Treadmill Measured vs. Questionnaire Estimated Changes in Walking Ability in Patients With Peripheral Artery Disease

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WHAT THIS PAPER ADDS

In patients with peripheral artery disease, the Walking Estimated Limitation Calculated by History (WELCH) questionnaire score correlates with the maximum treadmill walking time. Changes in WELCH score tend to decrease more than the objective changes in walking impairment, particularly with a longer a test—retest interval. After revascularisation, a shortlived "honeymoon" (overestimation of the objectively measured change on the treadmill) is observed. For long test—retest intervals, self reported worsening according to the WELCH score should probably be confirmed on the treadmill before a decision to revascularise is taken. Whether other questionnaires estimating walking impairment face the same issue remains to be determined.

Objective: Determining the maximum walking time (MWT) using the treadmill test is the gold standard method for evaluating walking capacity and treatment effect in patients with peripheral arterial disease (PAD). However, self reported functional disability is important when assessing quality of life. Changes in the Walking Estimated Limitation Calculated by History (WELCH) questionnaire scores were compared with the MWT.

Methods: A cross sectional study was performed in patients with intermittent claudication. The treadmill test (3.2 km/h; 10% gradient) and WELCH questionnaire were administered to all patients for objective evaluation of walking capacity. Given the log normal distribution of these parameters in patients with PAD, a log transformation was applied to the WELCH score (LnW) and maximum walking time (LnT). The responsiveness of the WELCH score was determined using mean changes and correlation coefficients of LnW and LnT changes. The effect of time on the "estimated minus real" (E − R) changes (LnW − change minus LnT − change) was assessed after categorisation of patients into various test—retest intervals. Patients who underwent lower limb revascularisation between the two tests and those who underwent medical treatment only were analysed.

Results: Correlation coefficients between LnW and LnT for tests 1 and 2 were $r = 0.514$ and $r = 0.503$, respectively ($p < .001$, for both). Correlation for LnW change vs. LnT change was 0.384 ($p < .001$). E − R was positive only early after surgery. E − R was negative for all test—retest intervals >1 year in revascularised and non-revascularised patients.

Conclusion: Changes in WELCH scores correlated with changes observed on the treadmill in patients with intermittent claudication. For long test—retest intervals, WELCH changes tended to overestimate the worsening of walking impairment as compared with the measured difference observed in both revascularised and non-revascularised patients. A shortlived "honeymoon" (overestimation of the benefit for the shortest test—retest interval) was observed only in revascularised patients.

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INTRODUCTION

Estimation of walking impairment through standard questionnaires is easy, can be routinely performed and scored, and is of major interest in patients with peripheral artery disease (PAD) and claudication.[1] Questionnaire scores are generally validated against different objective

measurements of walking ability.[2–4] The effect of time between the two evaluations, specifically from the lower limb revascularisation procedure on the concordance of subjective to objective changes, has not been analysed. The Walking Estimated Limitation Calculated by History (WELCH) questionnaire[5] is a relatively simple tool to self report walking limitations in PAD. It can be self administered and compares favourably with previously proposed available tools.[2,6] It is currently available in different languages and is easy to use in routine practice.[7–9] Correlation of the WELCH score and objective measures of walking capacity range from 0.58 to 0.82,[6,8,9] and it is not impaired by age.[2] To date, the reliability and sensitivity to changes of the WELCH have not been studied extensively. The effect of the test–retest interval on WELCH changes compared with the changes in treadmill measured maximum walking time (MWT) is unknown.

This study determined whether the WELCH questionnaire was sensitive to changes in walking capacity and how the WELCH score changes compared with objectively measured MWT changes. Next, the aim was to determine whether the relationship between WELCH and MWT changes varied with the test–retest interval and if there was a difference between the two tests in patients who did not undergo revascularisation between the two estimates (medical treatment only) and in those subjected to lower limb arterial revascularisation.

MATERIALS AND METHODS

A cross sectional study was performed among patients referred for walking test investigations. On primary referral, most patients complained of claudication for months and most had previously benefited from optimal medical treatment for PAD. Retest visits were either based on the evaluation of residual limb or non-limb symptoms or sometimes on the surgeon's request for an objective evaluation of functional improvement. Eligibility criteria were age >18 years, the ability to walk on a treadmill, the ability to understand the study goals and instructions of the tests, and self completed questionnaires. The study was approved by the Institutional Review Board and was registered on CNIL (*Commission Nationale Informatique et Liberté*). It was performed according to the International Ethics Standards and conformed with the Declaration of Helsinki. Patients were aware that the results were being recorded during treadmill tests and that this investigation could be used for research purposes and were informed of their right to oppose. All investigators participating in the study were informed on how to perform the investigations, complete the files, and score the questionnaires. The study was registered with ClinicalTrials.gov (Identifier: NCT01424020).

