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Evaluation of functionality in acquired and congenital upper extremity child amputees

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Objective: The aim of this study was to evaluate the functional level of children with congenital and acquired upper limb loss after a rehabilitation program.

Methods: This study included a total of 40 children, aged 8 to 17 years with upper limb loss. Children were divided into two groups; congenital amputees (n=20) and acquired amputees (n=20). The children underwent prosthetic fitting, prosthetic training and rehabilitation. The Child Amputee Prosthetics Project - Functional Status Inventory (CAPP-FSI) and Prosthetic Upper Extremity Functional Index (PUFI) were used at the initial visit to the prosthetic unit without prosthesis, 3 weeks after the prosthetic training and 6 months after discharge with and without prosthesis. The results with and without the prosthesis were compared between the acquired and congenital amputee groups.

Results: There were significant differences in all tests performed at the baseline, at the 3rd week, and at the 6th month without prosthesis and at the 3rd week and at the 6th month with prosthesis ($p<0.05$). The congenital group received higher scores in the CAPP-FSI and PUFI at the baseline, at the 3rd week and at the 6th month ($p<0.05$). Patients in the congenital group used their prostheses for 8 hours a day and the acquired group for 4 to 8 hours.

Conclusion: Daily prosthesis usage time and the child's experience with the prosthesis during daily activities are the determining factors for the functional level in upper limb child amputees. Functionality may improve based on these factors.

Key words: Child amputees; functional tests; rehabilitation; upper extremity amputation.

A child amputee is defined as an individual with skeletal development insufficiency despite open epiphyses or who underwent amputation for any reason.[1,2]

Rehabilitation is related to many factors in congenital or acquired child amputees. The child should be evaluated according to amputation levels and enrolled in rehabilitation programs according to functional loss and a decision of prosthetic fitting should be made.[1-3]

Prosthetics are fitted in pediatric upper limb loss to obtain a regular and symmetrical posture, to stimulate bilateral and bimanual functions, to enable the child and the family to adopt the prosthesis in terms of function and appearance and to reduce or abolish dependence of the child to their environment.[1-3]

Knowing the type and level of physical disorder that may affect independence and the determination of functional level are of importance for child amputees to achieve functional activities. Prosthetic use, prosthetic fitting and comfort are also important in determining functional level. Additionally, prosthesis type

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and length of prosthetic use are factors for objective evaluation of functional level. Activities that evaluate functional level which should be appropriate for the developmental status of the child are other contributing parameters. Rehabilitation success depends on the correct detection of the child's needs, assessment of his/her skills and development of his/her potential.[1,2,4,5]

This aim of this study was to determine functional levels of congenital and acquired child amputees following a rehabilitation program. We hypothesized that functional difference between congenital and acquired upper limb amputees exists during a 3-week training period and at 6 months following discharge.

Patients and methods

This study included a total of 40 child amputees equally divided into two groups; congenital amputees and acquired amputees. All children were upper limb amputees aged between 8 and 17 years who were admitted to our unit for prosthesis for the first time and who participated voluntarily after signing an informed consent form. Inclusion criteria were patients with no systemic diseases, a mean muscle power of 4, no open wounds at the amputated and intact limb, no postural disorders that may affect prosthetic use, and congenital cases that did not undergo a surgical revision. Congenital amputees had transverse limb losses of which 10 were below-elbow and 10 above-elbow. Cases were enrolled in our study in the preprosthetic period. The decision for prosthesis was made following a comprehensive assessment and patients were enrolled in a physiotherapy and rehabilitation program for 3 weeks along with the prosthetic fitting. The study was conducted at Hacettepe University, Department of Physiotherapy and Rehabilitation, after approval was obtained from the Ethics Committee of Non-Invasive Clinical Research of the same institution.

Patients were given strengthening exercises for stump and intact limb muscles, stretching and strengthening exercises for the shoulder and scapular muscles, strengthening exercises for abdominal and back muscles and posture training as part of physiotherapy program. Exercises were applied twice a day with 15 repetitions.

