Categorisation of activities of daily living of lower limb amputees during short-term use of a portable kinetic recording system: a preliminary study

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ABSTRACT
The purpose of this preliminary study was to determine the relevance of the categorisation of the load regime data to assess the functional output and usage of the prosthesis of lower limb amputees. The objectives were (A) to introduce a categorisation of load regime, (B) to present some descriptors of each activity and (C) to report the results for a case. The load applied on the osseointegrated fixation of one transfemoral amputee was recorded using a portable kinetic system for five hours. The periods of directional locomotion, localised locomotion and stationary loading occurred 44%, 34% and 22% of recording time and each accounted for 51%, 38% and 12% of the duration of the periods of activity, respectively. The absolute maximum force during directional locomotion, localised locomotion and stationary loading was 19%, 15% and 8% of the BW on the antero-posterior axis, 20%, 19% and 12% on the medio-lateral axis as well as 121%, 106% and 99% on the long axis. A total of 2,783 gait cycles were recorded. Approximately 10% more gait cycles and 50% more of the total impulse than conventional analyses were identified. The proposed categorisation and apparatus have the potential to complement conventional instruments, particularly for difficult cases.

KEYWORD
Classification, load sensor, lower limb amputation, outcome assessment, activities of daily living

INTRODUCTION
Classification of lower limb amputees
Assessments of functional outcome and usage of prosthesis during activities of daily living (ADL) of lower limb amputees has gained increasing importance to support evidence-based practice (e.g., issue of under- and over-prescription of prosthetic components). One of the most critical end products of these assessments is to scale amputees from the least to the most functional. Current practice is to use the US Medicare Functional Classification Levels, including four mobility grades or K-levels [(1)]. Clinicians can classify their patients using a wide range of

instruments, that can be used separately or in combination, as recommended in recent guidelines [2-3]. An overview of the resources and comprehensiveness of the output of instruments that are most commonly used is presented in Figure 1.

*** Insert Figure 1 here ***

Surrogate measurements of functional outcome
According to Parker *et al* (2010), the capacity to undertake ADL can be defined as "a participant's ability to walk and move with his/her prosthesis and ambulation aids (canes, crutches, or walkers) in a standardized environment (rehabilitation, clinics)" [4]. In most cases, this capacity is assessed after or during the fitting of the prosthesis using standardised instruments based on:

- Self-reports (e.g., Amputee Activity Survey, Prosthetic Profile of the Amputee and Locomotor Capabilities Index [5], Russek's code, Prosthetic Evaluation Questionnaire and Orthotic Prosthetic Users [6], Questionnaire for Persons with a Transfemoral Amputation [7], Special Interest Group in Amputee Medicine (SIGAM) [8]),
- Physical tasks (e.g., Two-minute walk, Six-minute walk, Functional Ambulation Profile, Timed Get-Up and Go, Amputee Mobility Predictor with Prosthesis) [3, 9]. The performance is expressed in unit of time or distance.

Both types of instruments are easy to administer in clinical settings and require little resources while providing a simple scoring matrix [2]. The standardisation enables inter- and intra-patient comparisons (e.g., before and after fitting of a hydraulic knee). However, Most of the physical tasks performed are partially representative of the full range of ADL. Indeed, evidence that K-levels correlate with a Six-minute walk test, for example, are unsatisfactory [9]. Furthermore, the predictive ability of these instruments of actual functional outcome is limited. Several studies demonstrated that amputees do not reliably self-report their ADL [10]. For instance, comparison between Two-minute walk, Timed Get-Up and Go, Locomotor Capabilities Index and self-report performance measurement showed moderate correlations [4, 11].

Physical measurements of ADL
Alternatively, the actual functional outcome, defined as "a participant's mobility with his/her prosthesis and ambulation aids in the home and community environment" [4], can be assessed after fitting of the prosthesis using physical measurements during real world ADL.
The most sophisticated pedometers (e.g., Step Activity Monitor) have the capacity to record continuously the number of steps and the cadence for periods of days to months [12-15]. A recent study demonstrated that Two-minute walk test was highly correlated with step counts [4]. Pedometers are accurate to detect distinct gait cycles. However, they provide an incomplete description of the level of intensity and type of activities, particularly the ones that are not derived from steps.
Other studies used a portable kinematic recording system based on several 2D or 3D accelerometer-type sensors (e.g., Patient Activity Monitor) to monitor the frequency and duration of activities in patients' habitual environments over several hours [16-18]. Studies focusing on other populations (e.g., total hip replacement) completed analysis of the raw data by implementing an algorithm recognising typical patterns of certain ADL, such as lying, sitting, standing, level and incline walking as well as ascending and descending stairs [16]. These analyses have the potential to give a more comprehensive and realistic insight into the actual functional outcome, provided that the population involved presents small variability of kinematic patterns. However, activities that are unclearly defined are dismissed although they might represent a significant portion of time.

