Global Positioning System Use in the Community to Evaluate Improvements in Walking After Revascularization

A Prospective Multicenter Study With 6-Month Follow-Up in Patients With Peripheral Arterial Disease

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Abstract: Revascularization aims at improving walking ability in patients with arterial claudication. The highest measured distance between 2 stops (highest-MDCW), the average walking speed (average-WSCW), and the average stop duration (average-DSCW) can be measured by global positioning system, but their evolution after revascularization is unknown.

We included 251 peripheral artery diseased patients with self-reported limitation (highest-MDCW recorded by a global positioning system receiver. Patients (n = 172) with confirmed limitation (highest-MDCW <2000m) at inclusion were reevaluated after 6 months. Patients revascularized during the follow-up period were compared with reference patients (ie, with unchanged lifestyle medical or surgical status). Other patients (lost to follow-up or treatment change) were excluded (n = 99).

We studied 44 revascularized and 39 reference patients. Changes in highest-MDCW (+442 vs. +13 m) and average-WSCW (+0.3 vs. −0.2 km h⁻¹) were greater in revascularized than in reference patients (both p < 0.01). In contrast, no significant difference in average-DSCW changes was found between the groups. Among the revascularized patients, 13 (29.5%) had a change in average-WSCW, but not in highest-MDCW, greater than the mean ± 1 standard deviation of the change observed for reference patients.

Revascularization may improve highest-MDCW and/or average-WSCW. This first report of changes in community walking ability in revascularized patients suggests that, beyond measuring walking distances, average-WSCW measurement is essential to monitor these changes. Applicability to other surgical populations remains to be evaluated.

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INTRODUCTION

Patients with intermittent claudication resulting from lower-extremity peripheral artery disease (PAD) report impaired walking ability, as can also do patients with lumbar spinal stenosis, lower-limb neuropathy or certain musculoskeletal conditions. In claudication, the maximal walking distance (MWD) is defined by the distance covered before limb discomfort or pain forces the patient to stop. PAD = Peripheral Arterial disease. PASE = Physical Activity Scale for the Elderly. WIQ = Walking Impairment Questionnaire, WS CW = Walking Speed During Community Walking: Mean walking speed between two stops during community walking.
symptom-limited community walking. The duration of a walking stop has been shown to be a major determinant of immediately forthcoming walking ability. However, to date, changes in highest-MDCW, average-WSCW and average-DSCW have not been specifically studied in revascularized or reference patients (ie, an unchanged medical or surgical status).

We analyzed the following hypotheses: On average, highest-MDCW and average-WSCW would increase and average-DSCW would decrease (for those patients who still had to stop) due to revascularization, whereas no change would be observed in the reference group; At the individual level, various walking strategies (ie, in walking speed and or in distance) would be observed among revascularized patients, with certain patients preferentially increasing their highest-MDCW after revascularization, whereas other patients would preferentially increase their average-WSCW. This point was of particular interest because if this hypothesis were true, the estimation of MWD alone with the usual tools could lead to underestimation of the functional benefit for those patients who increase their average-WSCW rather than their highest-MDCW; and WIQ-distance score changes and highest-MDCW changes would be reasonably correlated together whereas a weaker correlation would be found between WIQ-speed score changes with average-WSCW changes.

METHODS

The protocol was approved and monitored by the University Hospital of Angers (France) and performed according to the international ethics standards and the Declaration of Helsinki. The “Post-GPS” study was approved by the CPP-Ouest-II ethics committee and registered under the reference no. NCT01141361 (ClinicalTrials.gov). Twenty different physicians participated in the study (9 angiologists, 8 vascular surgeons, 2 cardiologists, and 1 rehabilitation physician). The present multi-center study is the second part of previously reported results on the applicability of GPS recording in clinical routine.

Inclusion Criteria

Patients fulfilling the inclusion criteria (Table 1) were invited to participate. Patients provided written consent after being provided with oral and written information about the protocol.

