# FUNCTIONAL AND PSYCHOLOGICAL OUTCOMES 50 YEARS AFTER A JUVENILE AMPUTATION

**GA Aiordachioae[1], A Pop[1], H Haragus[2], D Vermesan[2], I Stoia[3]**

**Abstract**

The results after amputation compared to a salvaged lower limb are currently debated. For below the knee the outcomes vary and there is no consensus. We therefore consider important to present long-term outcomes of pediatric amputations. Our case has had half a decade of active living after a juvenile amputation. The now elderly patient is evaluated using gait analysis and functional outcome scores and compared to similar level amputees adjusted for age and gender from a group of 18 lower limb amputees that performed gait analysis as part of a larger study to determine gait modifications in below the knee amputees. The measurements were taken using a Zebris spatial detection instrument. The reason for amputation was severe trauma (crush injury) at the age of 5. The female patient had a transtibial amputation of the left leg that subsequently underwent repeated prosthetic fittings.The Gillette gait index revealed abnormal gait for the entire group of 18 participants, including the juvenile amputee. For this case the score was 42.1 compared to a mean of the group of 39.7. This can be interpreted as a poorer function compared to the mean of the study group. The Prosthesis Evaluation Questionnaire: for Appearance, Frustration, Perceived Response, Social Burden, Well Being, Satisfaction, Self efficacy and Importance the juvenile amputee produced higher values compared to the group average. These were considered significant since they were more that 15% better. For Ambulation, Residual Limb Health, Sounds, Utility, Pain, Transfer and Prosthetic care the values were below this cut-off value and thus were deemed comparable. Qualitative increased asymmetry can be found for adduction-abduction and inward-outward rotation of the hip and inward-outward rotation of the ankle. We conclude that juvenile below the knee amputations can be successful procedures for severe trauma. They produce favorable outcomes up to 50 years. The psychological results are dependent on time from index surgery and personality and are not necessarily correlated to function and gait symmetry, but more to acceptance of the disease.

**Key words:** juvenile amputation, gait analysis, psychological outcome, prosthesis evaluation questionnaire, Gillette gait index

## Introduction

Lower limb amputations are one of the oldest major surgical procedures still in use. They predate even anesthesia and are highly debilitating. With limited use these procedures are used in children mainly in treating malignancy or severe trauma. With all advancement in limb salvage and reconstruction there are still situations where below the knee amputations will be applied to children.

The results after amputation compared to a salvaged lower limb are currently debated. For above the knee amputation, studies provide superior function and physiological results favoring limb salvage. However, for below the knee the outcomes vary and there is no consensus. Some find limb-salvage surgery offers better gait efficiency and return to normal living but does not improve the patient's perception of quality of life [1]. A study on combat injuries found that lower limb amputees had increased risk for infectious complications but not post traumatic stress disorder and proved better use of rehabilitation clinics [2].

A meta-analysis of observational studies found that overall hospital stay and costs are higher for limb salvage patients with comparable long-term functional outcomes, self-reported disability, pain and return to work. The most interesting finding is that at the time of injury patients prefer limb salvage, but the majority of failed salvage patients would opt for early amputation if they could decide again [3].

Factors that are considered to have the largest impact on decision-making for an elective amputation are pain and function, whereas body image and peer perception had less influence. Satisfaction with the surgical outcome is mostly related to how closely the result matched the patient's expectations [4].

For pediatric patients in particular, there are certain complications associated with amputations. One less frequent is secondary tibia vara after synostosis formation. This later has been found to contribute to the development of a progressive varus deformity and should be monitored during a child's growth [5]. A more common incident is osseous overgrowth. Metaphyseal and diaphyseal amputations are likely to develop some degree of overgrowth requiring revision whereas joint disarticulations never develop overgrowth. Traumatic amputations more frequently require stump revisions compared to elective procedures [6]. This is important since apex stump growth may lead to skin perforation, pressure ulcers, and difficulties in accommodating the prosthesis. Different stump capping procedures have been proposed to reduce this event [7].