Need for comprehensive assessment of ADL
All combined, these studies demonstrated a lack of correspondence within surrogate measurements as well as between surrogate and physical

measurements. This might be due to the fact that ecological measurements during actual ADL might not be sufficiently comprehensive and, more importantly, subjected to many more confounders (e.g., weather conditions, job demands, marital status). Clearly, there is a need for an instrument capable of assessing the actual function outcome during ADL.

Categorisation of the load regime data

More recently, a portable kinetic system, based on a transducer and data logger, was introduced for the continuous recording of the true load regime (i.e., frequency and magnitude of overall loading) applied on the residuum of a transfemoral amputee during ADL [(19)]. This study presented only the recording of the raw data and some overall performance indicators of the usage of the prosthesis.

However, the opportunities to use this load regime data to assess the actual functional outcome during ADL are yet to be fully explored. This could be achieved using the following approaches:

- ***Recognition of activities***. Set activities could be recognised using templates of patterns that have been established after controlled measurements of individual standardised activities (e.g., descending stairs) [(16, 20)]. These templates must be patient-specific and, therefore, not easily transferable, given gait variability within a population of amputees [(21-23)]. Also, templates are not always applicable to real world measurements due to variations in design of environment (e.g., height and depth of stairs) and amputee's ambulatory styles (e.g., descending front on or sideways, use of hand rail). This would be the conventional technique to assess the functional outcome, defined as the capacity to undertake recognisable, but limited, activities.
- ***Categorisation of activities***. As suggested by Frossard *et al* (2008) [(19)], the raw load data could be split into categories of ADL, such as inactivity, stationary loading and locomotion. The totality of the recording would be taken into consideration, instead of separate standard activities. Then, this innovative approach would assess the functional output, defined as the overall ability to undertake ADL.

In principle, the results of both techniques could be valuable for clinicians. However, the categorisation of load regime data seems to be more straight forward (i.e., not pre-analysis of standardised activities), complete (i.e., all activities included) and aligned with the underlying principles of Functional Classification Levels (i.e., determining overall ability).

Purposes and objectives

The purpose of this preliminary study was to determine the relevance of the categorisation of the load regime data to assess the actual functional output and usage of the prosthesis of lower limb amputees. The objectives were (A) to introduce a categorisation of load regime, (B) to present some descriptors of each activity and (C) to report the results for a case.

METHODS

The raw load data used in this study have been published in Frossard *et al* (2008) [(19)] along with the detailed account of methodological aspects including the portable kinetic system relying on a transducer and a data logger. Consequently, only the most relevant information is presented here.

Participant

One fully rehabilitated and active male (33 yr, 1.70 m, 85 kg or 833.85 N, 12 yr since amputation) fitted with an osseointegrated fixation [(24-27)] was asked to participate. He achieved an F in the SIGAM scale (i.e., normal or near normal gait [(8)]), therefore he was classified as a K4 in the Functional Classification Levels (i.e., ability or potential for prosthetic ambulation that exceeds basic ambulation skills, exhibiting high impact, stress or energy levels [(1)]).

The research institution's human ethics committee approved this study. The participant provided informed written consent.

*** Insert Figure 2 here ***

Apparatus

The prosthesis included a Rotasafe, a transducer, the participant's usual knee (Otto-Bock 3R80) and foot (Otto-Bock 1D10) fitted with hard running shoes as presented in Figure 2. The mass of the prosthesis below the transducer was approximately 0.65 kg The forces and moments, commonly referred to as the load, were directly measured by a six-channel transducer (Model 45E15A; JR3 Inc, Woodland, CA, USA), similar to the one used in a previous studies [19, 28-30]. The power was supplied by a customized battery pack placed in a waist pack attached to the subject. Data was processed using a calibration matrix to eliminate cross-talk between axial sensors. A preliminary experiment demonstrated that forces and moments along the three axes were measured by the transducer with an error of less than ±1 N and ±1 Nm[30]. The transducer was mounted to customized plates that were positioned between the Rotasafe and the knee. These plates were used to anchor the transducer to pyramidal adaptors.