Completion of questionnaires

Each patient was provided a pen and reading glasses (if needed) and received oral instructions on completing the questionnaire on arrival at the laboratory. Each patient self completed the questionnaires in the waiting room of the laboratory before the walking test was performed. The questionnaire included date of the visit, history and ongoing treatments, name and surname, age, sex, body weight, stature, active smoking, and the WELCH (in French). The WELCH is a four item questionnaire that can be self administered. The original questionnaire was developed in French but is currently available in various languages. In brief, the first three items refer to the maximum time that can be sustained when walking at different walking speeds. Answers to each item include proposals ranging from impossible (0 points) to 3 h or more (7 points). The fourth and last item requires the patient to estimate his/her usual walking speed as compared with that of his/her siblings or of people of comparable age. Possible answers ranged from "much slower" (coefficient = 1) to "faster" (coefficient = 5). The WELCH score was calculated as follows. One is subtracted from the sum of the points of the three first items. The result of this subtraction is multiplied by the coefficient of item four. Assuming that patients can walk at least 30 s at a low speed, the final score ranges from 0 (severe disability) to 100 (ability to walk faster than other people for at least 3 h). Note that patients were never reminded of their answers to the previously completed WELCH questionnaires or their previous walking distance on the treadmill. A typical example of filling of the WELCH questionnaire is provided in Fig. 1.

Clinical data and investigations

Patients were admitted to the test room and their usual walking speed was measured between two lines 10 m apart, which were traced on the floor between the waiting room and the testing room. As in previous studies, patients unable to walk 10 m in less than 15 s were considered unable to walk 3.2 km/h on the treadmill and underwent a specific protocol on the treadmill;[10] they were excluded from the study. Technicians, nurses, or physicians supervised the completion of the questionnaires and completed any eventual incomplete items or clinical characteristics from the patient's most recent file or by immediate measurement. The WELCH score; presence/absence of lower limb revascularisation (bypass surgery or angioplasty) in the past or since the first visit for returning patients; age; sex; body weight; stature; and ankle brachial pressure index (ABI) were systematically recorded. Last, the type of revascularisation for the revascularised patients was retrieved from their medical file or from contact with the surgeon (for patients referred from private practice physicians).

Treadmill test

To assess walking capacity, all patients performed a standardised constant load treadmill test under medical supervision, at a constant speed of 3.2 km/h, at a 10% incline progressively reached in 1 min. For patients who were able to walk 15 min (900 s) at a constant workload, at minute 15,

Please answer each of the following 4 items by placing an "x" in the box that best describes your situation. Please mark only one box per item. If you never perform an activity, estimate what it would be like if you did perform it. For the first 3 items, if you think that you would not be able to perform a specified task for at least 30 seconds without stopping to rest, please answer "impossible".

For each of the three following activities, how long can you perform the task easily on level ground & without stopping when...

1/ ... Walking slowly (slower than usual speed of relatives, friends, or other people of your own age)?

Impossible	30 seconds	1 minute	3 minutes	10 minutes	30 minutes	1 hour	3 hours or more
☐	☐	☐	☐	☐	✗	☐	☐
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*

2/ ... Walking normally (same as usual speed of relatives, friends, or other people of your own age)?

Impossible	30 seconds	1 minute	3 minutes	10 minutes	30 minutes	1 hour	3 hours or more
☐	☐	✗	☐	☐	☐	☐	☐
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*

3/ ... Walking quickly (faster than usual speed of relatives, friends, or other people of your own age)?

Impossible	30 seconds	1 minute	3 minutes	10 minutes	30 minutes	1 hour	3 hours or more
✗	☐	☐	☐	☐	☐	☐	☐
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*

Compared to the usual walking speed of your relatives, friends, or people of your own age, do you think that you personally usually walk ... (Tick only one box)

much slower	☐	*1*
moderately slower	☐	*2*
a bit slower	✗	*3*
at the same speed	☐	*4*
faster	☐	*5*

THANK YOU: You should have 1 box per item ticker... please check.

$$\underline{\text{WELCH score}} = [(5+2+0)–1] \times 3 = \underline{18}$$

**Figure 1.** English version of the Walking Estimated Limitation Calculated by History (WELCH) questionnaire with example of scoring.

the protocol was changed to an incremental load protocol with steps of 1 min duration until exhaustion or pain limitation.[11] The treadmill tests were performed with 12 lead electrocardiogram monitoring. The test variable used during the treadmill test was the MWT, defined as the time that severe claudication pain forced cessation of exercise or as the time that the test was interrupted for medical reasons (severe cardiac arrhythmia, abnormal repolarisation, etc.).

