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Standing balance in trans-tibial amputees following vascular disease or trauma: a comparative study with healthy subjects

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Abstract

Standing balance measured as sway and standing time both on one and two legs, was studied by use of a stable force platform (Kistler) in 36 patients aged 48-87 years with trans-tibial amputation and 27 healthy subjects matched for age. The aim of the study was to compare postural function in standing in two groups with unilateral trans-tibial amputations, separating vascular disease from trauma. Results revealed that the vascular group had a significantly increased sway in the lateral direction compared with the healthy group, when standing on both feet close together for 30 seconds, looking straight ahead or blindfolded (p values ranging from 0.003 to 0.02). In the sagittal direction the trauma amputees had a significantly decreased sway when looking straight ahead, compared to the vascular and healthy groups (p values = 0.03). No significant differences in the lateral or sagittal direction were seen among the three groups when comparing standing on one leg. There was a significant difference, however, in the standing time in the one-leg standing test of the vascular group when compared with the trauma and healthy groups (p values ranging from 0.0009 to 0.02). In contrast to the vascular group, all subjects in the trauma and healthy groups from 48 to 59 years could stand on the healthy leg for 30 seconds when looking straight ahead, and from 60 to 79 years they could stand for 5 seconds. None in the vascular or trauma group older than 80 years could stand on the healthy leg for 5 seconds. The standing balance of the vascular amputees was found to be inferior to that of the trauma amputees. In conclusion, vascular and trauma trans-tibial amputees should not be considered as an entity in test situations or rehabilitation programmes.

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Introduction

In physiotherapy early rehabilitation of the leg amputee comprises exercises in one-leg standing. Not until the patient is fitted with a prosthesis is training in standing and walking on both feet possible (Moncur, 1969).

In Northern Europe, 85% of the amputations are performed because of vascular disease with or without diabetes mellitus, the rest are because of trauma, tumours or congenital deficiency (Murdoch, 1984). Many of the vascular amputees have concomitant diseases reducing their chances of regaining their balance while standing and of becoming a user of a prosthesis (Hansson, 1964; Levine, 1984). Smoking is a well-known factor affecting the course of vascular disease (Liedberg and Persson, 1983). The vascular amputee has a lower success rate in prosthetic fitting than other groups of amputees, and female vascular amputees have a higher failure rate than males in using the prosthesis (McKenzie, 1953). Due to the systemic disease, the vascular amputee is generally older than 50 years at the time of amputation in contrast to the trauma amputee who usually is younger, with men being predominant (Hansson, 1964).

Sway is a measurement of standing balance (Begbie, 1969; Brocklehurst *et al.*, 1982; Mathias *et al.*, 1986). Many reports have described sway as being related to age (Brocklehurst *et al.*, 1982; Dornan *et al.*, 1978; Ekdahl *et al.*, 1989; Ekdahl and Andersson, 1989; Fernie *et al.*, 1978; Overstall *et al.*, 1977; Sheldon, 1963) and sex (Ekdahl *et al.*, 1989; Ekdahl and Andersson, 1989, Juntunen *et al.*, 1987; Overstall *et al.*, 1977; Yoshida *et al.*, 1983) in healthy subjects. Vision influences sway (Jarnlo and Thorngren, 1991; Pykkö *et al.*, 1990) and this has by some authors been shown to be of particular importance when the somatosensory information is reduced as in leg-amputees (Dornan *et al.*, 1978; Fernie *et al.*, 1978; Guerts *et al.*, 1992; Holliday *et al.*, 1978) though this has not been found by others (Vittas *et al.*, 1986). In a recent investigation, male trans-tibial amputees with diabetes mellitus were found to sway more than healthy subjects, with eyes either open or closed when standing on both feet (Isakov *et al.*, 1992). Medication is likely to influence sway, but has not been proven to do so (Brocklehurst *et al.*, 1982; Overstall *et al.*, 1977).

Timed balance tests are related to age in the same way as sway (Bohannon *et al.*, 1984). In the literature various time limits such as 30 seconds (Bohannon *et al.*, 1984; Ekdahl *et al.*, 1989; Ekdahl and Andersson 1989) and 60 seconds (Brocklehurst *et al.*, 1982; Dornan *et al.*, 1978; Fernie *et al.*, 1978) have been used to test the ability to stand on both feet with eyes open or closed. Standing on one leg while looking straight ahead for 30 seconds was regarded as normal for healthy subjects up to the age of 54 by Ekdahl *et al.* (1989), while a time limit of 5 seconds for this test was considered to be adequate by Bohannon *et al.* (1984) for healthy subjects from 60 to 69 years.