The data logger was connected to the transducer by a serial cable and placed in the waist pack. The output of the transducer was digitally stored using an 8-bit data logger (Valitec AD128, Daytona, Ohio, USA) via additional interface circuitry. The 8-bit resolution of the data logger corresponds to a measurement resolution of approximately 8.95 N for the force along the long axis, 4.75 N for forces along the antero-posterior and medio-lateral axes, 0.25 Nm for the moment about the long axis and 0.785 Nm for moments about the antero-posterior and medio-lateral axes. The forces and moments were recorded with a sampling frequency of 10 Hz allowing a continuous monitoring period of five hours corresponding to 175,600 samples per channel, given the 2Mb memory limitation of the data logger.

Procedure

The prosthesis including the transducer was configured by a qualified prosthetist and fitted to the participant. The prosthetist attempted to align the leg as closely as possible to the usual alignment. The prosthetic leg was worn approximately 15 minutes before recording to ensure subject confidence and comfort.

The participant was asked to carry on his activities as normally as possible. The recording started shortly after 1:30 pm and lasted until 6:30 pm, giving a continuous recording of approximately five hours of the recreational afternoon, like comparable studies [16]. The testing took place in January with an ambient temperature of approximately 17oC and overcast conditions, allowing the participant to carry on normal activities. He walked without aids.

Finally, the kinetic system was removed. It should be noted that the participant reported no problems wearing the apparatus, although the waist pack was found cumbersome in some instances (e.g., seating).

Data processing: categorisation

The load was divided into four categories of activities: directional locomotion, localised locomotion, stationary loading and inactivity. An overview of the definition, the estimated range of displacement, the loading characteristics and some typical examples of possible activities for each category is presented in Table 1. A combination of duration and magnitude of the signal were used to differentiate categories. These thresholds emanated from a heuristic approach and review of the literature focusing on classification and detection of ADL [3, 16, 22-23] as well as pre-analysis of the raw data. The typical examples of possible activities were presented to illustrate the type of activities that the participant might undertake. There were illustrative and tentative as no separate measurements (e.g., shadowing, pattern recognition) were conducted. For instance, the categorisation encompassed a number of evaluation criteria of the Functional Classification Levels and other instruments. The periods of ambulation when the participant engaged into a displacement included directional and localised locomotion. The periods of activity included the periods of ambulation and the stationary loading. A customized Matlab software program (Math Works Inc, Natick, MA) was used to separate automatically each category. The detection of each activity consisted on recognising first the inactivity, stationary loading and directional locomotion activities, respectively. Activities that were not detected as one of these three activities were considered as localised locomotion. The program provided a reliable process including a faster computing time and consistent separation compared to manual technique. For instance, the software detected 98% of the phases picked manually for three random portions of the recording.

*** Insert Table 1 here ***

Data analysis: characterisation

Each category was characterised by:

- ***General descriptors*** including the number of occurrences corresponding to the number of times an activity was detected and the duration of each category corresponding to the cumulated amount of time spent for each occurrence. They provided a broad insight on the functional level and usage of the prosthesis (e.g., activity vs. inactivity).
- ***Loading characteristics*** reflected by median, minimum and maximum of the magnitude of the raw forces and moments applied on the three axes. Also, the duration of the resultant force between 12.5% and 37.5% and above 50% of the body weight (BW) was assessed for each activity. All combined, these indicators reflected the loading abilities of the participant which depend on comfort, confidence, relevant fitting, etc. For example, it is more likely that a load corresponding to 50% of BW during stationary loading reflects a well fitted prosthesis.
- ***Impulse*** of the forces on the three axes, calculated using conventional trapeze methods based on the integration of the area under the force-time curves (31). This indicator summed up the overall usage of the prosthesis taking into consideration the magnitude and the duration of the load (19, 21). The higher the value, the more the prosthesis was used.

Gait cycles were subjected to complementary analysis. The temporal variables were extracted including the cadence expressed in number of strides of the prosthetic leg per minute, the duration of the gait cycle, and the support and swing phases expressed in seconds and percentage of gait cycle.

RESULTS

Example of raw data

A sample of two minutes of recording presented in Figure 3 illustrated the identification of directional locomotion (e.g., 10 gait cycles, 0-15 s), localised locomotion (e.g., 15-30 s), stationary loading (e.g., 75-82 s) and inactivity (e.g., 90-110 s).

*** Insert Figure 3 here ***

General descriptors

The occurrence and duration of each category of activities are presented in Table 2. The directional locomotion, localised locomotion and stationary loading corresponded to 44%, 34% and 22% of the occurrences as well as 51%, 38% and 12% of the duration of the periods of activity, respectively. The ambulation represented over 78% of the periods of activity.