Self-care activities, eating activities, desk activities, household activities, fine motor skills and general activities were included in prosthetic training. Training for putting on and taking off the prosthesis and prosthesis/stump hygiene was also given.

Functional assessments were made using the Child Amputee Prosthetic Project - Functional Status Inventory (CAPP-FSI) and the Prosthetic Upper Extremity Functional Index (PUFI) three times; at a baseline when admitted to our unit, following the 3-week period of prosthetic training and at a 6-month follow-up. First assessments were made without prosthesis and second and third assessments were made with and without prosthesis.

The CAPP-FSI is a valid and reliable test applied to child amputees between 8 and 17 years. It includes 34 items about daily living activities, self-care activities and activities consistent with developmental status of upper limb amputees and 6 items for lower limb activities.[5] Only the items on activities of upper limb amputees were evaluated in our study. The child was evaluated with and without the prosthesis. Each activity is scored on ability to perform the action (0: never, 1: rarely, 2: sometimes, 3: often, 4: always).

The PUFI compares the child's functional performance with or without prosthesis and evaluates the usefulness of the prosthesis in daily living activities. It includes 26 upper limb items for little children (3-6 years) and 38 items for older children (7 years and above). Fourteen activities are similar in both versions with more simple variations (e.g., using bigger blocks) for little children. Both versions of the PUFI have the same structure and scoring. This test can also be used with older patients.[6] Each item was scored in terms of ability (0: cannot do with prosthesis, 1: can do with the aid of someone else, 2: can do with great difficulty, 3: can do with mild difficulty, 4: can do without difficulty) and recorded.

A short questionnaire form as used to determine how frequently/how long the subjects use prostheses during the day.[7]

In addition to physical properties, type and level of limb loss, cause and date of amputation were also recorded.

Data were expressed as mean ± standard deviation (X±SD) and number (percent) (n [%]). In-group comparisons with and without prosthesis were analyzed using the Wilcoxon rank test. The Mann-Whitney U test was used for the comparison of inter-group data. P values less than 0.05 were considered statistically significant.

Results

A total of 40 cases (19 boys, 21 girls) in two groups, congenital and acquired amputees (20 patients each, 10 below-elbow and 10 above-elbow amputations), participated in our study. There was no significant difference

between the groups in terms of physical characteristics (p>0.05) (Table 1).

Cases in the acquired group amputated due to trauma who did not receive a preoperative and postoperative physiotherapy program joined the study at an average of 3.25±1.77 months following amputation (Table 1).

Significant differences were detected in favor of 3rd week values when compared to the baseline assessments without prosthesis for both the CAPP-FSI and PUFI tests were compared (p<0.05) (Table 2). Similarly, assessment results at 6th month were higher than the baseline values for cases without prosthesis (p<0.05) (Table 3).

Sixth month CAPP-FSI and PUFI tests scores were significantly different than those taken the 3rd week without prosthesis (p<0.05). CAPP-FSI and PUFI test scores with prosthesis significantly increased at the end of the 6th month compared to those of the 3rd week assessments (p<0.05) (Table 4).

The congenital group had higher CAPP-FSI and PUFI tests scores than the acquired group with and without prosthesis at the baseline, 3rd week and 6th month (p<0.05) (Table 5). When assessment results of CAPP-FSI and PUFI tests with and without prosthesis at the 3rd week and 6th month were compared between acquired and congenital groups, significant differences in favor of assessment without prosthesis were detected in both tests (p<0.05) (Table 6).

The majority of both acquired (55%) and congenital (70%) group cases used their prosthesis at school, in the community and functionally but not at home (Table 7).

Table 1. Distribution of characteristics of cases according to groups.