Most studies concerning standing balance in leg-amputees have been carried out with regard to the level, irrespective of the cause of the amputation. Thus, there is a lack of knowledge as to whether the standing balance in vascular amputees differs from that of other amputees and little interest has been shown in the one-leg standing of the leg amputee. In this study the authors have focused on the standing balance during quiet stance in leg amputees, measured as sway and standing time both on one and two legs.

The aim of the study was to compare postural function in standing in two groups with unilateral trans-tibial amputations for either vascular disease or trauma and to compare the results of the two groups with the results from a group of healthy subjects.

Subjects and methods

Subjects

The criteria for inclusion in this study were: unilateral trans-tibial amputation for either vascular disease or trauma with an age of 48 years and above at the time of investigation; no major sight problems (with glasses if needed); ability to talk and write in Swedish and to be able to walk indoors with a prosthesis without using a walking aid.

A total of 36 patients fitted with a prosthesis at the Orthopaedic Workshop at the Helsingborg Hospital, Sweden, fulfilled the inclusion criteria and were asked to participate in the study. All the men in the vascular group and all the women in the vascular and trauma groups selected agreed to participate. Two men in the trauma group were unwilling to take part in the study and one man was excluded due to drug abuse.

Vascular amputee group. Included in the study were 18 subjects (6 women, 12 men; mean age = 68.8 years, SD = 12.0, range = 48-87 years). The mean age of the women was 71.8 years (SD = 15.0, range = 51-87), and of the men 64.7 years (SD = 10.6, range = 48–82). Mean time since the amputation was for the women 5.0 years (SD = 4.7, range = 2-14) and for the men 7.0 years (SD = 5.7, range = 0-18). Half of the women and one third of the men in the vascular group had diabetes mellitus. Concomitant diseases among the women were hypertension in 3 cases and among the men, gastric ulcer in 1 case and varicose ulcer of the healthy leg in another. In addition, 1 woman and 2 men had a big toe amputation on the healthy leg. Concerning pharmacological treatment, 5 of the 6 women and 6 of the 12 men were on antihypertensives and/or analgesics; 1 woman and 1 man were on antihypertensives, analgesics and sedatives; 1 man was on antacids and 4 were not on drugs at all. Three men considered their hearing to be bad, but this was not evident at the clinical investigation. Further characteristics of the vascular group are shown in Table 1.

Trauma amputee group. Included in the study were 18 subjects (3 women, 15 men; mean age = 63.9 years, SD = 10.0, range = 48-82 years). The mean age of the women was 57.0 years (SD = 7.8, range = 48-62), and of the men 65.3 years (SD = 10.0, range = 48-82). Mean time since the amputation and the first prosthesis was for

Table 1. Characteristics for the groups studied.

	Vascular		Trauma		Healthy	
Characteristics	Women n = 6 f	Men n = 12 f	Women n = 3 f	Men n = 15 f	Women n = 8 f	Men n = 19 f
Sight (normal/ slight impairment)	3/3	7/5	2/1	10/5	3/5	14/5
Hearing (normal/ slight impairment/bad)	3/3/0	7/2/3	3/0/0	8/5/2	6/2/0	8/11/0
Smoking habits (smokers/ ex-smokers/non-smokers)	1/1/4	5/4/3	1/0/2	3/7/5	0/1/7	3/6/10
Concomitant diseases (yes/no)	3/3	2/10	2/1	6/9	–	–
Medication (yes/no)	6/0	8/4	2/1	8/7	–	–
Side of amputation (right/left)	3/3	5/7	2/1	8/7	–	–
Stump pain (yes/no)	4/2	4/8	0/3	5/10	–	–
Phantom sensation (yes/no)	4/2	11/1	0/3	5/10	–	–
Phantom pain (yes/no)	4/2	10/2	2/1	8/7	–	–
Walking aid outdoors (yes/no)	5/1	5/7	1/2	6/9	–	–

the women 11.3 years (SD = 11.0, range = 4-24) and for the men 36.3 years (SD = 19.4, range = 5-62). Concomitant diseases among the women were thyroid enlargement in 1 case and hypertension in another. Among the men, 2 had asthma and 1 had both cardiac insufficiency and chronic bronchitis. Two men had had myocardial infarction and another had had a minor stroke more than one year previously but they were all back to normal again without any sequelae. Concerning pharmacological treatment, 1 woman and 6 men were on antihypertensives and/or analgesics; 1 man was on antihypertensives, analgesics and sedatives; 1 woman was on thyroid hormone medication and 1 man was on anti-asthmatic inhalation medication; 1 woman and 7 men were not on drugs at all. Two men considered their hearing to be bad, but this was not evident at the clinical investigation. Further characteristics of the trauma group are shown in Table 1.