*** Insert Table 2 here ***

Loading characteristics

The median, minimum and maximum of the forces and moments applied along the three axes of the residuum for each category of activities are presented in Table 3. The absolute maximum force during directional locomotion, localised locomotion and stationary loading represented 19%, 15% and 8% of BW on the antero-posterior axis, 20%, 19% and 12% on the medio-lateral axis as well as 121%, 106% and 99% on the long axis. The minimum load applied on the long axis was negative (traction) due to gravity acting on the prosthetic components below the transducer during the swing phase. The resultant of the force was between 12.5% and 37.5% of the BW for 5%, 23% and 14%, as well as above half of the BW for 47%, 20% and 3% of the duration of directional locomotion, localised locomotion and stationary loading, respectively. The minimum and maximum of the load registered during the inactivity category corresponded to odd movements produced to readjust the resting posture.

*** Insert Table 3 here ***

Impulse

The impulse of the force for each category of activities is presented in Table 4. Approximately half of the total impulse of the resultant force was due to directional locomotion. Localised locomotion, stationary loading and inactivity represented 31%, 11% and 9%, respectively.

*** Insert Table 4 here ***

Characterisation of gait cycles

The participant generated a total of 2,783 gait cycles of the prosthesis during the recording period. Directional and localised locomotion included 90% (2,512) and 10% (271) of these gait cycles, respectively. The overall cadence was 10 strides/min, but the more meaningful cadence during directional locomotion was 47 strides/min. The mean duration of the gait cycle was 1.26±0.16 s. The mean duration of the swing and support phases were 0.58±0.12 s and 0.67±0.09 s, corresponding to 46% and 54% of the gait cycle, respectively.

DISCUSSION

Limitations

This preliminary study was designed to determine the feasibility of categorisation of ADL alone, in contrast with a comparative study looking at the performance of the categorisation in relation to other physical measurements or a case study discussing the participant's results.
Nonetheless, the recognition of activities is also partially validated. A study demonstrated that the direct measurements are as accurate as the ones obtained with inverse dynamics [30]. Recognising inactivity is rather straightforward. In principle, several studies focusing on load bearing exercises [32], activities of standardized [22-23, 28, 33] and real world ADL [19] could provide a surrogate validation of the recognition of the stationary loading and directional locomotion, respectively. By definition, localised locomotion is more an in-between activity difficult to validate. One way to validate the recognition would be to shadow the participant while tracking activity and filling a detailed diary. This is particularly challenging during ecological assessments (i.e., invasion of private space, getting in and out public or private transports) of rapidly changing activities.
Furthermore, the extraction of clinical information for this young and active participant is limited.The domination of long periods of inactivity might be explained by the fact the recording occurred during a recreational afternoon. More emphasis might have been placed on resting. However, a number of indicators demonstrated the ambulatory abilities of the participant and proper fitting of the prosthesis, including:

- The number of occurrences and duration of periods of activity and ambulation,
- The maximum loading on the long axis during directional locomotion,
- The duration of loading above and below half of the body weight,
- The temporal characteristics of the gait cycles were in the upper end of the ones reported for transfemoral amputees in previous studies [10, 34-36].

All combined the results concurred with previous self-report assessments (i.e., F in SIGAM and K4).

Relevance of proposed categorisation

This work highlighted the difficulty of achieving appropriate assessment of the true functional output and usage of the prosthesis with typical resources available in clinical settings.

This study demonstrated that the proposed categorisation of ADL has the potential to provide a more comprehensive assessment than current instruments mainly because the measurements were not limited to directional locomotion. In this case, this enabled the detection of approximately 10% more gait cycles that were unlikely to be registered by conventional pedometers. Furthermore, it enabled the measurement of approximately 50% more of the total impulse, occurring during localised locomotion, stationary loading and inactivity, that would have been difficult to estimate using conventional analysis (i.e., the number of steps measured by pedometers in real world [13] multiplied by the impulse obtained in gait laboratory for a few steps [37-38]). Some of the conventional instruments require little resources compared to the proposed apparatus. Consequently, its systematic implementation in clinical settings is somewhat unrealistic. Nonetheless, one can argue that this type of assessment will be best used as a complement rather than a replacement of conventional instruments. For example, it will be relevant to differentiate difficult patients who are in-between K3 and K4 levels.