	Acquired group (n=20)	Congenital group (n=20)	Mann-Whitney U	
Characteristics	**X±SD**	**X±SD**	**T**	**p**
Age (year)	12.70±3.03	12.40±3.05	0.31	0.76
Height (cm)	158.15±13.00	154.30±13.23	0.93	0.36
Weight (kg)	56.65±13.33	49.25±13.33	1.76	0.09
Time from amputation (month)	3.25±1.77	12.40±3.05	-11.60	0.00*

*p<0.05

Discussion

This study was conducted to determine the effect on functional levels of children with acquired or congenital upper limb loss. Functionality was determined to improve in upper limb child amputees depending on time of prosthetic use, supporting our hypothesis.

Recent studies carried out with amputees using prosthesis have focused on functional status. Determining functional level is of great importance in amputees of all ages. A variety of questionnaires, scales and tests have been developed to determine this level.[8-18]

In our study, we used the upper extremity-specific form of the CAPP-FSI questionnaire prepared for children aged 8 to 17 years. Pruitt et al.[19] developed three different forms of the same questionnaire for different age groups; 1 to 4 years, 4 to 17 years and 8 to 17 years. They emphasized that activity level increased with age and reported the questionnaire to be appropriate, valid and reliable for child amputees in their age group.

Significant differences were found between the assessments at the baseline, 3rd week and 6th month without prosthesis in both the congenital and acquired groups and between the assessments at the 3rd week and 6th month with prosthesis. This is believed to be the result of the positive effect of prosthetic use and rehabilitation program on amputees. Additionally, congenital group scores without prosthesis at the baseline, following 3 weeks of training program and after 6

Table 2. Comparison of results of CAPP-FSI and PUFI tests at baseline without prosthesis and at the 3rd week in congenital and acquired groups (n=20).

		Assessment at baseline	Assessment at Week 3	Wilcoxon rank test	
		X±SD	**X±SD**	**z**	**p**
Acquired	CAPP-FSI (0-136)	92.00±9.46	94.00±9.03	-9.75	0.00*
	PUFI (0-152)	76.90±7.93	78.80±8.08	-11.83	0.00*
Congenital	CAPP-FSI (0-136)	111.55±6.41	113.90±6.41	-14.10	0.00*
	PUFI (0-152)	91.65±8.24	93.90±8.33	-18.29	0.00*

*p<0.05

Table 3. Comparison of results of CAPP-FSI and PUFI tests at baseline without prosthesis and at the 6th month in congenital and acquired groups (n=20).

		Assessment at baseline	Assessment at Month 6	Wilcoxon rank test	
		X±SD	X±SD	z	p
Acquired	CAPP-FSI (0-136)	92.00±9.46	95.15±9.06	-10.76	0.00*
	PUFI (0-152)	76.90±7.93	80.05±8.41	-10.16	0.00*
Congenital	CAPP-FSI (0-136)	111.55±6.41	114.90±7.18	-5.90	0.00*
	PUFI (0-152)	91.65±8.24	95.15±8.10	-16.55	0.00*

*p<0.05

months were better than those of acquired group; in other words they were found to do most activities without prosthesis. The highest score without prosthesis was obtained at the end of the 6th month in congenital amputees. While all activities were completed without prosthesis, the ratio of patients doing the activities with prosthesis increased in later assessments due to the increase in prosthetic use.

The congenital group had higher scores than the acquired group also in the assessments done with prosthesis at the 3rd week and 6th month. Patients in the congenital group had higher scores at the first assessment because of their experience doing these activities without. The acquired group lost the ability to do these activities after amputation although they regained the ability to perform them following prosthetic rehabilitation. The improvement in the scores with prosthesis of all cases at the sixth month indicates that functional levels improved as the result of training and patients become functionally independent individuals through active prosthetic use in social life regardless of the level and the cause of amputation. This result is consistent with studies reporting that upper limb amputees require prostheses to perform activities and that CAPP-FSI scores improve with increased duration of prosthetic use.[19-22]

Similar to a study by Pruitt et al.,[21] scores without prosthesis were 1.5-fold higher than scores with prosthesis in both the acquired and congenital groups. Specific adaptations made by patients to for their daily lives and activities have led to high scores at assessment done without prosthesis. This result supports those of Buffart et al.[8] who evaluated functionality in children with and without prostheses using the CAPP-FSI and PUFI tests and reported that results were better without prostheses.