Procedures

We recorded the characteristics of each patient, including gender, age, stature, body weight, the ankle-to-brachial index (ABI; lowest right or left ABI, with ABI calculated as the highest ankle value divided by the highest arm pressure) and self-reported MWD. Thereafter, patients were provided clinical questionnaires that included specific items asking about their medical and surgical histories and ongoing medication, in addition to the Physical Activity Scale for the Elderly (PASE) questionnaire and the WIQ. Lastly, patients were given oral and written walking (Figure 1) and technical instructions as well as a GPS device to record a 1-hour outdoor stroll in the community. To avoid any confusion between the walking ability measured by the questionnaires and the ability measured by GPS, the outdoor community walk is referred to as a “stroll” throughout this paper, although patients were asked to walk at a regular pace. A pre-stamped envelope was provided to each patient to return the questionnaires and the GPS device to the coordinating center after the stroll. As previously reported, we used DG-100 GPS data loggers and the AT-65 GPS Active Antenna (GlobalSat Technology Corp., New Taipei City, Taiwan) that included the “European Geostationary Navigation Overlay Service” function. The recording rate was preset to 0.5 Hz. Patients only had access to the start and stop buttons of the recorder. Patients were asked to walk at their usual pace for 1 hour on a flat area free of compact trees or buildings. They were instructed to stop only because of lower limb pain and not necessarily to wait for the pain to disappear before beginning walking again.

GPS Analysis

Validation of the use of the GPS technique to analyze walking parameters in healthy and PAD patients has been reported elsewhere. In brief, GPS-derived parameters included the total distance walked, the total duration of the walk (including the stop duration), the number of stops, highest-MDCW, average-WSCW and average-DSCW. A technically satisfactory recording was defined as: a total walk duration >30 minutes, the presence of recorded data in the GPS device, and the presence of identifiable periods of walking (a succession of periods of displacement compatible with walking, that is, with speeds between 1 and 10 km h⁻¹ and with durations of at least 10 seconds). At time-0 (T0) and time-1 (T1), if the recording was not technically satisfactory, a second attempt was performed within a month of the first attempt.

Follow-up, Exclusion Criteria and Inter-Current Events

Please note that the study is not randomizing patients into different treatment groups but just observing what happened over the follow up period. Following the initial 1-hour stroll

| TABLE 1. Inclusion and Exclusion Criteria |
| Inclusion criteria |
| Age >18 years old |
| Clinical stability of vascular-type intermittent claudication* in the last 3 months |
| Self-reported maximal walking distance ≤500 m |
| Ankle-to-brachial index at rest <0.90 or a history of lower limb revascularization |
| Absence of any systemic disease limiting exercise other than claudication |
| Absence of myocardial infarction in the last 6 months |
| Absence of heart disease requiring surgery |
| Absence of angina pectoris |
| Absence of sustained ventricular arrhythmias |
| Absence of abdominal aortic aneurysm >40 mm |
| Absence of uncontrolled hypertension |

| Exclusion criteria |
| Highest GPS-measured distance in the community not available or >2000 m at T0 |
| Missing data for the GPS recording at 6 months |
| Modified treatment other than lower limb revascularization |

* Vascular-type intermittent claudication was defined as limb fatigue, discomfort, or pain that did not exist at rest, that occurred during walking, that forced the individual to stop and that resolved within 10 minutes of rest.
INSTRUCTIONS FOR THE WALK

We thank you for kindly agreeing to participate in the POST-GPS study.
You must be currently sitting or standing still close to a chosen location that is done to a river, seawall, public park, athletic running track, pedestrian field, etc. Please note that the second stroll should be performed at the same place as the first one. Please take a few minutes to completely read the following instructions.

Place the strap as shown in this figure over your coat, with the antenna (small black cube) on the top of your shoulder. The GPS device should be around the belt, as in the adjacent figure. Please remain seated or standing (not walking) for a few minutes (30 minutes or until) in order to read the following instructions.