Development of future prototypes

From an engineering point of view, this study corresponded to a proof-of-concept study. Indeed, it provided sufficient technical information to further develop a fully functioning prototype of an instrument (i.e., hardware and software) specifically designed for clinical applications. This study revealed that a more compact recording device will be needed to reduce encumbrance (e.g., carrying batteries in waist pack). A recording frequency of up to 120 Hz will give a better insight into the maximum loading and impulse generated as well as more accurate detection of gait events such heelstrike transient, provided that it occurs close to 60 Hz. Like any other battery operated device, a recording capacity will reduce the number of shutdown times to change batteries and download data logger, and therefore, enabling more frequent recordings and representative snapshots of ADL. Finally, improving the clinician-software interface will be required to ease setting up of detection parameters and report of results. All these features could be easily implemented using a handheld computer, for example.

Tool for clinical studies

The instrument presented here will facilitate longitudinal studies of ADL for a larger cohort of participants. This study involved an amputee fitted with an osseointegrated fixation because the initial purpose of the recording was to monitor the load regime applied on the residuum to better design the fixation (e.g., fatigue, fracture)[19]. However, it is important to indicate that a similar analysis could have been conducted on any other lower limb amputees fitted with a socket (e.g., quadrilateral[28, 30], ischial-containment). The proposed categorisation can be done regardless of the attachment, providing that the transducer can be mounted within the prosthesis above or below the knee (e.g., pylon). Such longitudinal studies will provide a better understanding of the participant-to-participant variability on level and category of activities. Some confirmation of the K level and SIGAM score were provided. However, a comprehensive comparison of the results from other instruments (i.e., self-report, physical tasks) and the proposed categorisation was outside the scope to this proof-of-concept study. However, the possibilities for cross-sectional studies are endless, particularly for the ones allowing reciprocal validation of these instruments (e.g., number of steps measured with the transducer and Step Activity Monitor) and correlation of the outcomes (e.g., K-level and impulse during directional locomotion). Further work is needed to identify the activities undertook in each category.

Both longitudinal and cross-sectional studies will be essential to improve basic knowledge in the areas of rehabilitation (e.g., loading technique, usage of walking aids [(29)]), design of components (e.g., fatigue, loading requirement, product classification, fall detection) and fitting of prosthesis (e.g., alignment, threshold of protective device, prescription of components). They might also help to refine the definition of activity and function outcome as well as standard of activity levels as presented in the WHO International Classification of Functioning, Disability and Health [(39)].

CONCLUSIONS

A categorisation of activities of daily living based on a portable kinetic system has been presented that enables the characterisation of the actual functional output and usage of the prosthesis. An example of raw results and some of the derived information were provided for one transfemoral amputee to illustrate the capacities of this new categorisation.

This study highlighted some shortcomings of the current instruments measuring physical variables in real world settings. This study established that the core principle underlying categorisation of activities have the potential to provide more comprehensive outcomes than the recognition of activities because it takes into consideration activities other than directional locomotion.

In conclusion, the categorisation presented here is a stepping-stone in the development of a user-friendly instrument based on a portable kinetic system to be used by clinicians responsible for outcome measures and classification of lower limb amputees.

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LIST OF FIGURES AND TABLES

Figure 1. Overview of resources (e.g., time, cost, equipment, space, etc) and comprehensiveness of the output (e.g., range, realism, accuracy, degrees of freedom, etc) of the current and proposed instruments used to assess the functional outcome and usage of prosthesis during ADL.