Data analysis

From the laboratory database, patients who had undergone at least two different consecutive tests were selected. For patients who had performed multiple tests, only the last two visits were analysed because of data accessibility. It was previously reported that in patients with limiting claudication, both MWT treadmill constant load tests[12] and WELCH scores[6] show a log normal distribution in patients with PAD

Figure 2. Flowchart of database analysis and resulting study population.
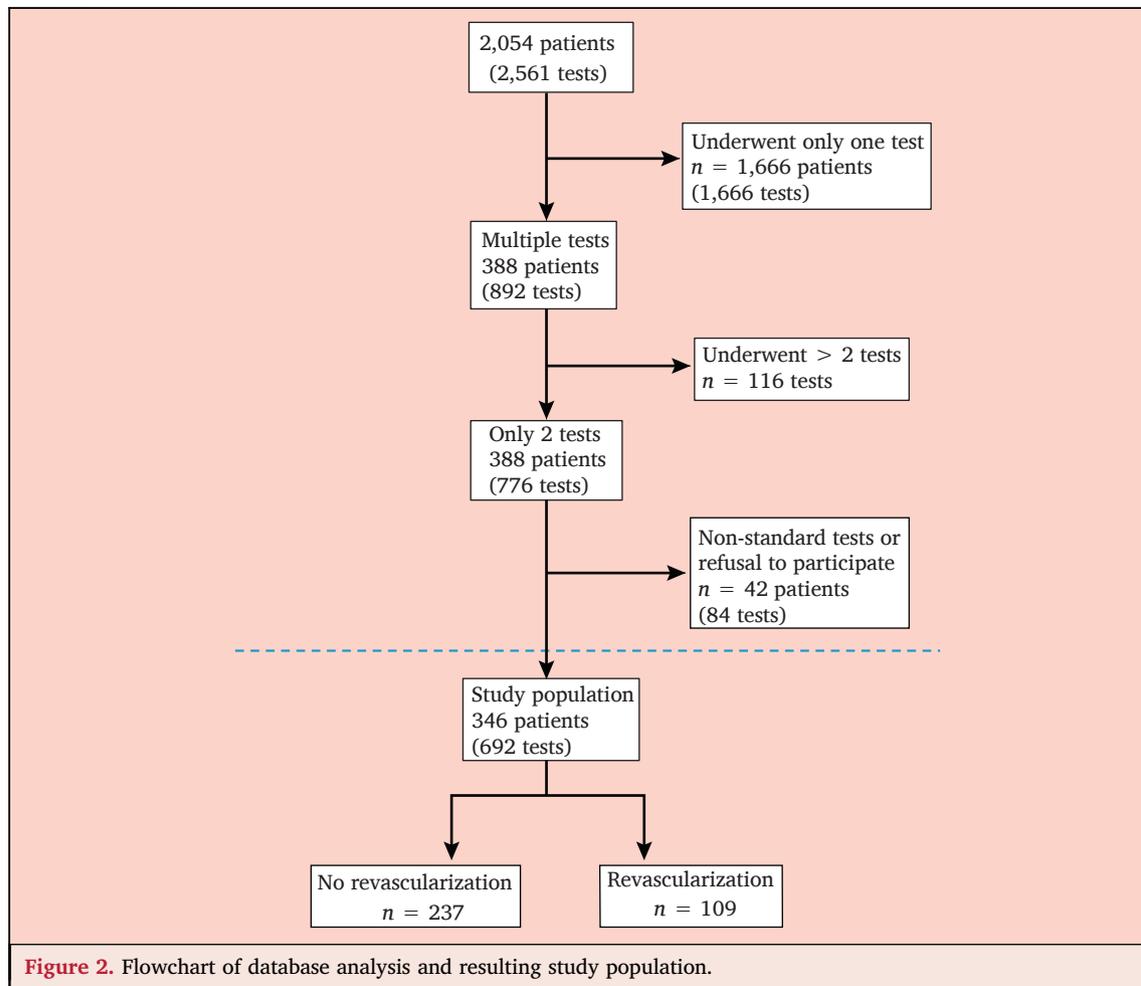
complaining of exertional limb pain. Subsequently, the MWT and WELCH scores were log transformed for analysis and were referred to as LnT and LnW, respectively. Changes in MWT and WELCH scores were calculated as the difference in the LnT or LnW determined in the second test from the respective LnT and LnW determined at the first visit and were analysed for the whole population. The Spearman "r" coefficient of correlation between LnT and LnW changes was estimated to be 0.30. This was determined from previous studies, which showed the correlation of the walking impairment questionnaire score to maximum walking distance was 0.33,[4] and because the correlation of the WELCH score and treadmill MWT was found to range from 0.58 to 0.61;[6] thus, the resulting estimation of the correlation to be expected for WELCH and MWT changes was the square of the "r" correlation values (0.34–0.37). For the alpha two tailed 0.05 and 80% power, the minimal observation number was 85.