We would like to remind you that:
- Once the GPS is turned on, you should wait for 10 minutes before starting your walk.
- You should walk at your usual walking pace. Do not walk slowly to try to avoid stop periods or at a forced pace.
- The walk should last 1 hour (excluding the initial walking period of 10 min).
- Please do not stop as soon as pain occurs: only stop when pain becomes unbearable.
- You can restart the walk whenever you want after a stop period.
- The stop durations are included in the total overall walk.
- Please do not stop to look at the landscape or other things. All your stops should be due to walking-induced limb pain.
- You can be accompanied by a relative or a friend, provided that you walk at your own pace.
- Please do not walk with a dog.

It probably took you 2 to 3 minutes to read this test. This may not be enough time to obtain an accurate signal for the GPS to be ready for recordings (flashing green LED). Even if the GPS seems ready, please wait for a few more minutes (a total of 10 minutes) and then enjoy your walk.

FIGURE 1. English translation of the recto-verso recommendation sheet provided to each patient for the stroll.

(T0), patients for whom a technically satisfactory GPS recording was not available at T0 or who had GPS recording results that were inconsistent with walking limitations (ie, highest-MDCW >2000 m) were excluded. Patients with a successful T0 measurement underwent a second test 6 months later (T1). T1 was eventually delayed to allow a minimum of 3 months to elapse after any surgical or medical event (e.g., revascularization, change in treatment, non-vascular surgery, infraction, and stroke). For the T1 test, the participating patients were recommended to follow the same instructions as for the first test. Following the walk at T1, these patients were asked to complete items on whether they had to stop for any reason other than limb pain (e.g., dyspnea, road crossing, tying shoelaces, urinating, etc.), whether or not they experienced lower limb pain during the walk. Finally, patients for whom no technically satisfactory GPS recording could be obtained after 2 attempts at T1 were also excluded from the study.

Analysis of Data

Patients were classified into the following groups based on treatments or medical status changes that occurred over the study follow-up period: i) revascularized patients were patients who had any type of lower-limb arterial surgery or angioplasty between T0 and T1; ii) reference patients were patients who had no apparent changes in their treatments or medical status and no revascularization procedures between T0 and T1; and iii) patients who had any type of medical or non-vascular surgical intervention between T0 and T1 (e.g., bone or spine surgery, rehabilitation program, modification of cardiovascular drug regimen) were excluded from the study. Excluded patients with available T0 and T1 tests (n=32) are described in Supplemental Digital Content 1, http://links.lww.com/MD/A265.

Statistical Analysis

The normality of distribution was first assessed for variables of interest using the Kolmogorov-Smirnov test. For continuous variables, the data are expressed as the mean ± standard deviation (SD) for normally distributed variables and as the median [25th;75th percentiles] for non-normally distributed variables. For categorical variables, the data are expressed as numbers and percentages. Accordingly, for continuous variables, between-group differences were examined using paired-t tests (normally distributed variables) or a Wilcoxon test (non-normally distributed variables). For categorical variables, Fisher’s exact test was used to assess differences between groups.

We referred to the mean ± 1 SD of the changes observed in the reference group to detect meaningful improvements (ie, minimal clinically important improvement: MCI) in highest-MDCW, average-WSCW, WIQ-distance and WIQ-speed among the revascularized compared with the reference patients. The concordance between GPS changes and WIQ changes in speed or distance were analyzed with linear regression analysis and Pearson’s coefficient of correlation. For all statistical tests, a 2-tailed probability level of P < 0.05 was used to indicate statistical significance. SPSS (V15.0 SPSS Inc., 2004) was used for all statistical analyses. The study was designed to include 250 patients, assuming that nearly half of the patients would have no limitations while walking at T0, would be lost to follow-up, or would have unsatisfactory recordings. We also expected that at least one-third of the patients would undergo revascularization during the follow-up period.
RESULTS