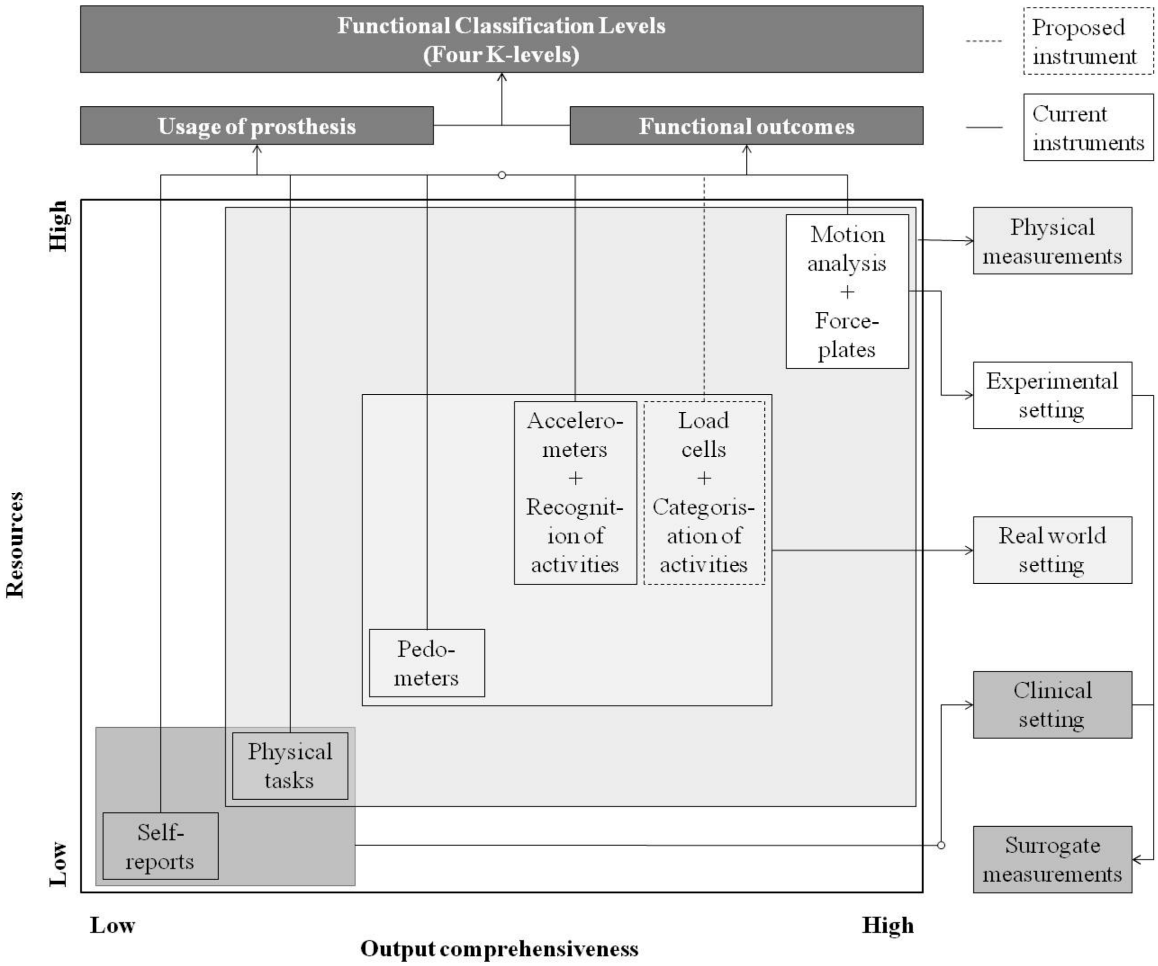

Figure 2. Side (left) and front (right) views of the prosthetic limb including a multi-axial transducer (A) mounted to designed adaptors (B) that were positioned between the Rotasafe (C) and the abutment (D), and the knee mechanism (E).