Healthy reference group. The vascular and trauma amputee groups were matched for age with a group of 27 healthy persons (8 women, 19 men; mean age = 69.6 years, SD = 9.8, range = 48-86). The mean age of the women was 71.8 years (SD = 11.2, range = 52-86), and of the men 68.7 years (SD = 9.4, range = 48-82). The criteria for inclusion in this group were feeling healthy, taking no medicine and having experienced no problems with standing balance. All the subjects selected according to these criteria agreed to participate. Further characteristics of the healthy group are shown in Table 1.

Methods

Force platform. A stable force platform (Kistler) in the Vifor system was used for the data collection (Lanshammar, 1991). The standing balance was measured with 50 samples per second during 30 seconds, after which a summary of the measurement was displayed on the screen connected to the force platform. This summary contains a graphic illustration of the variations as standard deviations of the position of the centre of pressure on the platform. Parameters shown on the summary picture for the test battery: S(x), S(y) = the standard deviations of the sway amplitudes (mm) in the lateral and sagittal directions, respectively. During the test battery standing time (ms) was recorded simultaneously on the screen (Lanshammar, 1991).

Standing balance. The standing balance test was carried out according to the test battery of Ekdahl *et al.* (1989), earlier shown to be satisfactorily valid and reliable. Every test was performed three times for a period of 30 seconds, in order to obtain the best performance from each person and according to increasing degree of difficulty. The recording with the smallest sway amplitude from the three tests was chosen. Standing blindfolded on one leg was found to be too difficult in a pilot test and for that reason was excluded. During the following tests all persons had their ordinary walking shoes on.

Test I: Standing with feet close together, looking straight ahead and with arms hanging.

Test II: Standing blindfolded in the same position as in Test I.

Tests III and IV: Standing on one leg. For the leg-amputees: first the sound leg (Test III) and then the leg with the prosthesis (Test IV). For the healthy subjects: first the right (Test III) and then the left leg (Test IV). All looking straight ahead and with arms hanging. Compensatory movements of the arms and the lifted leg were accepted in Tests III and IV.

Questionnaires. Before the tests for postural function, the subjects were asked to fill in a questionnaire about sight (normal/slight impairment), hearing (normal/slight impairment/bad), smoking habits (yes/ex-smokers/non-smokers), concomitant disease (yes/no) and medication (yes/no). For the leg-amputees, additional questions were asked about time since the amputation (years), side of amputation (right/left), stump pain (yes/no), phantom sensation (yes/no), phantom pain (yes/no) and if they used any walking aids outdoors (yes/no).

Statistics. When overall significance testing was performed, that is, when all three groups were compared, the Kruskal-Wallis test was used (Siegel and Castellan, 1988). All pairwise comparisons were analysed using the Wilcoxon Rank Sum test and the within group comparisons were analysed with the Wilcoxon Signed Rank test (Siegel and Castellan, 1988). Analysis of covariance was used to investigate whether the year since amputation or phantom sensation had any influence on Tests I, II and III (Berenson *et al.*, 1983). The Chi-square test was used to analyse 2*2 tables (Pocock, 1983). The significance level was set to 5%, a two-sided test. The statistical software used in the analysis was SAS Version 6.08.

Results

There were no sex or age differences between the vascular, trauma and healthy groups. Thus, the results are presented for women and men together. A longer period of time since the amputation (p = 0.0001) and a lower frequency of phantom sensation (p = 0.0001) among the trauma amputees were the only characteristics showing significant differences between the vascular and trauma groups, but these were not found to affect the results of the test battery. There were no significant differences between the three groups concerning the characteristics in common.