Thereafter, patients were divided into two groups: patients who underwent medical treatment only between their two tests (non-revascularised group) and patients who had some form of lower limb revascularisation between their two tests (S group). In each group, time intervals were categorised into six test–retest intervals as follows: test–retest intervals ranging from 0 – < 6 m, 6 m – < 12 m,

1 – < 2 y, 2 – < 3 y, 3 – <4 y, and ≥4 years. For each test–retest interval, the median duration of the test–retest interval was recorded. Within each interval, the mean and SEM of the difference between LnW changes and LnT changes was calculated. This difference was noted as E − R. In practice, E − R was assumed to reflect overestimation of the benefit or underestimation of the impairment (positive difference) or the inverse, underestimation of the benefit or overestimation of the impairment (negative difference) of the subjective estimation of walking impairment evolution (WELCH questionnaire) as compared with the "real" objective evolution in the MWT between the two visits. A database analysis was performed on the observation of at least six non-revascularised and revascularised patients, in each test–retest interval.

Statistical analysis

Results are presented as mean ± SEM when normally distributed, as median (interquartile range [IQR]) when appropriate, and as percentages. The unpaired *t*-test, Mann–Whitney test, and chi-square test were used to compare non-revascularised and revascularised patients. ANOVA with Dunnett's post-hoc test was used to compare patients within different test–retest intervals with patients

with the shortest (0 to < 6 m) interval. Two tailed paired *t*-tests were used for LnT and LnW to compare results of the first and second test, respectively. Correlation of the LnW changes with LnT changes was analysed for the whole population. Non-linear logarithmic models were chosen as apparent models that best fitted the values observed for mean E − R for the six test—retest intervals in non-revascularised and revascularised patients. Statistical analyses were performed using SPSS V15.0 (IBM, Armonk, NY, USA). For all tests, a two tailed *p* value of < 0.05 was used to indicate statistical significance.

RESULTS

This study included 346 consecutive patients with a mean age of 61.9 years; 87% were men. A flowchart of recruitment is presented in Fig. 2. Baseline characteristics of the study population are presented in Table 1. Among the revascularised patients, 52 had an aortic and/or iliac angioplasty, 31 femoral and/or popliteal angioplasty, 14 aortic and/or iliac bypass surgery, and 12 femoral and/or popliteal bypass surgery between the two tests. No significant difference in morphology or treatment was found between non-revascularised and revascularised patients. However, at baseline, both PAD (lower ABI) and walking impairment were more severe (lower WELCH score and lower maximum walking time on treadmill) in revascularised than in non-revascularised patients. The WELCH scores of the 346 patients were 20 (IQR 10—33) vs. 22 (IQR 10—39) (Wilcoxon's *p* = .27), based on the first and second test, respectively. Table 2 reports the major characteristics of the revascularised and non-revascularised patients as a function of test—retest interval.

No complications were noted during the walking test, although 153 (44.2%) and 149 (43.1%) patients reported dyspnoea, fatigue, or chest pain during tests 1 and 2, respectively. Fifty-nine of the patients studied at test 1 and 94 of the patients studied at test 2 reached the incremental phase of the treadmill test (MWT > 900 s).

The correlation coefficient between LnW and LnT was *r* = 0.514 in test 1 and *r* = 0.503 in test 2, respectively (*p* < .01 for both) (Fig. 3). The correlation for LnW change vs. LnT change was 0.384 (*p* < .01).

The LnW and LnT values observed for the six test—retest intervals are shown in Fig. 4. On average, the revascularised patients showed an increase in walking time (LnT was 0.65 for the shortest test—retest interval and 0.58 for the largest test—retest interval) after revascularisation, while the non-revascularised patients had minimal, if any, increase in walking time between their tests, irrespective of the test—retest interval (LnT being slightly above or close to zero). Of note, in most patients, the first evaluation was performed while medical treatment was optimal and not when the diagnosis of PAD was determined. Therefore, non-revascularised patients generally presented stable, previously diagnosed, claudication. Only 18 patients were evaluated during the first test before the onset of medical therapy (start of antiplatelet and/or cholesterol

Table 1. Baseline characteristics of the study population (n=346)

