found between life satisfaction and prosthetic mobility with an appropriate prosthesis.

Ambulation is defined as a well-learned activity that does not come at a high cognitive workload by healthy adults.[12] Walking with a lower limb prosthesis requires a considerable larger amount of cognitive effort and energy expenditure. Amputees are often encountered with challenging conditions while walking with a prosthesis, such as walking on uneven terrain or simultaneously engaging in a cognitively demanding task.[13] Cognitive impairment may also have a negative effect on the lives of individuals who are not fitted with a prosthesis following lower limb amputation. The findings indicate that, cognitive impairment may be an issue of some importance for persons who have lost a lower limb, with significant implications for their post-amputation functioning.[14,15]

Studies evaluating cognitive performance among prosthetic users have received little attention in the literature. Several recent studies have used a dual-task paradigm, which is very common in daily life activities.[16,17] Moreover, neuropsychological tests, the Montreal Cognitive Assessment and the Mini Mental Test are other tests which are used in some studies to evaluate cognitive performance.[18]

Numerous studies have shown that amputation due to diabetes and peripheral arterial disease affects cognitive functions more than other causes of amputation.[15,19]

Individuals with a traumatic amputation were included in this study to examine the factors objectively associated with cognitive performance. The aim of our study was to examine the association between body image perception, compliance with the prosthesis and cognitive performance in transfemoral amputees.

Material and methods

Participants

The study included 45 patients selected according to eligibility criteria who had been followed in prostetic clinics. Inclusion criteria for enrollment were ages between 18 and 50, unilateral transfemoral amputation due to trauma, a minimum of 6 months of prosthetic use and the ability to walk independently. MoCA was used in the present study to assess participants cognitive performance and to exclude participants who were not eligible to follow instructions. Five patients cognitive problem or incomplete data were excluded from the study.

This study approved by the Research Ethic Commitee and conducted in accordance with the declaration of Helsinki.

Questionnaires

The Amputee Evaluation Survey was prepared for this study. Participants were asked to complete demographical and clinical questions which were similar in other studies in the literature. The survey included questions about demographics, prosthesis use, amputation and stump information.

The Trinity Amputation and Prosthesis Experience Scales (TAPES) were used to assess adjustment to amputation. The TAPES consists of three sections relating to psychosocial adjustment, activity restriction and satisfaction with the prosthesis.[20] The psychosocial adjustment section contains three subscales measuring general adjustment, social adjustment and adjustment to limitations. It contains 15 items in total, each of which is rated on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores are indicative of greater levels of adjustment. The activity restriction section comprises of the following three subscales: functional activity restriction, social activity restriction and athletic activity restriction. The 12 items in this section are rated on a 3-point scale (limited a lot, limited a little, not limited at all). Higher scores are related with greater limitation. Satisfaction with the prosthesis is measured using three subscales. The Functional Satisfaction subscale assesses the extent of satisfaction associated with the following functional characteristics of the artificial limb: 'reliability', 'comfort', 'fit', and 'overall satisfaction'. Aesthetic Satisfaction reflects contentment with cosmetic characteristics such as 'shape', 'colour' and 'noise', while the final subscale Weight Satisfaction is a single item measure assessing satisfaction with the weight of the prosthesis. Items are rated on a 5-point scale ranging from 'very dissatisfied' (1) to 'very satisfied' (5). Higher scores indicate greater Prosthesis Satisfaction. The final section of the TAPES includes an assessment of other medical problems and phantom and residual limb pain experience.

The Amputee Body Image Scale (ABIS) is a 20-item measuring tool developed to evaluate body image disturbances among the amputee population.[3] The subjects answered questions about their perceptions and feelings on a 5-point Likert scale. Three of these questions are reversed-scored. The score ranges from 20 to 100. High scores indicate a disturbance of body image.

The Montreal Cognitive Assessment (MoCA) is a rapid screening test designed to assess cognitive ability. MoCA is a one-page 30-point test administered in 10 minutes.[21] Details on the specific MoCA items are as follows: Attention and concentration, executive functions, working memory, language, visuoconstructional skills, conceptual thinking, calculation and orientation. 21 points and above are considered as normal cognitive functions.