In our study, scores without prosthesis were better between the assessments at baseline, 3rd week and 6th month in congenital and acquired group and assessments at 3rd week and 6th month with prosthesis in both groups. Tactile sensation, coordinated motions of the hand, proprioceptive feedback and esthetic appearance are affected negatively after upper limb amputations; and these functions may be performed in a cer-

Table 4. Comparison of results of CAPP-FSI and PUFI tests at the 3rd week and 6th month in congenital and acquired groups with and without prosthesis (n=20).

			Assessment at Week 3	Assessment at Month 6	Wilcoxon rank test	
			X±SD	X±SD	z	p
Without prosthesis	**Acquired**	CAPP-FSI (0-136)	94.00±9.03	95.15±9.06	-5.20	0.00*
		PUFI (0-152)	78.80±8.08	80.05±8.41	-5.23	0.00*
	Congenital	CAPP-FSI (0-136)	113.90±6.41	114.90±7.18	-2.06	0.04*
		PUFI (0-152)	93.90±8.33	95.15±8.10	-7.11	0.00*
With prosthesis	**Acquired**	CAPP-FSI (0-136)	50.35±6.26	60.15±7.02	-13.14	0.00*
		PUFI (0-152)	56.55±4.72	64.90±4.88	-25.56	0.00*
	Congenital	CAPP-FSI (0-136)	65.65±5.91	75.45±5.75	-21.20	0.00*
		PUFI (0-152)	65.80±5.14	75.05±6.17	-23.32	0.00*

*p<0.05

Table 5. Intergroup comparison of CAPP-FSI and PUFI functional assessments at baseline, after 3 weeks of training and 6 months later (n=20).

	Acquired group	Congenital group	Mann-Whitney U	
CAPP-FSI	**X±SD**	**X±SD**	**z**	**p**
Assessment at baseline without prosthesis	92.00±9.46	111.55±6.41	-7.65	0.00*
3rd week assessment without prosthesis	94.00±9.03	113.9±6.41	-8.04	0.00*
3rd week assessment with prosthesis	50.35±6.26	65.65±5.91	-7.95	0.00*
6th month assessment without prosthesis	95.15±9.06	114.9±7.18	-7.64	0.00*
6th month assessment with prosthesis	60.15±7.02	75.45±5.75	-7.54	0.00*
PUFI	**X±SD**	**X±SD**	**z**	**p**
Assessment at baseline without prosthesis	76.90±7.93	91.65±8.24	-5.77	0.00*
3rd week assessment without prosthesis	78.80±8.08	93.90±8.33	-5.82	0.00*
3rd week assessment with prosthesis	56.55±4.72	65.80±5.14	-5.93	0.00*
6th month assessment without prosthesis	80.05±8.41	95.15±8.10	-5.78	0.00*
6th month assessment with prosthesis	64.90±4.88	75.05±6.17	-5.77	0.00*

*p<0.05

tain ratio with the use of a prosthesis. Unilateral upper limb amputees tend to use their intact limb. However, they preferred to use their prosthesis to both aid and support the intact limb after they began its use.

PUFI results were higher at the 6th month both with and without prosthesis in the congenital group than the acquired group. Children in the congenital group were able to complete all activities of daily life and motor skills from birth although prosthesis became necessary at adolescence due to esthetic concerns, various recreational activities, sports and participating in work-life. Child amputees are generally kept in the home, thus the child may remain without a prosthesis until they become conscious of the option.[1,2] The development of a lifestyle and compensation mechanisms towards activities explains the high scores obtained in the congenital group with and without prosthesis. The acquired group's lower scores arose from the embitterment due to the experienced trauma, dependence on parents and inability to regain functional levels and motor skills. Cases in the acquired group consequently became motivated through regaining functionality and ability to maintain daily activities during prosthetic training. These regained skills were apparent at the 3rd week and 6th month.