Population Description

Of the 251 included patients, only 172 had limitations confirmed with GPS at T0 (79 exclusions). Among these 172 patients, 57 patients were excluded, mostly because they refused to perform the second test at T1, and another 32 were excluded because they could not be classified in the reference group because they had no revascularization but changes in medical, lifestyle or non-vascular surgical status between T0 and T1 (Figure 2). The clinical characteristics and results of the included patients at T0 are presented in Table 2. Note that the ABI was missing for 14 patients, either because “non-measurable pressure” or “incompressible arteries” were noted or, in 1 case, because of values that were missing from the data file. Of the 83 studied patients, 44 underwent revascularization (24 had angioplasty, and 20 had surgery) between T0 and T1 (Table 3). The median time interval between revascularization and T1 was 143 [110;176] days. In total, 39 patients reported no revascularization and no significant changes in treatments, rehabilitation or smoking habits between T0 and T1 (reference patients). Additionally, as shown in Table 2, no differences were found between revascularized and reference patients at T0. Thus, no adjustment was required in further analyses of changes in GPS parameters or other functional parameters between T0 and T1. As is also shown in Table 2, few PASE and WIQ questionnaires could not be scored despite the use of pre-defined rules to account for missing answers, because the patients had not filled out the questionnaires adequately.

GPS Results

Two typical examples of GPS recordings, 1 in a patient who experienced revascularization and in a reference patient, are presented in Figure 3. Figure 3 illustrates the variability in walking bouts and stop durations observed at T0 and T1 and provides the values of highest-MD_{CW}, average-DSCW and average-WSCW. As shown, important variability existed in the peak distances before each stop and in the stop durations during each stroll, whereas walking speed (which can be visually estimated from the slope of each walking bout) remained relatively stable throughout the different walking periods during the stroll. The revascularized patient (upper panel) had circled around 2 football fields. After revascularization, both highest-MD_{CW} and average-WSCW increased, whereas average-DSCW decreased at T1 compared with T0.

FIGURE 2. Flow diagram of the patients, with the corresponding numbers of technically satisfactory GPS recordings and the causes of technically unsuccessful GPS recordings.
The reference patient (lower panel) walked along a lake during both strolls. Of interest is the fact that during T1, the patient B stopped multiple times for very short durations but covered a relatively long distance when the previous stop was long enough.

### TABLE 3. Type of Revascularization Occurring Between T0 and T1 Among Patients in the Revascularization Group

| Type of Revascularization | N (%)  |
|---------------------------|--------|
| Surgery                   | 20 (45.5%) |
| Angioplasty               | 24 (54.5%) |
| Level of the revascularization |          |
| Femoro-popliteal          | 11      |
| Aorto-liiac               | 32      |
| Infra-popliteal           | 1       |

The number of patients as well as the percentage are reported in the case of missing values.

### Average Changes Between T0 and T1

Changes in walking limitations that were estimated by the questionnaires and measured by GPS are reported by group in Table 4. As shown, for nearly all questionnaire results, the differences observed in revascularized patients were significantly higher than those found in reference patients. For GPS, the increases in highest-MD_{cw} and average-WSCW were significantly higher than in reference patients. However, although the decrease in average-DS_{cw} was nearly 2 times higher in revascularized than in reference patients among those patients who still had to stop at T1, this difference did not reach statistical significance (P = 0.0767).

### Individual Changes Between T0 and T1

When using the mean ± 1 SD of the changes in the reference group as limits for the detection of MCII among the 44 revascularized patients, 13 patients (29.5%) had MCII in both highest-MD_{cw} and average-WSCW, 3 patients (7%) had MCII in highest-MD_{cw} but non-improved average-WSCW, and 13 (29.5%) patients had MCII in average-WSCW but not
highest-MDCW. The other 15 patients (34%) had no MCII in either the average-WSCW or highest-MDCW compared with the reference patients, as shown in Figure 4 (upper panel). However, among the 37 revascularized patients with available data for WIQ distance and speed sub-scores, 2 (5.5%) patients had MCII in both the WIQ distance and speed sub-scores, no patient (0%) had MCII in only the WIQ distance sub-score, and 10 (27%) patients had MCII in the WIQ speed sub-score but not the WIQ distance sub-score. The other 25 patients (67.5%) had no MCII in either the distance or the speed WIQ sub-scores compared with reference patients, as shown in Figure 4 (lower panel).