[1]West University 'Vasile Goldis' Arad
[2]University of Medicine and Pharmacy 'Victor Babes' Timisoara
[3]Polytechnic University Timisoara
E-mail: gigi_aiordachioaie@yahoo.com, alexandrupop@yahoo.com, horia.haragus@yahoo.com, vermesan@gmail.com, ionut@cmpicsu.upt.ro

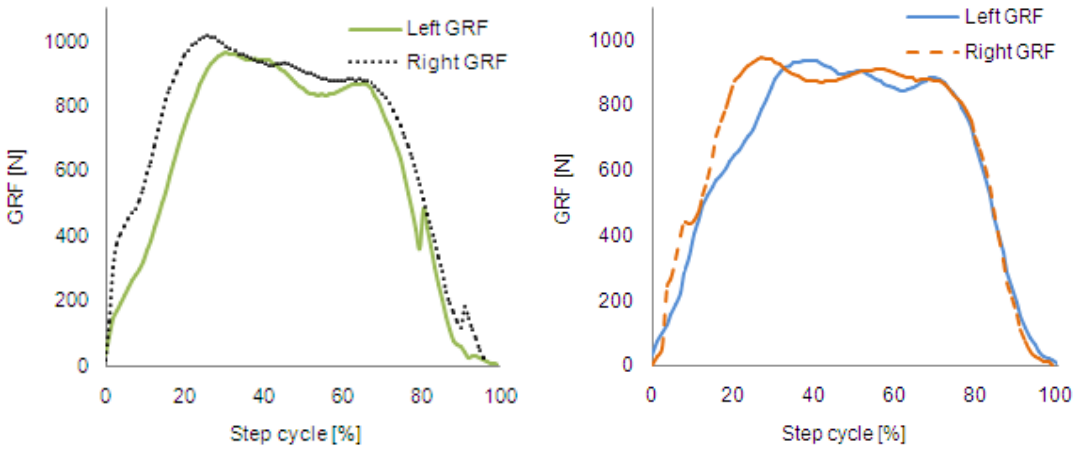


Fig. 1 Ground reaction forces recorded in stance phase of the gait.

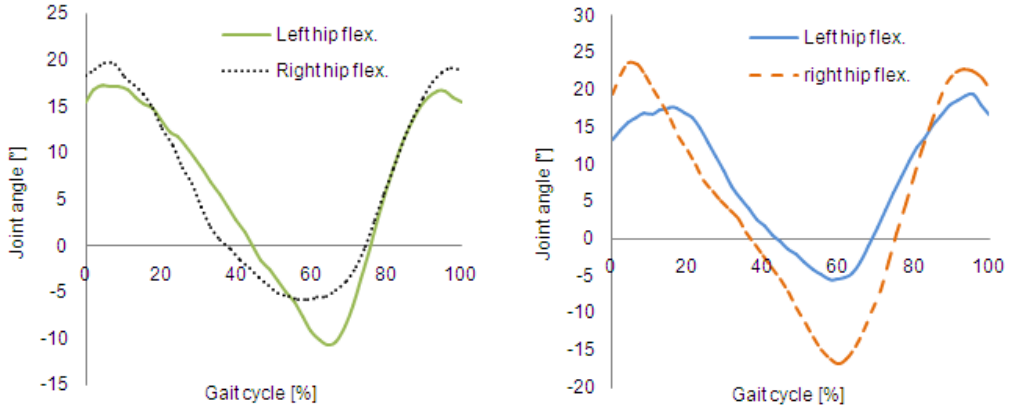


Fig. 2 Flexion-extension movement in hip joint.

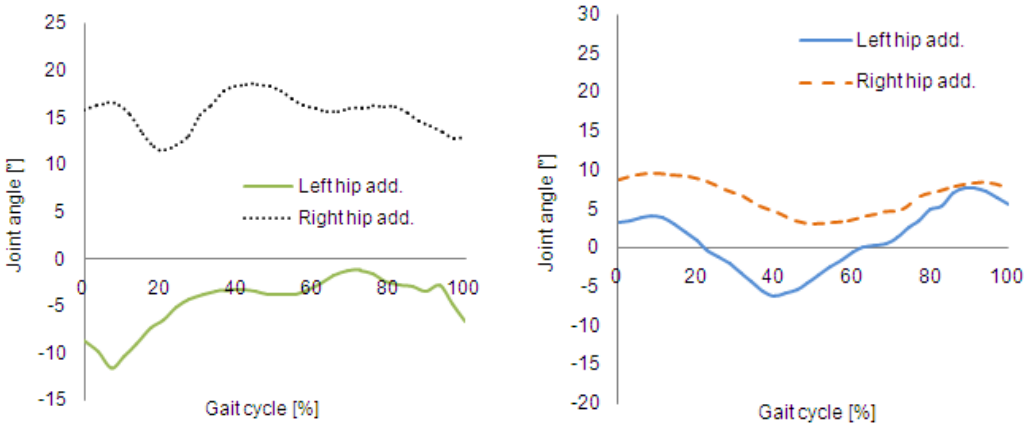


Fig. 3 Adduction-abduction of the hip joint in a gait cycle.