When the frequency of prosthetic use was analyzed, all cases were seen to prefer to use their prostheses at school and in their social life rather than at home. Child amputees also verbally stated that they felt better with prosthesis and did not feel esthetic concerns. Studies

Table 6. Comparison of results of assessments at the 3rd week and 6th month with and without prosthesis in acquired and congenital groups.

			With prosthesis (n=20)	Without prosthesis (n=20)	Wilcoxon rank test	
			X±SD	**X±SD**	**z**	**p**
3rd week	**Acquired**	CAPP-FSI	50.35±6.26	94.00±9.03	-3.93	0.00*
		PUFI	56.55±4.72	78.80±8.08	-3.92	0.00*
	Congenital	CAPP-FSI	65.65±5.91	113.90±6.40	-3.93	0.00*
		PUFI	65.80±5.14	93.90±8.33	-3.92	0.00*
6th month	**Acquired**	CAPP-FSI	60.15±7.02	95.15±9.06	-3.98	0.00*
		PUFI	64.90±4.88	80.05±8.41	-3.93	0.00*
	Congenital	CAPP-FSI	75.45±5.75	114.90±7.18	-3.93	0.00*
		PUFI	75.05±6.17	95.15±8.10	-3.93	0.00*

*p<0.05

Table 7. Distribution of cases according to the frequency of prosthesis use.

		Acquired group (n=20)	Congenital group (n=20)
		n (%)	n (%)
At home	Never	11 (55)	14 (70)
	Sometimes	6 (30)	6 (30)
	Always	3 (15)	0 (0)
At school	Never	0 (0)	0 (0)
	Sometimes	12 (60)	13 (65)
	Always	8 (40)	7 (35)
At social environment	Never	0 (0)	0 (0)
	Sometimes	11 (55)	11 (55)
	Always	9 (45)	9 (45)
Functional	Never	3 (15)	0 (0)
	Sometimes	12 (60)	14 (70)
	Always	5 (25)	6 (30)
Daily prosthesis use	0-4 hours	0 (0)	1 (5)
	4-8 hours	11 (55)	9 (45)
	Longer than 8 hours	9 (45)	10 (50)

emphasize that an increase in prosthetic use is a frequent indicator of the adaptation to the prosthesis.[18,22] We found that approximately 50% of cases used their prostheses for longer than 8 hours, which is supported in the literature.

A limitation to our study was the small number of cases. However, in our experience this is mainly due to social constraints. In our country, the number of prosthetic fittings and rehabilitation is greater in lower limb amputations to overcome motor function loss than upper limb amputations which require prostheses to school, work, status change or marriage. In addition, upper limb amputees are often hidden by their families.

Although studies on amputees are increasing, more focus on amputees of the lower limb than the upper limb in our country. The analysis of the long-term effects of the level of amputation on functional results is a future prospect for research. The literature mainly focuses on innovations in upper limb prostheses, the feasibility of participating in sports and recreational activities using these prostheses and the frequency of prosthesis use in upper limb amputees. Our study, however, is unique as it investigates the effectiveness of rehabilitation programs.

In conclusion, the detailed evaluation and comparison of activities that can be performed with and without prosthesis is necessary to determine functional limitations in children with upper limb loss. Daily prosthesis usage time and the child's experience with the prosthesis during daily activities are the determining factors for the functional level in upper limb child amputees. Functionality may improve based on these factors.

Conflicts of Interest: No conflicts declared.