Concordance of GPS and Questionnaire Changes

Finally, the correlation of highest-MDCW changes with WIQ-distance changes was statistically significant in the patients who had all data available (n = 96, r = 0.599; P < 0.001). The correlation of average-WSCW changes to WIQ-speed changes was also significant (n = 102, r = 0.394; P < 0.001).

DISCUSSION

Isolated case reports using GPS after spine surgery\textsuperscript{16} or amputation\textsuperscript{17} have recently been published. To the best of our
Though highest-MDCW determined by GPS generally ranges from 37% to 203%, no study to date has simultaneously evaluated WSCW and average-DSCW after surgery, specifically after revascularization. Many studies have analyzed the changes in MWD-on-treadmill or the changes in the WIQ score after revascularization, with results ranging from 163% to 176% and from 37% to 203%, respectively, but the correlation coefficient between the change in the total WIQ score and changes in WSCW. Specifically, very few patients reported isolated speed improvement in such patients. Another possibility could be that GPS underestimates the distance walked. It has been shown that women with PAD have a slower walking speed than men do and that following revascularization, the WIQ-speed sub-score improves by 18.6% to 130%. Unlike distance, although significant, the correlation of the WIQ-speed subscore to average-WSCW changes was fair in the present study, suggesting that self-reported responses cannot reliably estimate changes in average-WSCW. Specifically, very few patients reported isolated speed improvement on the WIQ questionnaire, whereas GPS results suggested that more than one-third of patients had MCII in the average-WSCW without improvement in the highest-MDCW.

One explanation could be that GPS underestimates the distance improvement in such patients. Another possibility could be that WIQ-distance changes and WIQ-speed changes are not sufficiently independent of one another to assess speed and distance changes separately. Many studies using the WIQ have shown that both the WIQ-speed and the WIQ-distance scores improved after revascularization, but no previous study has analyzed the relationship between measured distance changes and measured speed changes.

Whether certain patients preferentially maintain a constant speed and improve their distance, whereas others increase their walking speed rather than their maximal walking distance, is unknown. Furthermore, no previous study has confirmed these changes using objective measurements. Clearly, in the present study, many more patients had an MCII according to the GPS-derived highest-MDCW result than according to the WIQ-distance. The issue of speed and/or distance changes while walking is of major interest not only in revascularized patients but also in PAD patients with claudication, despite the well-known decrease in velocity in PAD compared with non-PAD patients and the inverse relationship that exists between walking distance and walking intensity in claudicants. It has been shown that women with PAD have a slower walking speed than men do and that following revascularization, the WIQ-speed sub-score improves by 18.6% to 130%. Unlike distance, although significant, the correlation of the WIQ-speed subscore to average-WSCW changes was fair in the present study, suggesting that self-reported responses cannot reliably estimate changes in average-WSCW. Specifically, very few patients reported isolated speed improvement on the WIQ questionnaire, whereas GPS results suggested that more than one-third of patients had MCII in the average-WSCW without improvement in the highest-MDCW. One explanation could be that GPS underestimates the distance improvement in such patients. Another possibility could be that WIQ-distance changes and WIQ-speed changes are not sufficiently independent of one another to assess speed and distance changes separately. Many studies using the WIQ have shown that both the WIQ-speed and the WIQ-distance scores improved after revascularization, but no previous study has analyzed the relationship between measured distance changes and measured speed changes.