	No revascularisation (n=237)	Revascularisation (n=109)	*p*-value
Age, years	61.6 ± 9.3	62.5 ± 9.6	.40
Men	206 (87)	95 (87)	.95
Body mass index, kg/m²	27.1 ± 4.4	27.1 ± 4.6	.89
Antiplatelet drugs	209 (88)	98 (90)	.64
Antihypertensive drugs	178 (75)	76 (67)	.29
Cholesterol lowering drugs	189 (80)	89 (82)	.68
Antidiabetic agents	59 (25)	29 (27)	.73
History of previous lower limb bypass	98 (41)	35 (32)	.10
Resting ankle brachial index	0.80 ± 0.22	0.73 ± 0.21	.004
Current smoker	83 (35)	40 (37)	.76
Median WELCH score (IQR)	22 [12-36]	18 [10-28]	.005
Logarithmic value of WELCH score	2.98 ± 0.84	2.72 ± 0.84	.005
Median maximum walking time (IQR), sec	324 [209-756]	213 [150-345]	.001
Logarithmic value of walking time on treadmill	5.90 ± 0.81	5.51 ± 0.66	.001

Data are presented as mean ± standard deviation or n (%), unless indicated otherwise. IQR = interquartile range; WELCH = Walking Estimated Limitation Calculation by History.

lowering drugs) or before referral to a rehabilitation programme. Furthermore, the change in self reported evaluation of walking capacity (through the change in WELCH score) decreased with an increase in the test—retest interval. LnT started from 0.99 and decreased to −0.02 in revascularised patients and decreased from 0.01 to −0.53 in non-revascularised patients. As a result, the E-R difference (Fig. 5) was negative in all except one case and generally decreased with an increase in the test—retest intervals. The only exception was for the shortest interval corresponding to the pre- and early post-revascularisation estimation in the non-revascularised group. This was the only group in which the subjective estimation of changes by the patients (LnW of the WELCH score) was, on average, higher than the objective measurement of changes (LnT of the MWT on the treadmill). Note that the SEM of the 2—3 year interval was large given the limited number of observations (*n* = 6).

DISCUSSION

The present study aimed to determine whether the WELCH questionnaire is sensitive to changes in walking capacity

Table 2. Major characteristics of patients in each of the test—retest intervals of 237 non-revascularised (medically treated) and 109 revascularised patients

Test—retest interval	Subjects (n)	Age, years	Men	Body mass index, kg/m²	ABI	ABI change	Current smoker
Not revascularised							
0 − < 6 mo	47	60.0 ± 9.9	35 (75)	26.2 ± 4.2	0.78 ± 0.24	0.01 ± 0.18	17 (36)
6 − < 12 mo	57	63.3 ± 8.5	45 (79)	27.9 ± 4.6	0.82 ± 0.20	−0.01 ± 0.19	13 (23)
1 − < 2 y	69	62.4 ± 8.9	64 (93)	27.6 ± 4.2	0.80 ± 0.24	−0.04 ± 0.19	19 (28)
2 − < 3 y	35	61.8 ± 10.7	33 (94)	26.3 ± 4.7	0.84 ± 0.19	−0.05 ± 0.22	5 (14)
3 − < 4 y	19	60.6 ± 8.5	19 (100)	26.6 ± 3.8	0.82 ± 0.17	0.01 ± 0.15	6 (32)
≥4 y	10	56.7 ± 10.1	10 (100)	26.8 ± 4.7	0.68 ± 0.15	−0.01 ± 0.14	1 (10)
Lower limb revascularised							
0 − < 6 mo	34	60.5 ± 10.7	26 (76)	26.6 ± 4.1	0.68 ± 0.17	0.19 ± 0.22	11 (32)
6 − < 12 mo	33	64.0 ± 8.5	30 (91)	27.4 ± 4.8	0.75 ± 0.20	0.17 ± 0.27	7 (21)
1 − < 2 y	18	63.4 ± 10.0	18 (100)	25.8 ± 4.7	0.70 ± 0.28	0.03 ± 0.21	7 (39)
2 − < 3	6	59.7 ± 8.8	6 (100)	27.9 ± 4.3	0.87 ± 0.24	0.07 ± 0.26	1 (17)
3 − < 4 y	10	65.9 ± 8.1	10 (100)	26.3 ± 3.1	0.74 ± 0.16	0.11 ± 0.12	3 (30)
≥4 y	8	64.5 ± 11.3	8 (100)	30.2 ± 6.4	0.83 ± 0.32	0.03 ± 0.23	1 (12)