References

1. Sener G, Yigiter KB, Erbahçeci F. Prosthetic fitting and rehabilitation principles for children with congenital and acquired limb loss. [Article in Turkish] Turkiye Klinikleri J PM&R-Special Topics 2010;3:79-85.
2. Ülger Ö, Topuz S, Bayramlar K, Sener G. Determining the functional state in acquired and congenital child amputees. [Article in Turkish] Fizyoterapi Rehabilitasyon 2007;18:187-93.
3. Jain S. Rehabilitation in limb deficiency. 2. The pediatric amputee. Arch Phys Med Rehabil 1996;77:S9-13.
4. Wright FV, Hubbard S, Naumann S, Jutai J. Evaluation of the validity of the prosthetic upper extremity functional index for children. Arch Phys Med Rehabil 2003;84;518-27.
5. Pruitt SD, Varni JW, Setoguchi Y. Functional status in children with limb deficiency: development and initial validation of an outcome measure. Arch Phys Med Rehabil 1996;77;1233-8.
6. Pruitt SD, Varni JW, Seid M, Setoguchi Y. Prosthesis satisfaction outcome measurement in pediatric limb deficiency. Arch Phys Med Rehabil 1997;78:750-4.
7. Scotland TR, Galway HR. A long-term review of children with congenital and acquired upper limb deficiency. J Bone Joint Surg Br 1983;65:346-9.
8. Buffart LM, Roebroeck ME, Heijningen VG, Pesch-Batenburg JM, Stam HJ. Evaluation of arm and prosthetic functioning in children with a congenital transverse reduction deficiency of the upper limb. J Rehabil Med 2007;39:379-86.

9. Legro MW, Reiber GE, Czerniecki JM, Sangeorzan BJ. Recreational activities of lower-limb amputees with prostheses. J Rehabil Res Dev 2001;38:319-25.
10. Miller WC, Deathe AB, Speechley M. Lower extremity prosthetic mobility: a comparison of 3 self-report scales. Arch Phys Med Rehabil 2001;82:1432-40.
11. Treweek SP, Condie ME. Three measures of functional outcome for lower limb amputees: a retrospective review. Prosthet Orthot Int 1998;22:178-85.
12. Leung EC, Rush PJ, Devlin M. Predicting prosthetic rehabilitation outcome in lower limb amputee patients with the functional independence measure. Arch Phys Med Rehabil 1996;77:605-8.
13. Tinetti ME. Performance-oriented assessment of mobility problems in elderly patients. J Am Geriatr Soc 1986;34:119-26.
14. Studenski S, Duncan PW, Chandler J, Samsa G, Prescott B, Hogue C, et al. Predicting falls: the role of mobility and nonphysical factors. J Am Geriatr Soc 1994;42:297-302.
15. Muecke L, Shekar S, Dwyer D, Israel E, Flynn JP. Functional screening of lower-limb amputees: a role in predicting rehabilitation outcome? Arch Phys Med Rehabil 1992;73:851-8.
16. Gailey RS, Roach KE, Applegate EB, Cho B, Cunniffe B, Licht S, et al. The amputee mobility predictor: an instrument to assess determinants of the lower-limb amputee's ability to ambulate. Arch Phys Med Rehabil 2002;83:613-27.
17. Schmidt LJ, Garratt AM, Fitzpatrick R. Child/parent-assessed population health outcome measures: a structured review. Child Care Health Dev 2002;28:227-37.
18. Huizing K, Reinders-Messelink H, Maathuis C, Hadders-Algra M, van der Sluis CK. Age at first prosthetic fitting and later functional outcome in children and young adults with unilateral congenital below-elbow deficiency: a cross-sectional study. Prosthet Orthot Int 2010;34:166-74.
19. Pruitt SD, Seid M, Varni JW, Setoguchi Y. Toddlers with limb deficiency: conceptual basis and initial application of a functional status outcome measure. Am J Phys Med Rehabil 1999;80:819-24.
20. Mayfield JA, Reiber GE, Maynard C, Czerniecki JM, Caps MT, Sangeorzan BJ. Trends in lower limb amputation in the Veterans Health Administration, 1989-1998. J Rehabil Res Dev 2000;37:23-30.
21. Pruitt SD, Varni JW, Seid M, Setoguchi Y. Functional status in limb deficiency: development of an outcome measure for preschool children. Arch Phys Med Rehabil 1998;79:405-11.
22. Varni JW, Setoguchi Y. Self-perceived physical appearance in children and adolescents with congenital/acquired limb deficiencies. JACPOC 1991;26:56-8.