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### Table 4. Walking Capacity Changes Between T0 and T1 Among the 83 Studied Patients (Revascularized Group vs. Reference Group)

| Hemodynamic changes | Revascularization Group (n = 44) | Reference Group (n = 39) | P value |
|---------------------|---------------------------------|--------------------------|--------|
| Ankle-to-brachial index | +0.22 ± 0.26 (n = 37) | −0.01 ± 0.19 (n = 31) | 0.0004 |
| Total walked time (min) | −2.55 [−6.39;+0.43] | −3.90 [−7.86;+3.29] | 0.3727 |
| Total walked distance (m) | +455 ± 786 | −181 ± 561 | 0.0001 |
| Number of stops per hour | −5 ± 5 | +1 ± 7 | <0.0001 |
| Highest-MDCW (m) | +442 [+213;+2474] | +13 [+218;+561] | 0.0006 |
| Average-WSCW (km·h⁻¹) | +0.3 ± 0.5 (n = 44) | −0.2 ± 0.4 (n = 39) | 0.0004 |
| Average-DSCW (min) | −0.81 ± 1.34 (n = 44) | −0.26 ± 1.43 (n = 39) | 0.0767 |

Questionnaire changes

| PASE score | +10.7 ± 84.8 (n = 23) | +10.5 ± 62.2 (n = 33) | 0.9425 |
| WIQ average score | +31.2 ± 22.0 (n = 38) | +3.0 ± 14.4 (n = 33) | <0.0001 |
| WIQ-speed score | +24.8 ± 21.7 (n = 37) | +1.9 ± 17.0 (n = 34) | <0.0001 |
| WIQ-distance score | +40.8 ± 29.8 (n = 37) | +4.5 ± 25.0 (n = 33) | <0.0001 |
| WIQ-stairs score | +26.5 ± 24.5 (n = 36) | +3.8 ± 14.5 (n = 33) | <0.0001 |
| Self-reported MWD (m) | +400 [+200;+700] (n = 43) | 0 [−50;+130] (n = 37) | <0.0001 |

Data expressed as median [25th;75th percentiles] or mean ± SD. The number of available values is reported between parentheses in the case of missing data.

- Highest-MDCW is the highest measured distance measured by GPS.
- Average-WSCW is the average walking speed measured by GPS.
- Average-DSCW is the average duration of stops measured by GPS (Calculated only for patients with at least 1 stop at T0 and T1).
- PASE is the Physical Activity Scale for the Elderly.
- WIQ is the Walking Impairment Questionnaire.
- MWD is the maximal walking distance.
- P is the Wilcoxon coefficient of correlation.
the evolution of PAD in patients. Indeed, in addition to hemodynamic tests, the gold standard for estimating the worsening of PAD is a decrease in MWD. Nevertheless, it is probable that certain patients progressively and unconsciously decrease their community walking speed, while their distance walked remains stable. At worst, the speed decrease could be so extreme that the patients remain asymptomatic while walking. Together with the decrease in lifetime recreational activity in PAD patients, this phenomenon could lead to patients remaining asymptomatic while their disease progresses. This situation might explain why the general prognosis of asymptomatic PAD patients is worse than that of symptomatic PAD patients. We initially expected average-DSWCW to be an index of improved perfusion in revascularized patients. Indeed, the recovery time for muscle oxygenation accurately differentiates severe from moderate claudication, and angioplasty increases the hemoglobin oxygen recovery rate after exercise. Although we previously showed that the stop duration between

FIGURE 4. Changes in walking speed (average-WSCW) and the highest measured distance (highest-MDCW) during a community walk among reference (red dots) and revascularized patients (blue squares). The dashed lines represent the mean ± 1 SD of changes needed to detect MCII compared with reference patients. Yellow square: average-WSCW or WIQ-speed improved only; Orange square: highest-MDCW or WIQ-distance improved only; Purple square: Both average-WSCW and highest-MDCW or both WIQ-speed and WIQ-distance improved; White square: No MCII.
2 walking bouts limited by usual symptoms is probably an important predictor of forthcoming community-based walking impairment,\textsuperscript{10} the present study does not appear to confirm one of our initial hypothesis regarding this aspect. One explanation is the absence of concordance between pain relief and hemodynamic recovery in PAD patients.\textsuperscript{35} This lack of concordance could explain that the duration of a stop is less influenced by revascularization than the hemodynamic parameters are. The GPS device used does not allow physiological parameters to be analyzed, but future developments could allow for the recording of physiological signals and a better estimation of the relationship between average-\textsubscript{DS\textsubscript{CW}} and hemodynamic recovery.