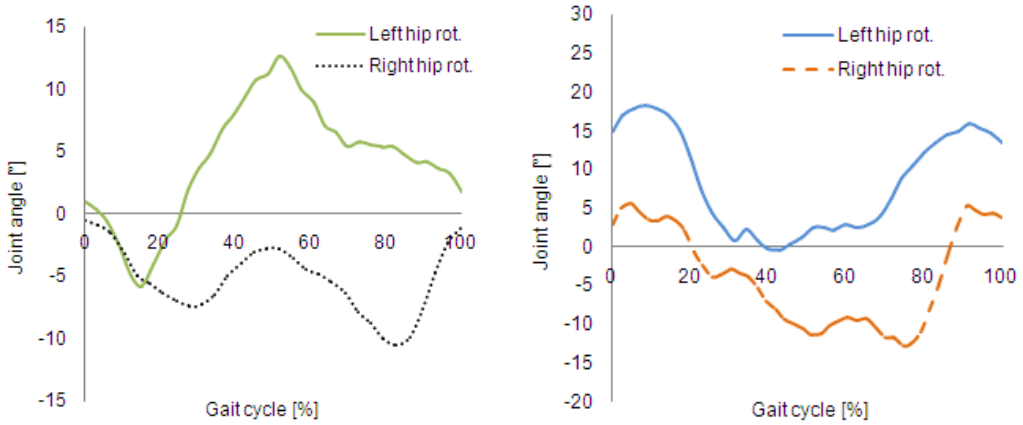


Fig. 4 Inward-outward rotation of the hip joint in a gait cycle.

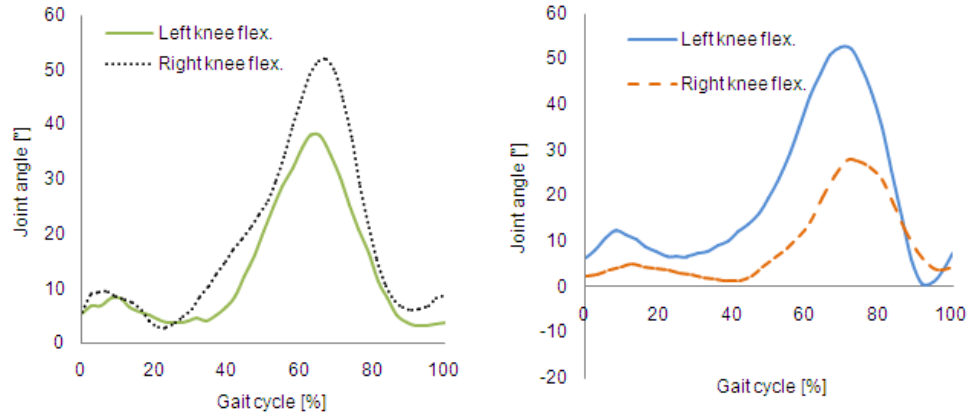


Fig. 5 Flexion-extension movement in knee joint.

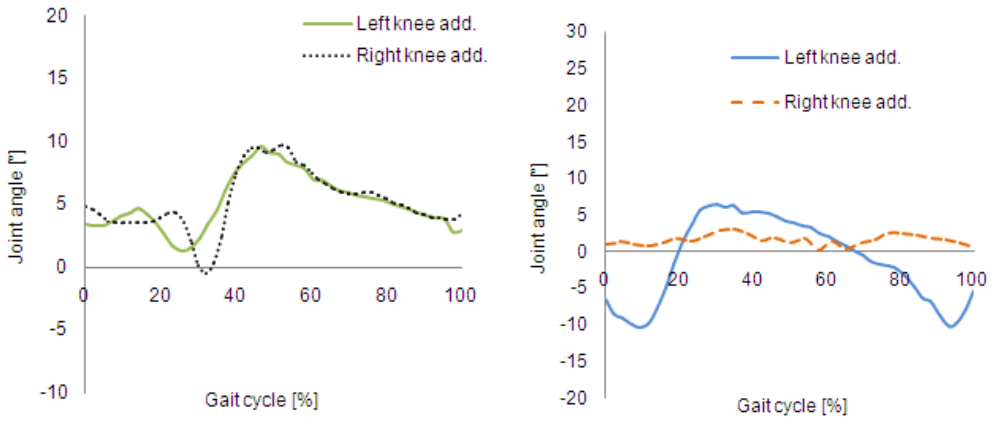


Fig. 6 Adduction-abduction of the knee joint in a gait cycle.

