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Rearfoot-forefoot profile defined by vertical ground reaction forces during gait is altered in patients with unilateral intermittent claudication

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Abstract

Intermittent Claudication due to Peripheral Arterial Disease (PAD-IC) induces ischemic pain in exercising muscles, and therefore impaired gait. In a pathological context, the analysis of the Vertical component of Ground Reaction Force (VGRF) is frequently used to describe gait pattern. This paper aims to define gait profiles according to the relative difference between peaks of VGRF; a Rearfoot and a Forefoot profile revealing a more loading or push-off strategy. We evaluated 70 participants (24 with unilateral disease (Unilat-IC), 22 with bilateral disease (Bilat-IC) and 24 Controls) during a walk test on an instrumented treadmill. Results indicate that Unilat-IC patients present a Rearfoot-profile in both legs during the pain-free gait period, likely to stabilize their gait. With the onset and increase of pain, the asymptomatic leg changes for a Forefoot-profile. This asymmetrical pattern suggests that a compensatory mechanism occurred to unload the symptomatic (painful) leg, possibly creating an imbalance. In Bilat-IC and Controls subjects, a Forefoot-profile is found, with a symmetrical pattern. However, there is a trend for lower propulsive capacity in case of Bilat-IC due to ischemic pain, but patients did not have the ability to compensate as in Unilat-IC. Therefore, Bilat-IC should not be considered as a “double” Unilat-IC. This study highlights the existence of gait profiles based on VGRF in PAD-IC patients. These profiles are dependent on the type of disease. Analysis of these gait profiles can 1) provide a simple way to identify gait alterations and 2) participate in improving physical rehabilitation strategies in PAD-IC patients.

1. Introduction

The vertical component of the ground reaction force (VGRF) is considered as a representative measure to discriminate normal from pathological gait pattern because of its reproducibility (Horst et al., 2017). It is well established that the analysis of the two peaks of VGRF, corresponding to the loading (Peak 1) and the push-off (Peak 2) during stance phase, could be impacted by some diseases, pain and aging process (Boyer et al., 2017; Jacobs et al., 1972; Kim and Kim, 2017). Moreover, this variable allows to characterize individual gait pattern and to observe evolutions pre and post-treatment (Pietrosimone et al., 2019; Schenck and Kesar, 2017).

In patients affected by Peripheral Arterial Disease (PAD), atherosclerosis development in lower limbs may induce exercise ischemia and associated pain that could force the patients to stop. This pathological phenomenon is called Intermittent Claudication (PAD-IC). Therefore, when walking, PAD-IC patients adopt an altered gait pattern (Gommans et al., 2017; Szymczak et al., 2018), associated with an increased risk of fall (Gardner and Montgomery, 2001). VGRF is also altered (Ayzin Rosoky et al., 2000; Scott-Pandorf et al., 2007) due to reduced muscular strength and dynamic capacity (King et al., 2015). This can be explained by the fact that plantarflexor muscles are strongly involved in the push-off (Liu et al., 2006), and are the most quoted site for the patient's pain description.

According to PAD severity and extension, exercise ischemia and thus pain, can occur in one leg (i.e. unilateral ischemia) or both (i.e. bilateral ischemia). It has been shown that unilateral induced pain during a bilateral plantarflexion task leads to a particular motor alteration, since force and muscle activity decreased only in the painful limb (Hug et al., 2016, 2014), potentially impacting gait parameters. Despite this fact, few studies have distinguished gait parameters in unilateral claudicants (Unilat-IC) (Gardner et al., 2010; Gommans et al., 2017; Koutakis et al., 2010; Szymczak et al., 2018; Wurdeman et al., 2012) and bilateral

claudicants (Bilat-IC) (Chen et al., 2008; Koutakis et al., 2010; Mccamley and Yentes, 2018; McCamley et al., 2019), whereas most of the studies analyzed pooled results with neither distinctions between Unilat-IC and Bilat-IC or comparison between the two pathological conditions. In addition, results are discordant in studies on Unilat-IC impact on gait parameters since two studies found differences between the symptomatic and asymptomatic limbs (Gardner et al., 2010; Wurdeman et al., 2012) while others found none (Gommans et al., 2017; Koutakis et al., 2010; Szymczak et al., 2018). However, it is likely that VGRF should be impacted differently according to ischemia - and associated pain - extent between legs as a consequence of the different patterns of plantar force distribution between legs and feet during the stance phase of the gait cycle (Jacobs et al., 1972; Toda et al., 2015).