Table 2. Sway and standing time. Means, standard deviations and frequency of success at performing the tests for the vascular, trauma and healthy groups.
Abbreviations: S(x), S(y) = standard deviations of the sway amplitudes (mm) in the lateral and the saggittal directions, respectively.
Test I = standing on both feet looking straight ahead;
Test II = standing on both feet blindfolded;
Test III = standing on the healthy leg for the amputee groups/the right leg for the healthy group;
Test IV = standing on the prosthetic leg for the amputee groups/the left leg for the healthy group

		Vascular + trauma (n = 36)			Vascular group (n = 18)			Trauma group (n = 18)			Healthy group (n = 27)		
Test		M	SD	n	M	SD	n	M	SD	n	M	SD	n
I	S(x)	5.7	1.6	36	6.1	1.6	18	5.3	1.6	18	4.7	1.4	27
	S(y)	5.2	2.0	36	6.0	2.3	18	4.4	1.5	18	5.2	1.2	27
	Standing time (s)	30.0	0.0	36	30.0	0.0	18	30.0	0.0	18	30.0	0.0	27
II	S(x)	7.2	2.3	30	7.8	1.5	13	6.8	2.8	17	6.0	2.3	27
	S(y)	6.8	2.6	30	6.8	2.6	13	6.8	2.7	17	6.7	2.3	27
	Standing time (s)	22.6	8.7	36	23.3	11.3	18	30.0	0.0	18	30.0	0.0	27
III	S(x)	9.8	6.1	16	9.4	2.5	5	10.0	8.2	11	9.4	4.8	19
	S(y)	10.1	6.1	16	11.2	2.8	5	9.6	7.2	11	9.7	3.9	19
	Standing time (s)	16.4	14.3	36	10.9	14.3	18	22.3	12.2	18	24.5	9.9	27
IV	S(x)	–	–	0	–	–	0	–	–	0	10.3	7.0	19
	S(y)	–	–	0	–	–	0	–	–	0	10.6	6.0	19
	Standing time (s)	1.5	3.6	36	1.0	4.0	18	2.0	3.2	18	24.4	9.8	27

Table 3. Standing time. Frequency with respect to standing time in seconds for the vascular, trauma and healthy groups during the tests for 30 seconds.

Test	Time (s)	Vascular (n = 18) f	Trauma (n = 18) f	Healthy (n = 27) f
I	30	18	18	27
II	30	13	17	27
	15-29	–	–	–
	5-14	3	–	–
	1-4	1	–	–
	0	1	1	–
III	30	5	11	19
	15-29	2	1	1
	5-14	–	2	5
	1-4	–	–	–
	0	11	4	2
IV	30	–	–	19
	15-29	1	–	3
	5-14	–	2	2
	1-4	1	4	1
	0	16	12	2

Standing balance on two legs

Sway. Means, standard deviations and frequency of success in performing the tests included in the test battery are presented in Table 2. There were significant differences between the three groups, concerning the sway amplitudes in the lateral (p = 0.02) and the sagittal (p = 0.04) directions when looking straight ahead, but only in the lateral direction when blindfolded (p = 0.02). In both test situations, all amputees together and the vascular group separately had a significantly increased sway in the lateral direction (p values ranging from 0.003 to 0.02) compared with the healthy group (Table 5). In the sagittal direction, the trauma amputees had a significantly decreased sway (p = 0.03) when looking straight ahead compared with the vascular and healthy groups.

Standing time. There were no dropouts in the two-leg standing test looking straight ahead for 30 seconds (Table 2) and there was no significant difference in standing time between the three groups. When blindfolded, the five dropouts in the vascular group were two women (85 and 88 years) and one man (83 years) who stood less than 15 seconds, one man (65 years) who stood less than 5 seconds and one woman (78 years) could not stand at all on both feet when blindfolded (Table 3). The only dropout in the trauma group was a man (82 years) who was unable to stand for a single second on both feet blindfolded. There was a significant difference between the three groups concerning the standing time when blindfolded (p = 0.002). All amputees together (p = 0.04) and the vascular group separately (p = 0.004) had a significantly shorter standing time compared to the healthy group (Table 5). The vascular amputees had a significantly shorter standing time than the trauma amputees (p = 0.02). No such difference was seen when comparing the trauma amputees with the healthy subjects.

Standing balance on one leg

Sway. No significant differences in the lateral or sagittal directions were seen between the three groups when comparing standing on one leg. Due to complete failure to stand on the prosthetic leg for 30 seconds in all patients, a comparison with the prosthetic leg could not be carried out.

Standing time. The minimum standing time on one leg for the subjects between the age of 40 and 59 was for the healthy subjects 30 seconds for the right as well as for the left leg,

Table 4. One-leg standing and age. Distribution of frequency according to age in decades for the standing time in seconds looking straight ahead on the healthy leg for the vascular and trauma groups (Test III) and for the right and left leg, respectively, for the healthy group (Tests III-IV).