Data are presented as mean ± standard deviation or n (%), unless indicated otherwise. No significant change for any variable from the first group in non-revascularised or revascularised patients except for sex. Ankle brachial index (ABI) is the value at first visit.

and how the WELCH score changes compared with objectively measured changes MWT. It has been show that the WELCH score is as consistent in objective measurements as other, more complex tools and is an easy to use instrument that can determine changes in the walking capacity of patients with PAD. The correlation coefficient identified ($r = 0.38$) may appear low; however it is higher than the objective and subjective instruments of other studies. A previous study that assessed the effect of an intervention and observed a larger range of change found a correlation of changes in the treadmill distance with changes in the distance sub-scores of the walking impairment questionnaire, ranging from $r = 0.31$ to $r = 0.34$.[13,14] Comparable results were reported with Short Form 36 physical summary score changes of $r = 0.29$ or using the intermittent claudication questionnaire changes of 0.38.[13,14]

The original observation of the effect of interval duration on the relationship between WELCH and MWT changes in non-revascularised and patients is of specific importance. The non-revascularised patients showed no major differences in walking capacity (change in LnT close to 0) for the various time intervals, whereas changes in LnT were >0 for all test—retest intervals in non-revascularised patients. While the shortest test—retest LnW interval was also close to 0, LnW decreased with longer test—retest intervals. Thus, the E − R decreased with the increase in the test—retest interval. It was previously demonstrated that the WELCH was independent of age and the largest interval was only five years. Depression and anxiety are frequent symptoms in cardiovascular patients.[15–17] Whether mood changes could explain the results for long test—retest intervals remains to be determined. Overall, determining whether self reported or treadmill measured changes should prevail in the decision to revascularise a patient with PAD is open to debate.

Another interesting observation is the initial transient overestimation (positive E − R) in revascularised patients.

Conversely, "overestimation of the benefit" in revascularised patients could result from fear of a negative outcome before arterial revascularisation.[18] However, it is well known that initial excellent results one year after lower limb arterial revascularisation progressively worsen with time.[19] Subsequently, many patients become symptomatic again on a mid- and long-term basis after arterial revascularisation, facing the same issues of chronic pain and disease as non-revascularised patients. Nonetheless, the positive E − R phenomenon is a shortlived honeymoon.

Determining the changes in walking ability and evolution of walking impairment in patients with PAD is of major importance in routine clinical trials and research trials. Laboratory investigations (among which treadmill testing is the recommended "gold standard"), are time consuming, and are not necessarily accessible to physicians in routine clinical settings. Furthermore, results are influenced by the protocols used and may not optimally reflect overall walking impairment. Although subjective, questionnaires are of interest when accounting for the perceived impact of PAD in a patient's life. Various disease specific or non-disease specific tools are available. The "walking impairment questionnaire", the "intermittent claudication questionnaire", the "claudication scale", and the "vascular quality of life" questionnaires are generally considered specific for patients with PAD.[13,20–22] These questionnaires are long and impractical, with each including >14 items. A shorter version of the original 25 item "vascular quality of life" is available, but it focuses on the impact of walking impairment on usual activities, rather than on the severity of walking impairment itself.[23] Of these tools, the walking impairment questionnaire is the most widely used, with >150 references found in a MEDLINE search. Unfortunately, the questionnaire is lengthy, subject to errors when self completed, and cannot be scored simply by mental calculations.[5,24]