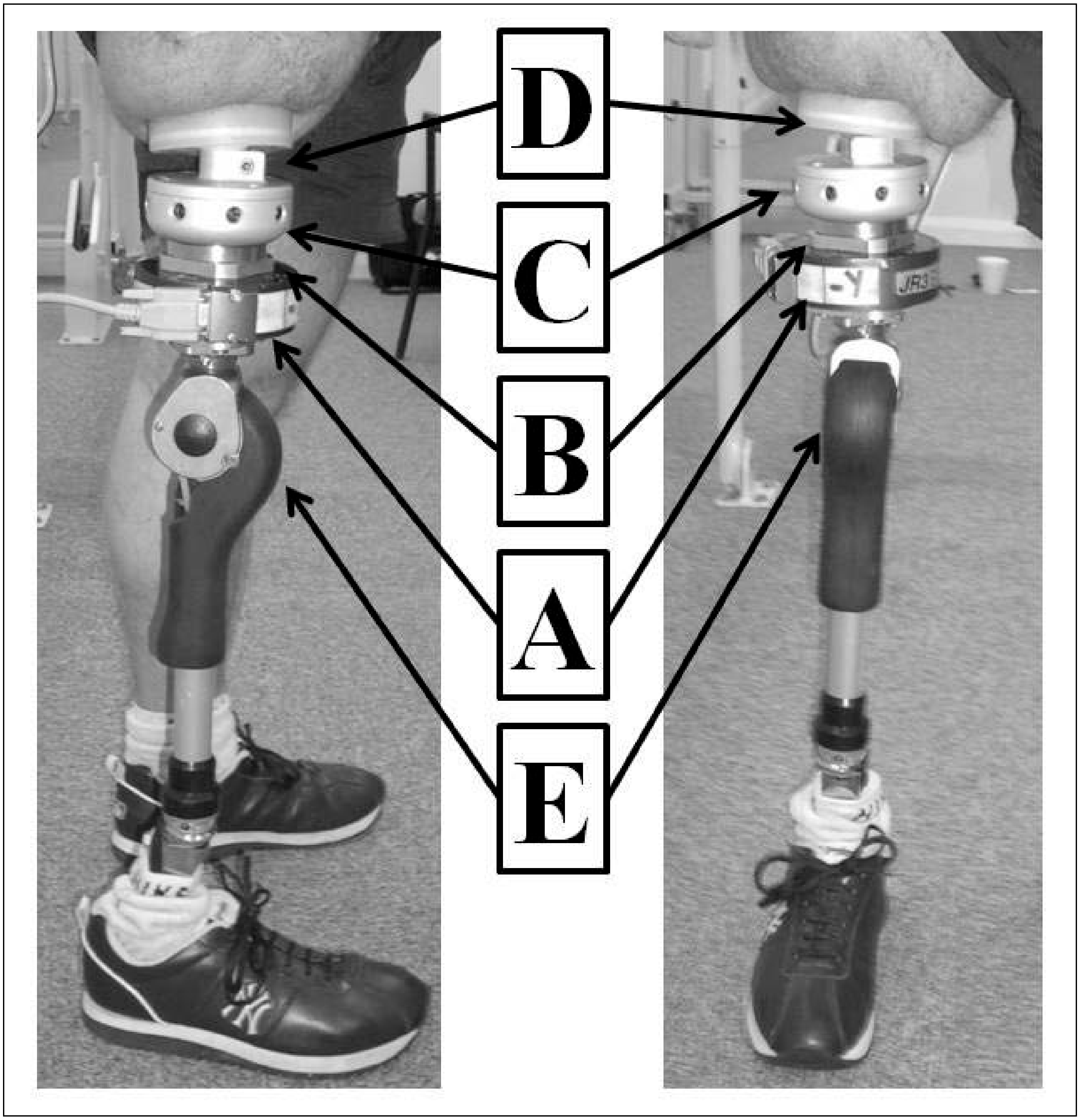

Figure 3. Sample of two minutes of recording illustrating the four categories of activity defined with respect to resultant of force applied on the osseointegrated fixation, including directional locomotion (DL), localised locomotion (LL) stationary loading (SL) and inactivity (IN). The INth line corresponded to the inactivity threshold set at 1/8th of the body weight (BW). An occurrence corresponded to a line. The duration of an occurrence corresponded to the length of the line.