	Vascular group (n = 18)		Trauma group (n = 18)		Healthy group (n = 27)			
	Healthy leg		Healthy leg		Right leg		Left leg	
Decades	0-4 s f	5-30s f	0-4s f	5-30s f	0-4s f	5-30s f	0-4s f	5-30s f
40-49	–	1	–	3	–	1	–	1
50-59	–	3	–	1	–	4	–	4
60-69	3	2	1	8	–	6	–	6
70-79	4	1	1	2	–	9	1	8
80-89	4	–	2	–	2	5	2	5

30 seconds for standing on the healthy leg for the trauma amputees and 20 seconds for the vascular amputees (Table 4). Of the subjects aged 60 to 69 years, all in the healthy group could stand for 5 seconds. In the trauma group only one woman failed and in the vascular group three men failed to stand on the healthy leg. Between the age of 70 and 79 years all the healthy subjects could stand for 5 seconds, except one woman who failed to stand on the left leg. In the trauma group one man failed to stand for 5 seconds, and in the vascular group only one man succeeded in standing on the healthy leg. When reaching the age of 80 to 89 years, all of the amputees failed to stand for 5 seconds. In the healthy group two women failed to stand on the right leg and one woman and one man failed to stand on the left leg. There was a significant difference between the three groups when standing on one leg ($p = 0.002$). Significantly shorter standing time was found when comparing all amputees together ($p = 0.02$) and the vascular group separately ($p = 0.0009$) with the healthy group as well as for the vascular amputees compared with the trauma amputees ($p = 0.02$) (Table 5). No such difference was seen when comparing the trauma amputees with the healthy subjects.

One man in the vascular group succeeded in standing on the prosthetic leg for 17 seconds and one woman in the trauma group succeeded in standing for 11 seconds. They were both 48 years. The one-leg standing on the prosthetic leg showed no significant difference between the vascular and trauma amputees.

Comparison of sway amplitudes when standing on both feet looking straight ahead and blindfolded

All the amputees, separately or together, and also the healthy subjects, increased their sway amplitudes in the lateral and the sagittal direction when blindfolded, compared to looking straight ahead in the two-leg standing test (p values ranging from 0.0002 to 0.05). None of the three groups had a significantly larger increase in the sway when blindfolded.

Discussion

The test battery of standing balance proved to discriminate between vascular and trauma amputees. The vascular amputees in this study represent the total population of the vascular amputees in the Helsingborg and Landskrona Health Care District in Southern Sweden who passed the inclusion criteria. The youngest in the vascular group was 48 years. In order to make a comparison with the trauma amputees in the same district, trauma amputees 48 years and older were included. The distribution of men and women among the amputee groups corresponds well to the proportion reported earlier in the literature (Hansson, 1964; Levine, 1984; McKenzie, 1953).

The results of this study show an increase in

Table 5. Within group differences (p values) for the variables of mean sway amplitude in the lateral and sagittal direction (x, y) and the standing time in Tests I-IV.

Test		Vascular + trauma /healthy	Vascular /healthy	Trauma /healthy	Vascular /trauma
		p	p	p	p
I	S(x)	0.01	0.0004	0.21	0.16
	S(y)	0.44	0.42	0.03	0.03
	Standing time	1.00	1.00	1.00	1.00
II	S(x)	0.02	0.003	0.30	0.13
	S(y)	0.93	0.88	0.79	0.83
	Standing time	0.04	0.004	1.00	0.02
III	S(x)	0.75	0.61	0.45	0.33
	S(y)	0.74	0.17	0.20	0.12
	Standing time	0.02	0.0009	0.59	0.02
IV	S(x)	a)	a)	a)	a)
	S(y)	a)	a)	a)	a)
	Standing time	0.0001	0.0001	0.0001	0.08

a) This test cannot be performed on empty groups.

the sway in trans-tibial amputees and healthy subjects when blindfolded compared to looking straight ahead in the two-leg standing test. All trans-tibial amputees showed an increase in the lateral sway in the two-leg standing test when looking straight ahead or blindfolded, compared to the healthy subjects. Trans-tibial amputees have earlier been found to sway more than healthy subjects when standing with eyes open or closed (Fernie *et al.*, 1978; Isakov *et al.*, 1992). Variations in foot position affect the measurements of standing balance (Kirby *et al.*, 1987) thus making comparisons with the result of these studies difficult (Fernie *et al.*, 1978; Isakov *et al.*, 1992). Vittas *et al.* (1986) found trans-tibial amputees for vascular disease and trauma, men and women between 16 and 59 years, to have a reduced sway in both directions, and men above 59 years to have a limited sway in the sagittal direction, compared to healthy subjects when standing for 60 seconds with their eyes closed. This is partly in agreement with the findings of the present study and further discussed below.