The fact that studied groups included different patients may represent an issue, with small clinical differences
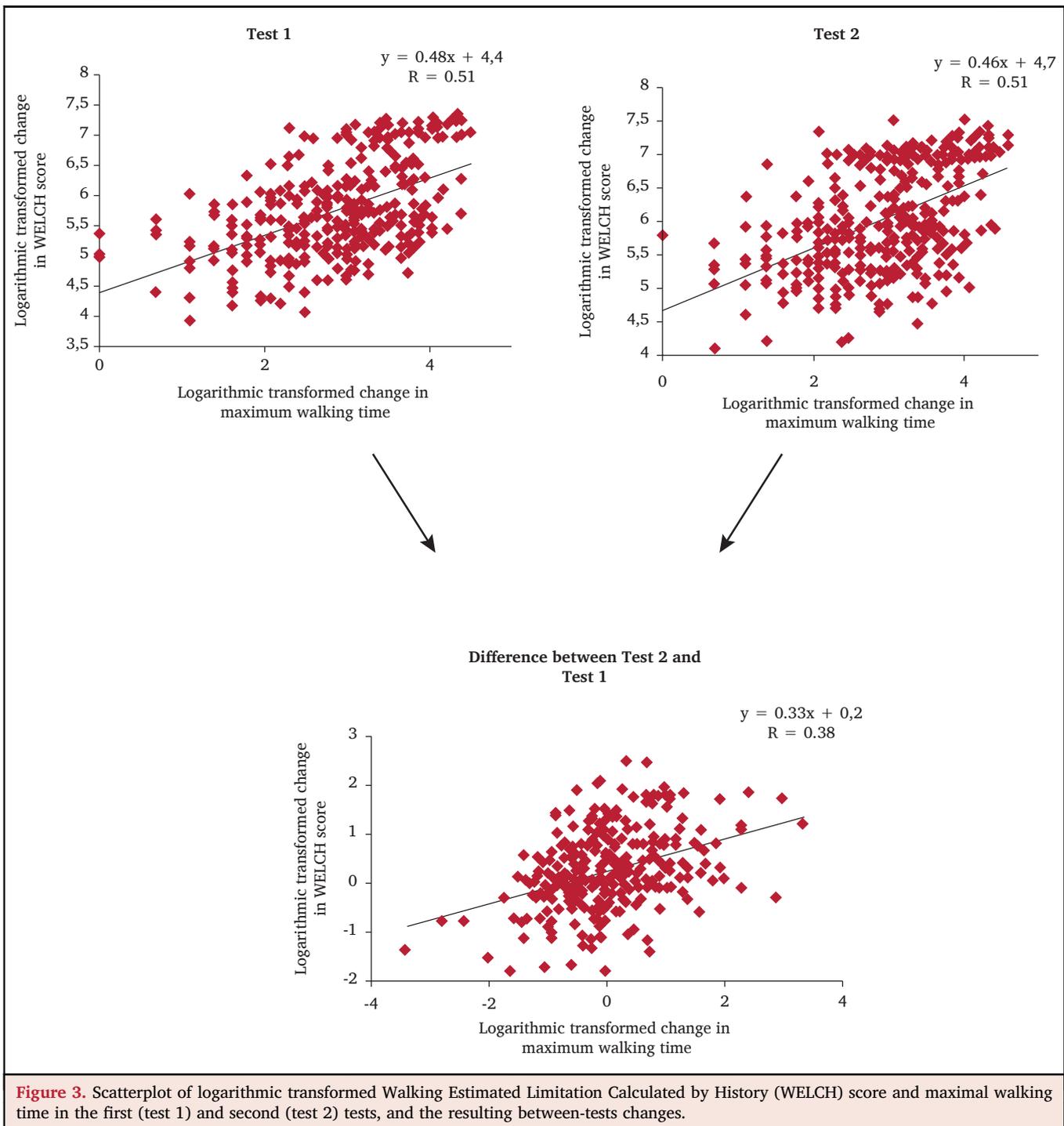
Figure 3. Scatterplot of logarithmic transformed Walking Estimated Limitation Calculated by History (WELCH) score and maximal walking time in the first (test 1) and second (test 2) tests, and the resulting between-tests changes.