Neuropsychological subtests (serial subtraction test, verbal phonetic fluency test, and semantic verbal fluency test) were assessed during a 5 min time frame in addition to the walking task in this study. Neuropsychological subtests were selected because these would reflect realistically day-to-day tasks. The serial subtraction test was used to evaluate the working memory. The verbal phonetic fluency test refers to creating a strategy in which a person speaks vocabulary and searches for vocabulary. The semantic verbal fluency test (category test) evaluates the organization of the vocabulary. The Category Test requires participants to list as many words as they can think of belonging to a certain category within 1 minute. The cognitive assessment protocol comprised of 5 1-minute tests. The cognitive tasks required during the walking motor task included: 1) Subtract 7 from 100 for 1 minute (serial 7 subtraction), 2) Count objects starting with the letter "K" for 1 minute, 3) Count objects starting with the letter "S" for 1 minute, 4) Count objects starting with

the letter "B" for 1 minute, and 5) Count ''things that you could buy in a supermarket'' for 1 minute.

Points considered during the assessments are as follows; all the assessments were done by the same physiotherapist, participants completed a couple of trials before starting the neuropsychological subtests, and before each test started participants took a 2 min break.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 21 for Windows. Spearman correlation coefficient was used to assess relationship between quantitative variables. Statistical significance was set at $p < 0.05$; no corrections for multiple testing were performed.

Results

The demographic characteristics are shown in Table 1.

Table 2 shows ABIS, TAPES and cognitive performance scores of the subjects participating in the study. The correct numbers recorded during serial subtraction test. Verbal fluency test and category test scores express words counted during tests.

Body image perception and compliance with the prosthesis were examined separately. There was a statistically significant relationship between an individual's body image perception and cognitive performance (Table 3). Body image perception was significantly and negatively correlated with the MoCA score ($r = -0.514$, $p < 0.001$). Compliance with the prosthesis was evaluated by TAPES. There was a statistically significant positive correlation between psychosocial adjustment, prosthesis satisfaction and MoCA scores ($r = 0.550$, $p < 0.001$). There was a moderately statistically significantly and negative correlation between activity restriction and MoCA scores ($r = -0.512$, $p < 0.001$). Similarly, serial subtraction test scores and psychosocial adjustment, activity restriction, and prosthesis satisfaction scores were statistically significant respectively at a weak level ($r = 0.323$, $r = -0.378$, $r = 0.241$, $p < 0.05$). Moreover, there was a significant relationship between the semantic verbal fluency, category test and TAPES part I ($p < 0.05$) (Table 4).

Table 1
Study cohort characteristics.

Total patients included		
Male		30
Female		10
Age (years)		
Mean		37
SD		9.9
Range		18–50
BMI (kg/m^2)		
Mean		25
SD		3.4
Range		18.8–31.6
Time since amputation (years)		
Mean		12.7
SD		9.4
Range		1–36
Time spent with prosthesis within day (hours)		
Mean		11.4
SD		2.8
Range		5–18
Amputation etiology (# of patients)		
Traffic accident	25	
Industrial accident		9
Gunshot injuries	6	

Abbreviations: SD, Standard deviation; BMI, Body Mass Index.

Table 2
Study cohort ABIS, TAPES and cognitive performance scores (n = 40).

Assessments parameters	Mean (SD)	Min.	Max.
ABIS	50.6 (16.6)	28	81
TAPES			
Psychosocial adjustment	54.7 (12.7)	35	73
Activity restriction	20.4 (3.7)	14	28
Prosthesis satisfaction	35.5 (7.3)	23	46
Cognitive Performance			
MoCA	25.3 (3.0)	18	29
Serial subtraction[a]	5.8 (3.7)	1	14
Verbal fluency test			
K[b]	10 (3.2)	5	17
S[b]	9.2 (3.3)	4	15
B[b]	9.5 (3.4)	4	15
Category test[c]	11 (3.3)	6	18

Abbreviations: ABIS, The Amputee Body Image Scale; TAPES, The Trinity Amputation and Prosthesis Experience Scales; MoCA, The Montreal Cognitive Assessment.
[a] Mean correct number during 7 subtraction test.
[b] Mean number of words identified across verbal fluency test.
[c] Mean number of words identified within a category test in 1 minute.

Table 3
The relationship between ABIS and cognitive performance scores.

	ABIS	
	r	p-value
MoCA	−0.514	0.000*
Serial subtraction test	−0.367	0.002*
Verbal fluency test		
K	−0.487	0.000*
S	−0.454	0.000*
B	−0.424	0.000*
Category test	−0.471	0.000*

All data are expressed by p value. *p < 0.05.
Abbreviations: MoCA, The Montreal Cognitive Assessment; ABIS, The Amputee Body Image Scale.

Discussion

The objective of this study was to determine the effects of body image perception and compliance with a prosthesis on cognitive performance in transfemoral amputees. The results of this study

Table 4
The relationship between TAPES and cognitive performance.