We defined two profiles, Rearfoot or Forefoot, according to the difference between the two peaks of VGRF during the stance phase. This new approach allows to make a functional classification of the plantar supports. A Rearfoot-profile suggests that subjects use preferentially a loading strategy that will help to increase body stability whereas a Forefoot-profile indicates rather a push-off strategy, considered more efficient for propulsion. Assuming that to adopt a Rearfoot strategy allows a safer and more stable walking pattern (Franz, 2016), we hypothesize that PAD-IC patients would have a Rearfoot strategy (due to pain and weakness related to ischemia) whereas Controls would have a Forefoot strategy. Furthermore, we believe that Unilat-IC patients will present an asymmetrical pattern and that this strategy could change with the intensity of pain during walking. This analysis of VGRF could be easily done in clinical routine. It would help to describe the impact of the disease on patients and to improve rehabilitation care.

2. Method

2.1. Participants

Subjects were recruited during an examination from the functional vascular investigations service in Angers' university hospital center (France). A total of 70 patients were recruited. There were divided into three groups: a group with Unilat-IC ($n = 24$, age = 67 ± 7 years; Body Mass Index (BMI) = 26.0 ± 4.5 kg/m²), another with Bilat-IC ($n = 22$, age = 64 ± 7 years; BMI = 26.8 ± 4.9 kg/m²) and a group without PAD-IC (Controls) ($n = 24$, age = 65 ± 7 years; BMI = 26.1 ± 3.6 kg/m²). All patients had angiography, Doppler and/or computed tomography examination. We recorded: age (years), height (m), body mass (kg), BMI (kg/m²), Ankle Brachial Index for both legs (ABI), smoking status (number (n)), presence of treated hypertension (n), diabetes (n), hypercholesterolemia (n), distance for the onset of pain (m) and maximal walking distance (m). The ABI of each limb was defined as the ratio of the highest systolic blood pressure measured at the ankle to the highest systolic blood pressure measured at the brachial artery, as recommended by the American Heart Association guidelines (Gerhard-Herman et al., 2017). According to their resting ABI, subjects were divided into two groups: Control subjects (Controls) with an ABI ≥ 0.90 , and presenting the same risk factors as PAD-IC participants and who were addressed to the service because of coronary and/or carotid artery disease or diabetes without PAD in lower limbs; and symptomatic PAD-IC with an ABI ≤ 0.90 and symptomatic claudication for at least 6 months (i.e. stade 2 according to Leriche and Fontaine classification). As previously described (Abraham et al., 2003a), the absence of ischemia or its presence and location were evaluated using transcutaneous oxygen pressure recordings during a constant load (3.2km/h, 10% slope) treadmill-walking test (Strandness Procedure (Strandness, 1970)). The presence of ischemia was defined with the delta from rest oxygen pressure index (DROP) < -15 mmHg (Abraham et al., 2005). If the test confirmed that they suffered unilateral or bilateral ischemia, subjects were included in the patient group. To avoid the possible influence of ischemia location in a leg (i.e. distal in the

calf, or proximal in buttock or thigh), we included subjects only if they present distal ischemia. Controls had no ischemia. Concordance between description of calf pain due to ischemia by patients during walking and location of ischemia was checked. Subjects were not included if they presented a comorbid condition that might influence gait pattern, such as previous lower extremities vascular surgery (bypass, percutaneous angioplasty), lower-extremity amputation, severe osteoarthritis, knee or hip prosthesis, low back pain during exercise, severe cardiopulmonary problems, neurological diseases such as diabetes neuropathy, Parkinson disease, stroke, use of walking aids or any pain or discomfort during exercise other than claudication. Patients were excluded if unable to walk ten meters in less than thirteen seconds and/or they had pain. Participants eligible for inclusion were informed and gave their written consent. Only patients with confirmed unilateral or bilateral ischemia and pain concordance, and controls with confirmed absence of ischemia were included.

The protocol conforms to the declaration of Helsinki, was promoted by the Angers university hospital and registered in Clinicaltrial.gov website under reference: NCT02754804 (April, 28, 2016).

2.2.Study protocol

2.2.1. Procedure

All subjects were instructed to walk on an instrumented gait analysis treadmill (Zebris; FDM-T, sampling rate: 100 Hz; Zebris medical GmbH, Isny, Germany) with a 10% slope, at a speed of 3.2 km/h (Strandness constant load procedure) (Besnier et al., 2017; Chaudru et al., 2019; Fabry et al., 2009; Strandness, 1970). During the test, we recorded transcutaneous pressure in dioxygen and we obtained DROP values variations with a custom-made automatic program. PAD-IC patients were instructed to describe location and pain intensity development in lower limbs during walking, and encouraged to perform as long as possible to reproduce claudication symptoms and to stop at maximal pain and not at pain occurrence.