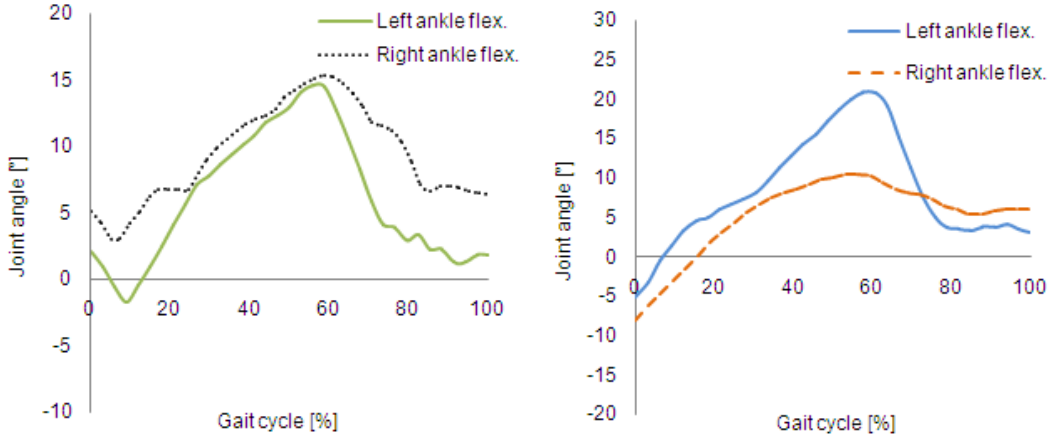


Fig. 7 Flexion-extension movement in ankle joint.

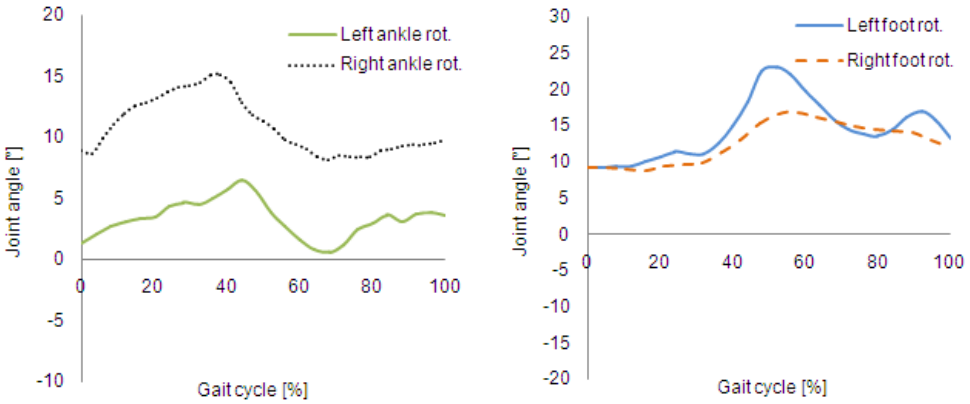


Fig. 8 Inward-outward rotation of the ankle joint in a gait cycle.

We therefore consider important to present long-term outcomes of pediatric amputations. Our case has had half a decade of active living after a juvenile amputation. The now elderly patient is evaluated using gait analysis and functional outcome scores and compared to similar level amputees adjusted for age, gender, level and prosthetic type.

**Material and Method**

From a group of 18 lower limb amputees that performed gait analysis one had the amputation as a child. The cause was severe trauma (crush injury) at the age of 5. The female patient had a transtibial amputation of the left leg that subsequently underwent repeated prosthetic fittings (8). The patient is now 64 years old and has had a normal life throughout. She had two natural births, has worked full time for 40 years at a manufacturing plant and is now caring for two grandsons. She is independent and walks without any assistive device.