Study Limitations

The limitations of the present study include the fact that we did not systematically study bypass patency or the results of angioplasty in terms of hemodynamic improvement (e.g., ABI or Doppler measurements) or MWD-on-treadmill, as many patients received their GPS at home at T1 and did not undergo de novo ABI measurement. It is also possible that certain patients in the revascularized group did not improve because their revascularizations failed. We hoped to avoid any additional visits for the routine follow-up of patients and to allow “at-home” estimation of walking limitation. These “at-home” procedures can also explain the relatively high number of missing scores, specifically for the WIQ and PASE, which are relatively complex questionnaires. Although it is clear that GPS will never replace vascular investigations, we think that it may improve our knowledge of the functional impairments that are associated with PAD.

A second limitation of this study is that we included only PAD patients with classical symptoms of intermittent claudication and for whom self-reported limitation was confirmed during the first GPS test. It would be of interest to evaluate the clinical applicability of and interest in the GPS technique in non-PAD patients (e.g., spinal stenosis, musculoskeletal lesions) or in PAD patients with atypical symptoms. It would also be of interest to analyze whether GPS may help to detect those patients who claim to be asymptomatic or who have stable moderate claudication but in fact progressively decrease walking speed rather than distance. Whether such patients require specific attention is a fascinating issue.

The third limitation is that the ability to perform GPS measurements may depend on the area where the system is used. The present study used a multicenter approach and appears to confirm that when patients are allowed to choose an area consistent with the study requirements, recordings of acceptable quality can be acquired in most cases.

Last, an hour-long stroll may be an unusually long exercise for most PAD patients with claudication. As most elderly patients walk <4000 steps per day,\textsuperscript{36,37} a 1-hour stroll may not reflect the usual physical activity of most patients. However, we previously showed that walking for 1 hour was considered very difficult in less than one-third of patients;\textsuperscript{11} nonetheless, reducing the duration of a stroll might dramatically affect the estimation of highest-\textsubscript{MD\textsubscript{CW}} (see Supplemental Digital Content 1, http://links.lww.com/MD/A265).

Conclusion and Clinical Perspective

The major results of the present study can be summarized as follows:

1. In patients who undergo revascularization for arterial claudication, highest-\textsubscript{MD\textsubscript{CW}} and average-\textsubscript{WS\textsubscript{CW}} are significantly increased. On the contrary average-\textsubscript{DS\textsubscript{CW}} changes in revascularized patients do not reach significance compared with reference patients.

2. Among revascularized patients with MCII compared with reference patients, nearly one-third of the patients increased their average-\textsubscript{WS\textsubscript{CW}}, but not their highest-\textsubscript{MD\textsubscript{CW}}, emphasizing the importance of evaluating speed changes in PAD patients.

3. The correlation between average-\textsubscript{WS\textsubscript{CW}} and WIQ-speed changes is weaker than between highest-\textsubscript{MD\textsubscript{CW}} and WIQ-distance changes.

Previous studies have demonstrated the accuracy of GPS in measuring community-based walking dimensions such as highest-\textsubscript{MD\textsubscript{CW}}, average-\textsubscript{WS\textsubscript{CW}} and average-\textsubscript{DS\textsubscript{CW}}\textsuperscript{10,12,13} in PAD patients. To the best of our knowledge, this is the first prospective multicenter follow-up study using GPS in patients with claudication. Although the present study focused on PAD patients, we assume that the technique could provide new and interesting information on changes in walking impairment resulting from various medical or surgical treatments. Of major interest is the fact that, at least in PAD, average-\textsubscript{WS\textsubscript{CW}} appears essential to account for the changes observed in revascularized patients, beyond the measurement of walking distance alone.

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