TAPES	n = 40	
	r	p-value
Psychosocial adjustment- MoCA	0.550	0.000*
serial subtraction test	0.323	0.005*
verbal fluency test		
K	0.401	0.001*
S	0.346	0.003*
B	0.341	0.003*
category test	0.288	0.013*
Activity restriction- MoCA	−0.512	0.000*
serial subtraction test	−0.378	0.001*
verbal fluency test		
K	−0.401	0.001*
S	−0.356	0.003*
B	−0.381	0.001*
category test	−0.481	0.000*
Prosthesis satisfaction- MoCA	0.550	0.000*
serial subtraction test	0.241	0.042*
verbal fluency test		
K	0.389	0.001*
S	0.365	0.002*
B	0.441	0.000*
category test	0.332	0.005*

The relationship between TAPES and cognitive performance.
All data are expressed by p value. *p < 0.05.

confirm our hypothesis that body image satisfaction and positive compliance with the prosthesis were associated with increased cognitive performance.

Studies in the amputee population more frequently focus on the rehabilitation process, such as age, amputation level, other accompanying chronic diseases, and physical factors affecting prosthetic compliance.[22,23] Amputation surgery affects the individual not only physically but also emotionally and socially. Therefore, in the last years, studies evaluating body image, depression, stress and cognitive functions have gained importance for amputees. Good emotional state positive effects of prosthesis compliance. Numerous studies have shown that amputation due to diabetes and peripheral arterial disease affects cognitive functions more than other causes of amputation.[15,19] For this reason, patients with amputation after traumatic or gun shot injury included in the study. Our study is important from the viewpoint of determining the relationship of body image satisfaction and compliance with a prosthesis with cognitive performance which could be essential for daily life activities.

Neuropsychological tests, SMMT and MoCA are frequently used in studies when evaluating the cognitive performance in the amputee population.[24–26] MoCA was preferred in this study because of its sensitivity when compared to the other brief cognitive assessment scales. Neuropsychological subtests were used during ambulation in our study due to these tests reflect the situations amputees may encounter in daily life activities.

In the literature, there have been few studies examining the relationship between body image perception and cognitive performance in amputees, and cognitive performance has been assessed mostly to predict prosthesis use and ambulatory capacity.[27–30] In this study, the significant relationship between body image perception and cognitive performance highlights the idea that increased satisfaction with physical appearance in the amputees decrease the affects of the negative outcomes related with depression, stress, social isolation, sleep and pain problems. It has also been concluded that an individual's self-esteem may be affected in purposeful use of cognitive functions by enhancing the orientation to the environment during daily life activities.

TAPES, comprises two domains. The first consists of the subdomains psychosocial adjustment, activity restriction and prosthesis satisfaction. The second domains of TAPES include questions regarding phantom pain.[20] Our cases did not have problems with pain due to phantom pain decreased with time after amputation.

Pinzur et al[26] investigated 60 amputees with lower extremity amputation with neuropsychological subtests and reported that attention, memory, organizational skills were related to prosthesis use and compliance with the prosthesis. In parallel with these findings, we found that there was a significant relation between psychosocial adjustment, prosthetic satisfaction scores and cognitive performance.

The findings of the current study highlight that body image satisfaction, psychosocial adjustment, activity restriction, and satisfaction with prosthesis have a positive influence on cognitive performance. Daily life activities, donning/doffing of the prosthesis, prosthetic use and maintenance require not only the physical competence, but also cognitive functions. Cognitive assessment and training programs should be included in amputee rehabilitation programs as a large part of the activities of daily living are accompanied by multiple tasks. Moreover it should not be overlooked that body image perception and prosthetic compliance may affect cognitive performance in amputees. We think that, in addition to functional features, designs that can facilitate psychosocial adjustment need to be taken into consideration in developing prosthesis technology. Our aim with this study was to increase the awareness in the amputee rehabilitation programs in the future to include information and education in these areas, as well as studies evaluating the physical capacity of the amputees, and evaluating cognitive performance and related factors.

Study limitations

The major limitation of this study was that we did not have any information about the pre-amputation cognitive performance levels of the individuals included in the study. Only assessment of cognitive performance level before and after amputation surgery would have enabled us to draw causal conclusions about the effects of body perception and compliance with a prosthesis. Additionally, our sample only included individuals with transfemoral amputation, so all our findings are restricted to this group.

Conclusion

In our study, body image perception and prosthesis adaptation correlated with cognitive performance of transfemoral amputees. Before beginning the amputee rehabilitation programs, we recommend to include not only physical functions, but also consider body image and cognitive functions as assessment parameters. In addition to improving physical functions, body awareness, psychosocial adjustment and cognitive rehabilitation programs may support the amputee's re-participation back to life and compliance with the prosthesis.

Conflicts of interest

None of the authors have relevant conflicts of interest to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.aott.2019.03.014.

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