The gait analysis was performed as part of a larger study to determine gait modifications in below the knee amputees. The measurements were taken using a Zebris spatial detection instrument. The functional outcome was determined by computing the Gillette gait index (formerly known as normalcy index) as described by Schutte et al [8]. This instrument was developed to assess the abnormal gait in children with cerebral palsy. It uses 16 gait parameters that have been shown to have less variability in adults compared to children, which makes it more sensitive. In addition, in the mature population this score is more dependent on one parameter among the ones initially proposed – time of peak flexion. Nonetheless it has been proved useful also in adults [9].

The patient perception of handicap, function and prosthesis was determined using the Prosthesis Evaluation Questionnaire, developed by the Prosthetics Research Study [10]. This complex evaluation tool consists of eighty-two questions with a linear analog scale response format. Nine scales are computed from forty-two items (ambulation, appearance, frustration, perceived response, residual limb health, social burden, sounds, utility, well being).

**Results**

The Gillette gait index revealed abnormal gait for the entire group of 18 participants, including the juvenile amputee. For this case the score was 42.1 compared to a

mean of the group of 39.7. This can be interpreted as a poorer function compared to the mean of the study group.

The Prosthesis Evaluation Questionnaire: for Appearance, Frustration, Perceived Response, Social Burden, Well Being, Satisfaction, Self efficacy and Importance the juvenile amputee produced higher values compared to the group average. These were considered significant since they were more that 15% better. For Ambulation, Residual Limb Health, Sounds, Utility, Pain, Transfer and Prosthetic care the values were below this cut-off value and thus were deemed comparable.

The charts below (Fig.1-8) represent the measured left to right gait symmetry of the juvenile amputee compared to a matched age, gender, prosthetic type and level control from the study group of 18. Qualitative increased asymmetry can be found for adduction-abduction and inward-outward rotation of the hip and inward-outward rotation of the ankle (Fig. 3, 4 and 8).

**Discussions and Conclusions**

There are limitations to this study. There is only one patient with such long term follow-up and pediatric amputation. Therefore, we only compared to a matched age, gender, prosthetic type and level since statistical processing would have yielded biased results. Nonetheless, we still find important to present the functional and psychological outcome of an old adult with juvenile amputation. This can be an example of long term outcome for present candidates that might help decide on therapeutic management regarding amputation or limb salvage.

Patients after a lower limb amputation reflect differently on body image and function. The handicap is reflected differently depending on the patient's awareness of the impairment [11]. A meta-analysis of amputation versus limb salvage in mangled lower limb injuries found that reconstruction is more acceptable psychologically to compared with amputation, even though the functional outcomes were comparable [12].

The psychosocial adjustment to lower-limb amputation is time dependant. Depression and anxiety can be high up to two years post-amputation. Positive adjustment to limb loss can be predicted by increased time since amputation, plentiful social support, higher satisfaction with the prosthetic device, active coping, an optimistic personality type, lower level of amputation and stump pain [13]. The same authors call for longitudinal rather than cross-sectional studies that can include immediate reactions, adjustment during postoperative rehabilitation period and development of changed identity [13].

Elderly people with lower limb amputations are high consumers of health care resources. Mobility is essential to regain independence and such skills are achievable. However, a literature review of the studies that included all subjects undergoing a lower limb amputation reported that less than half of the elderly reached this goal, mainly due to co morbidities [14]. Impairment variables predicting activity limitation are linked to strength, balance, demographics, time, cause and level of amputation. In one particular study, strength of the hip extensors was found to be the strongest predictor, judged by the six minute walk scores [15].

Vascular amputees are an important subgroup of elderly patients. Many are able to remain independent despite infrequent prosthesis use and outdoor ambulation. Ability to predict ambulation after below the knee amputations in the vascular population is unreliable but preservation of the knee is essential in regaining mobility [16].

Optimal treatment of pediatric lower limb malignancy has not reached a consensus. Studies have showed that physical and emotional outcomes in patients treated with an expandable endoprosthesis are good but complication rates remain high. Amputation and rotationplasty are successful alternative treatments if patients agree [17].

Juvenile amputation overgrowth has remained a minor setback for this subgroup. Alternative surgical procedures have been proposed either with the use of a synthetic cap [18] or by using different stump apex techniques such as the Ertl amputation [19].

We conclude that juvenile below the knee amputations can be successful procedures for severe trauma. They produce favorable outcomes up to 50 years. The psychological results are dependent on time from index surgery and personality and are not necessarily correlated to function and gait symmetry, but more to acceptance of the disease.