between the groups. A prospective study with repeated measurements would be a better approach; nevertheless, the feasibility of a prospective approach over a four year period is debatable for technical and financial reasons. In this cross sectional observational study, no patient pre-defined visits were proposed according to a predefined interval. Thus, there may be a bias with patients referred for multiple tests that are not comparable to general patients with PAD. A second issue involves the interval between tests that may slightly differ from the interval between revascularisation and the second visit in the revascularised group. This is only true for the largest test—retest interval because for the shortest intervals, the first visit generally preceded the revascularisation by approximately a few weeks. A third limitation is that comorbid conditions that may have occurred (or become exacerbated) during the interval between the two tests were not accounted for because the data submitted for analysis focused only on vascular diseases. It cannot be excluded that the self reported limitation could be influenced by an underlying cause (vascular vs. non-vascular) of the walking impairment. To date, the WELCH survey has not been tested in non-
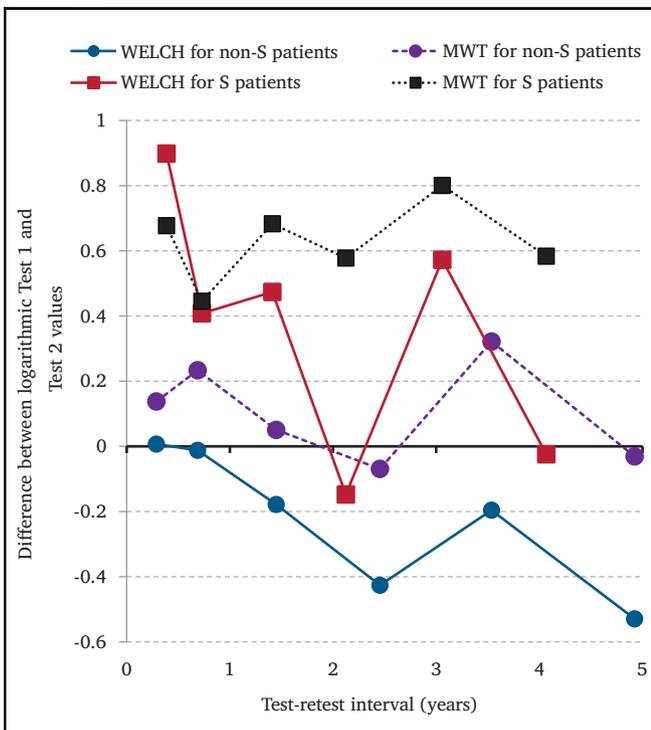
Figure 4. Mean logarithmic transformed Walking Estimated Limitation Calculated by History (WELCH) score (LnW) and maximum walking time (LnT) observed for the six test—retest intervals in patients who received medical treatment (non-revascularised [non-S]) or revascularisation (S) between tests 1 and 2. MWT = maximum walking time.
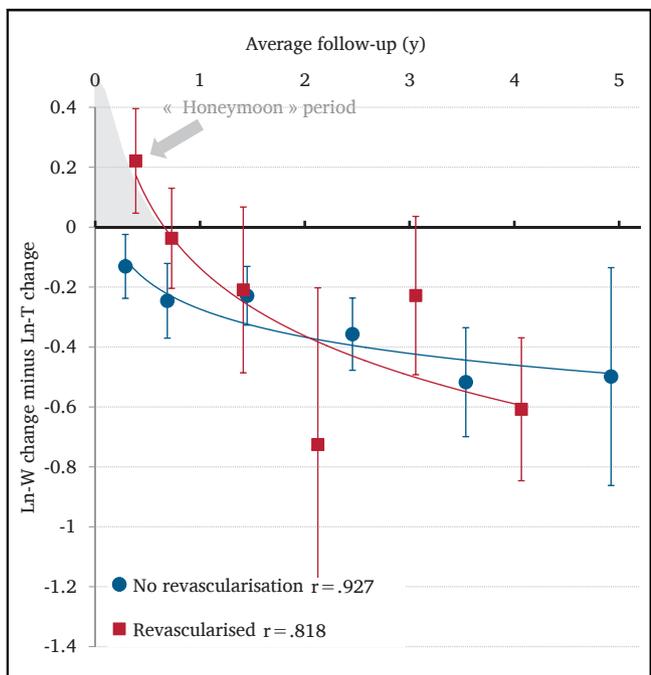

Figure 5. Changes (test 2 − test 1) in logarithmic transformed Walking Estimated Limitation Calculated by History (WELCH) scores (LnW) and maximum walking time (LnT) observed for the six test—retest intervals. R is the Spearman coefficient of correlation of the regression analysis of average LnW changes and LnT changes. The grey zone is the "honeymoon period" during which the self reported difference was superior to the measured difference in the treadmill test for patients with lower limb revascularisation. Each point indicates the mean and standard error mean.

vascular populations. Obviously, the difference in self reported and measured changes observed with test—retest interval in the revascularised group could also depend on a deterioration of the revascularisation over time in successful vs. unsuccessful revascularisation procedures. Unfortunately, there was no access to information on the primary patency of revascularisation. Of interest is the fact that the MWT difference between test 2 and test 1 remained positive for revascularised patients, while the WELCH score difference was, indeed, positive for short test—retest intervals but decreased with larger intervals (Fig. 4). Furthermore, the time evolution in the self reported vs. measured changes observed in the non-revascularised patients (Fig. 5) was similar to that of the revascularised patients, despite apparently comparable ABIs for the non-revascularised groups. Thus, it appears that the evolution of differences in changes are unrelated to haemodynamic changes

CONCLUSION

The WELCH questionnaire is a valid tool with which to detect changes in the daily walking ability of patients with intermittent claudication. The self reported WELCH score tends to decrease more than an objective measurement of walking impairment, especially if the test—retest interval is long. After revascularisation, a shortlived "honeymoon" (overestimation of the objectively measured change on the treadmill) may be observed. This honeymoon appears to last <1 year, after which revascularised patients follow the same evolution as non-revascularised patients for large test—retest intervals.

In patients with PAD, a self reported worsening identified using the WELCH score during two consecutive visits >1 year apart should probably be systematically confirmed on a treadmill, before a decision to revascularise is taken. Whether other questionnaires aiming at estimating walking impairment face the same issue remains to be determined.

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejvs.2018.11.015.

CONFLICT OF INTEREST

None.

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