When comparing the vascular and the trauma amputees separately, when standing on both legs, the sway amplitude of the trauma amputees in the sagittal direction was decreased compared to the healthy subjects, when looking straight ahead, while the vascular amputees showed increased postural sway in the lateral direction in both test situations compared to the healthy subjects. An increased sway in the lateral direction compared to the sagittal direction in elderly persons, was reported by Jarnlo and Thorngren (1991) as a possible sign of decreasing balance capacity. The men above 59 years in the study of Vittas *et al.* (1986) were also found to have a limited sway in the sagittal direction. They thought the reduced sway to be caused by the relatively stiff ankle of the prosthesis and the fact that the healthy leg only needs slight muscle movements to maintain balance.

No significant differences in the lateral or sagittal directions were seen between the three groups when comparing the sway amplitudes while standing on one leg. But the decreased balance capacity of the vascular amputees, reflected as increased postural sway in the lateral direction when standing on both feet, compared to the healthy subjects as mentioned previously, is now shown in the significant difference in standing time when compared with the trauma and healthy groups. This is caused by the many dropouts in the vascular group of all ages.

Not being able to stand with feet together, eyes open or closed, for 30 seconds was considered abnormal for subjects younger than 79 years by Bohannon *et al.* (1984). As the dropouts in the vascular and trauma groups were on the whole older than 79, the authors are inclined to say that a standing time of 30 seconds did not discriminate the amputees from the healthy subjects. Ekdahl and Andersson (1989) also came to this conclusion when comparing subjects with rheumatoid arthritis with healthy subjects.

Standing on one leg for 30 seconds with subjects between the age of 48 and 59 years caused dropouts exclusively among the vascular amputees. The standing capacity of the trauma amputees was quite up to the standard of the healthy subjects in this age group. No comparison can be made with others regarding the amputees, as the one-leg standing test has not been reported for amputees previously. The results obtained from the healthy subjects were in accordance with the findings of Ekdahl *et al.* (1989).

As the healthy subjects in this study were standing with their shoes on and were allowed to move their arms when standing on one leg, the time limit of 5 seconds could be considered adequate for the healthy subjects from 70 to 79 years as well as for this test. Still, the trauma amputees kept pace with the healthy subjects while the vascular amputees had some failures. In theory, the authors think it could have been possible for the trauma amputees to have had a better standing balance on the healthy leg than the healthy controls, but this study did not show that.

Considering the loss of the calf muscles, standing on the prosthetic leg cannot be recommended as a test of standing balance in amputees. However, the authors found it interesting to investigate as it has not been reported on previously.

One man in the vascular group and one man in the trauma group were on sedatives. Both failed in the one-leg standing test. The trauma amputee was the only dropout of a total of three in the trauma group between 70 and 79 years, while the vascular amputee did not affect the result of the vascular group in this age range. The authors are inclined to say that in agreement with the findings of Brocklehurst *et al.* (1982) and Overstall *et al.* (1977) medication has not been proven to influence standing balance.

At the age of 80 and above, all the amputees failed to stand on the healthy leg for 5 seconds with even the healthy subjects starting to show dropouts. This is worth noting as the age group of 80 years and older at amputation for vascular disease in the south of Sweden has been found to be the only age group showing an increase (Eneroth and Persson, 1992).

In the literature there is some disagreement as to whether women (Overstall *et al.*, 1977; Yoshida *et al.*, 1983) or men (Ekdahl *et al.*, 1989; Ekdahl and Andersson 1989; Juntunen *et al.*, 1987) show greater postural sway. There are, however, methodological differences that could affect the results of these measurements. It would be interesting to see in an extended study, whether the poor success of prosthetic fitting in female vascular amputees in the present study could be explained by a lower balance performance, compared to male vascular amputees.

As the vascular amputees showed a decreased balance capacity measured as standing time compared with the healthy subjects and the trauma amputees in the one-leg standing test, it may be argued that this difference could be explained by the vascular disease. Further studies will concentrate on the effect of specific training in the one leg standing of the vascular amputee in connection with the amputation. In addition, the possibilities of the vascular amputee becoming a user of a prosthesis will be investigated.

To conclude, the standing balance of the vascular trans-tibial amputees was found to be inferior to that of the trauma trans-tibial amputees. Consequently, vascular and trauma trans-tibial amputees should not be considered as an entity in test situations or rehabilitation programmes.

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