**References**


1. Malek F, Somerson JS, Mitchel S, Williams RP. Does limb-salvage surgery offer patients better quality of life and functional capacity than amputation? Clin Orthop Relat Res. 2012 Jul;470(7):2000-6.
2. Melcer T, Walker GJ, Sechriest VF 2nd, Galarneau M, Konoske P, Pyo J. Short-term physical and mental health outcomes for combat amputee and nonamputee extremity injury patients. J Orthop Trauma. 2013 Feb;27(2):e31-7
3. Busse JW, Jacobs CL, Swiontkowski MF, Bosse MJ, Bhandari M; Evidence-Based Orthopaedic Trauma Working Group. Complex limb salvage or early amputation for severe lower-limb injury: a meta-analysis of observational studies. J Orthop Trauma. 2007 Jan;21(1):70-6.
4. Quon DL, Dudek NL, Marks M, Boutet M, Varpio L. A qualitative study of factors influencing the decision to have an elective amputation. J Bone Joint Surg Am. 2011 Nov 16;93(22):2087-92.
5. Segal LS, Crandall RC. Tibia vara deformity after below knee amputation and synostosis formation in children. J Pediatr Orthop. 2009 Mar;29(2):120-3.
6. O'Neal ML, Bahner R, Ganey TM, Ogden JA. Osseous overgrowth after amputation in adolescents and children. J Pediatr Orthop. 1996 Jan-Feb;16(1):78-84.
7. Vocke AK, Schmid A. Osseous overgrowth after post-traumatic amputation of the lower extremity in

childhood. Arch Orthop Trauma Surg. 2000;120(7-8):452-4.
8. Schutte L ,Narayanan U ,Stout J ,Selber P ,Gage J ,Schwartz M. An index for quantifying deviations from normal gait. Gait&Posture 2000;11:25–31
9. Cretual A, Bervet K, Ballaz L. Gillette Gait Index in adults. Gait Posture. 2010 Jul;32(3):307-10.
10. Prosthetics Research Study. Prosthesis evaluation questionnaire. Available at: http://www.prs-research.org/htmPages/PEQ.html. Accessed 30 APR 2013.
11. Senra H, Oliveira RA, Leal I, Vieira C. Beyond the body image: a qualitative study on how adults experience lower limb amputation. Clin Rehabil. 2012 Feb;26(2):180-91.
12. Akula M, Gella S, Shaw CJ, McShane P, Mohsen AM. A meta-analysis of amputation versus limb salvage in mangled lower limb injuries--the patient perspective. Injury. 2011 Nov;42(11):1194-7.
13. Horgan O, MacLachlan M. Psychosocial adjustment to lower-limb amputation: a review. Disabil Rehabil. 2004 Jul 22-Aug 5;26(14-15):837-50.
14. Fortington LV, Rommers GM, Geertzen JH, Postema K, Dijkstra PU. Mobility in elderly people with a lower limb amputation: a systematic review. J Am Med Dir Assoc. 2012 May; 13 (4):319-25.
15. Raya MA, Gailey RS, Fiebert IM, Roach KE. Impairment variables predicting activity limitation in individuals with lower limb amputation. Prosthet Orthot Int. 2010 Mar;34(1):73-84.
16. Nehler MR, Coll JR, Hiatt WR, Regensteiner JG, Schnickel GT, Klenke WA, Strecker PK, Anderson MW, Jones DN, Whitehill TA, Moskowitz S, Krupski WC. Functional outcome in a contemporary series of major lower extremity amputations. J Vasc Surg. 2003 Jul; 38(1):7-14.
17. Henderson ER, Pepper AM, Marulanda G, Binitie OT, Cheong D, Letson GD. Outcome of lower-limb preservation with an expandable endoprosthesis after bone tumor resection in children. J Bone Joint Surg Am. 2012 Mar 21;94 (6):537-47.
18. Tenholder M, Davids JR, Gruber HE, Blackhurst DW. Surgical management of juvenile amputation overgrowth with a synthetic cap. J Pediatr Orthop. 2004 Mar-Apr; 24(2):218-26.
19. Firth GB, Masquijo JJ, Kontio K. Transtibial Ertl amputation for children and adolescents: a case series and literature review. J Child Orthop. 2011 Oct;5(5):357-62.

Correspondence to:
Horia Haragus
University of Medicine and Pharmacy Victor Babes,
Pta E. Murgu, 2, cod 300041,
Timisoara, Romania,
Telephone: 0040747025064
E-mail: horia.haragus@yahoo.com