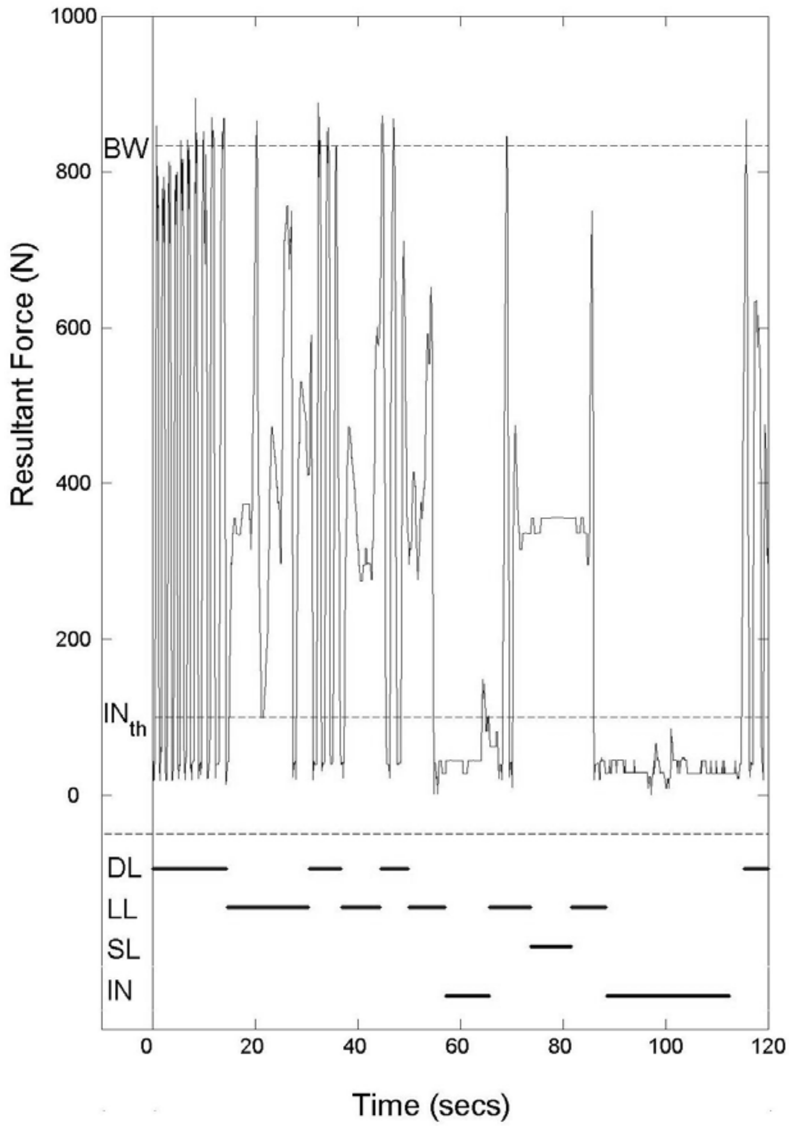

Table 1. Description of each category of activities. (1) Estimated based on participant's anthropometrics (e.g., height, body weight (BW)) and gait patterns (e.g., stride length) [22-23], (2) Some loads on the antero-posterior and medio-lateral axes might be applied on the residuum (e.g., seating with a cushion under the thigh or the leg on a stool).

	Periods of activity			
	Periods of ambulation			
	Directional locomotion	**Localised locomotion**	**Stationary loading**	**Inactivity**
Order of detection	3	4	2	1
Definition	Intentional displacement in a given direction at fixed or variable cadence to traverse low or high level environment barriers in even or uneven surfaces	In between directional locomotion and stationary loading	Limited diplacements, quasi static	No displacements
Range of displacement (1)	Net displacement of more than 3 m	Displacement within an area of 3 m^2	Displacement within an area of 0.5 m^2	Nil
Loading characteristics	Noticeable gait cycles repeated for more than 2 strides	Variations in magnitude ranging bewteen 0% and 150% with no more than 2 repeatable gait cycles over at least a 7 second window	Magnitude concentrated around the mean for at least a 7 second window	Long axis under 1/8th of BW for more than 2 seconds (2)
Typical examples of possible activities	Running, walking in a level straigh line, up and down stairs and slope	Doing a bed, preparing meal, sit-to-stand	Standing up while talking to someone, waiting for the bus	Lying down, seating

Table 2. Occurrence and duration of each category of activities.

		Periods of activity				
		Periods of ambulation				
		Directional locomotion	**Localised locomotion**	**Stationary loading**	**Inactivity**	**Total**
Occurrence	**(#)**	67	51	33	21	172
	(%)	39	30	19	12	100
Duration	**(hrs)**	0.89	0.66	0.21	3.10	4.87
	(%)	18	14	4	64	100

Table 3. Median, minimum and maximum of the forces and moments applied along the anterior-posterior, the medio-lateral and the long axes of the fixation for each category of activities.

	Periods of activity			
	Periods of ambulation			
	Directional locomotion	**Localised locomotion**	**Stationary loading**	**Inactivity**
Forces (N)				
Antero-posterior axis				
Median	315.68	-3.00	11.38	-12.44
Minimum	-181.30	-142.22	-107.85	-102.26
Maximum	157.36	123.52	67.60	106.84
Medio-lateral axis				
Median	-40.65	-34.47	-28.19	-5.19
Minimum	-170.27	-154.38	-102.78	-51.20
Maximum	25.63	19.13	16.88	40.41
Long axis				
Median	295.73	335.03	335.75	-17.71
Minimum	-83.67	-61.31	-64.67	-63.69
Maximum	1005.41	883.97	825.90	588.20
Moments (N.m)				
Antero-posterior axis				
Median	-8.25	-6.42	-4.52	-0.55
Minimum	-32.25	-98.76	-24.55	-19.34
Maximum	15.35	13.00	11.77	4.89
Medio-lateral axis				
Median	8.54	5.94	3.77	0.02
Minimum	-9.88	-10.07	-4.87	-7.75
Maximum	50.83	60.18	30.25	20.56
Long axis				
Median	-0.79	-1.11	-0.13	1.13
Minimum	-13.32	-7.24	-5.65	-16.64
Maximum	11.77	8.42	7.94	17.94

Table 4. Impulse of the force for each category of activities.

Impulse (kN.s)	Periods of activity			Inactivity	Total
	Periods of ambulation		Stationary loading		
	Directional locomotion	Localised locomotion			
Antero-posterior	9	11	12	6	17
Medio-lateral	162	89	80	20	351
Long	1,069	745	107	227	1,935
Resultant	1,214	767	268	230	2,479