Exercise was stopped on the patient's request (pain or other difficulties to maintain the effort) or after 15 minutes. Controls were invited to walk for 15 minutes without stopping.

2.2.2. Data recording

Data of 10 successive gait cycles at three-different periods were collected: in the 1st minute, 7th minute and 14th minute (1st, 2nd and 3rd periods respectively) for Controls, and in the 10th second (pain-free), in the moment of pain onset (pain) and just before stopping the test (max-pain) for the PAD-IC. The two peaks of the VGRF during gait for symptomatic (i.e., ischemic and painful) and asymptomatic legs for Unilat-IC, and for both legs in Bilat-IC and Controls were sampled from treadmills force plates at 100 Hz by the treadmill software (Zebris, Suite FDM-T): the first peak force during early stance (Peak 1, corresponding to the load of the bodyweight on the leg in stance and the moment when rearfoot is on contact with the floor) and the second peak force evident through push-off (Peak 2, corresponding to the forefoot push-off). These parameters have been found to have suitable repeatability (ICC>0.878) with this recording system (Nüesch et al., 2018).

Seeking a new approach to establish a functional classification of PAD-IC patients, we determined two gait profiles according to the difference between the peaks. We defined a Rearfoot-profile if Peak 1 > Peak 2, and a Forefoot-profile when Peak 1 < Peak 2 (Figure 1). Accordingly, for a Rearfoot-profile, the difference "Peak2 - Peak1" called Δ peaks is < 0 when, in a Forefoot-profile, Δ peaks is > 0. The foundations of this approach were previous descriptions of the braking and propulsive forces in the anteroposterior ground reaction force (Schenck and Kesar, 2017) and of impact of pathological conditions on the second peak of VGRF (Alam et al., 2017; Ayzin Rosoky et al., 2000; Celis et al., 2009; Luc-Harkey et al., 2018), indicating that the propulsive capacity is altered in pathological conditions.

Peak forces were normalized by the bodyweight (%BW). For data analysis, in Bilat-IC or in Controls, when values in the two legs were not different, data were averaged. We

determined the average profile for each group during each of the three periods of the gait (Figure 2 illustrates an example of recording).

2.3.Statistical analysis

Statistical analysis was performed using Statistica Software 13.0 (Software, Inc., Tulsa, USA) to analyze the Δ peaks. The normality and homogeneity of variance were respectively determined using the Kolmogorov-Smirnov and Levene tests. When the parametric assumptions were met, a factorial ANOVA was applied for the groups with a post-hoc Fisher's least significant difference (LSD multiple comparison procedure). We assessed before that values in right and left legs in Controls and Bilat-IC presented no significant differences, after that we made means between the two legs to simplify the analysis. For the Controls, we applied the factorial ANOVA [leg (mean of the two legs) \times period (1st, 2nd and 3rd) 2 \times 3 (Leg \times period)]. For the PAD-IC groups, we applied the factorial ANOVA [leg (symptomatic or asymptomatic for Unilat-IC and mean of the two legs for Bilat-IC) \times period (pain-free, pain and max-pain) 2 \times 3 (Leg \times period)]. Values are expressed as means (\pm standard deviation (SD)).

3. Results

3.1.Participants

There was no significant difference between groups concerning anthropometric parameters (Table 1), except for smoking, which prevalence was higher in PAD-IC patients. Controls walked significantly longer than PAD-IC groups (+25% and +22% compared to Unilat-IC and Bilat-IC respectively, with no differences between PAD-IC groups) and all Controls walked for 15 minutes, whereas all PAD-IC patients stopped before.

3.2. Profile

No interaction effect (leg x period) were found with the factorial ANOVA (observed power: 0.874).

3.2.1. Bilat-IC and Controls

No significant differences between periods were revealed on Δ peaks nor between these two groups. These groups presented a Forefoot-profile (Δ peaks > 0) during the three periods of the gait (Figure 3). Despite the absence of significant difference, Δ peaks in Controls seems higher than in Bilat-IC, even if both present positive values.

3.2.2. Unilat-IC

We found that both symptomatic and asymptomatic legs in Unilat-IC presented a Rearfoot-profile during the pain-free period and therefore were different from Controls only (in 1st period). Despite opposite profiles, Δ peaks in Unilat-IC were not different from Bilat-IC. In the pain period, the asymptomatic leg changes its profile and adopts a Forefoot-profile, whereas the symptomatic leg remains Rearfoot-profile and stays different from Controls (in the 2nd period). During the last period, the asymptomatic leg maintains a Forefoot-profile and the symptomatic leg remains with a Rearfoot-profile but with a Δ peaks near to 0, which means that in this period there is no longer any significant difference between Unilat-IC and Controls.

166 In addition, the asymptomatic leg was the only one to present a difference between the
167 pain-free and the max-pain period (due to the change of profile with the onset of pain).

4. Discussion

Our main finding is that ischemic pain extent in PAD-IC patients affects differently the Rearfoot-Forefoot profiles defined according to the peaks of VGRF. Such an approach highlights that Unilat-IC demonstrated altered profile even during pain-free walking and that pain induces gait asymmetry. Moreover, we show that Bilat-IC retains a Forefoot-profile along the test, and therefore, cannot be considered entirely as a “double” Unilat-IC.

We observed that with the onset of pain in Unilat-IC, the asymptomatic leg tends to change its profile to present a Forefoot-profile during max-pain, while the symptomatic leg keeps a Rearfoot-profile. This strategy leads to a significant difference in Δ peaks in the asymptomatic leg only between the pain-free and the max-pain periods. Pain in Unilat-IC induces an asymmetrical gait pattern. Ayzin Rosoky et al., (2000) indicate that the ischemic limb presents a descending pattern in the forefoot while the asymptomatic was no different from control limbs. This is in accordance with the theory of motor adaptation to pain (Hug et al., 2016; Lund et al., 1991). When pain is unilaterally induced, a redistribution of the load to the non-painful limb occurs to reduce solicitation of the painful limb. In our study, the asymptomatic leg adopts a Forefoot-profile when pain occurred in order to compensate for pain and weakness due to ischemia in the symptomatic leg. This agrees with two others studies founding differences between the symptomatic and asymptomatic legs reporting a decrease in the load on the symptomatic leg (Gardner et al., 2010; Wurdeman et al., 2012) but disagrees with three other ones describing no difference (Gommans et al., 2017; Koutakis et al., 2010; Szymczak et al., 2018). These discrepancies may be related to the fact that, in these studies, subjects were included in case of pathological ABI and ischemia extent was defined accordingly. Nevertheless, exercise ischemia can occur even in absence of pathological ABI, particularly in cases of proximal ischemia (Abraham et al., 2020, 2003b; Gernigon et al., 2013). Consequently, the legs considered asymptomatic are not guaranteed to

be non-ischemic during exercise and an ischemia considered clinically unilateral could be in fact bilateral (Henni et al., 2019). Therefore, the strength of our study is to allow a classification according to the effective ischemia during exercise, since we recorded transcutaneous pressure in dioxygen in both limbs throughout the procedure to assess its occurrence and location, and concurrence with patient's pain description. In addition, our results show that Unilat-IC patients present a Rearfoot-profile in both legs during the pain-free period compared to Bilat-IC patients and Controls. As previously observed, Unilat-IC patients present an asymmetrical gait pattern that likely impacts their balance (Gardner et al., 2010; Gardner and Montgomery, 2001). Consequently, a Rearfoot-profile, corresponding to a blunted propulsive force, during pain-free walking suggests that subjects adopt a safer and more stable walking pattern (Franz, 2016). This strategy is also found after a unilateral ACL reconstruction since an asymmetry between limbs is observed (Mantashloo et al., 2019). Interestingly, the symptomatic limb presents a Rearfoot-profile, while the non-symptomatic one presents a Forefoot-profile (personal observation based on their results). In addition, most PAD-IC patients have pain in the plantar flexor muscles which are responsible for the forward propulsion during the push-off phase of walking (Anderson and Pandy, 2003; Gottschall, 2005; Liu et al., 2006). Presenting a Rearfoot-profile limits the solicitation of these muscles. This adaptation can be used in pain-free conditions, but not with the onset of pain and subsequent asymmetry appearing between the legs; the asymptomatic leg is forced to increase its propulsion to maintain walking and to compensate for the symptomatic leg. This Rearfoot profile during the pain-free phase and the change of profile with the increase of pain underlined that Unilat-IC patients exhibit a particular motor adaptation to pain. This adaptation can have short-term advantages, such as reduction of pain and load on painful muscles. It can also induce negative long-term consequences, including an increase in the

biomechanical constraint at tendon and muscle levels in non-painful areas and a subsequent higher risk of injuries (Hug et al., 2016).

The results also show that the Rearfoot-Forefoot gait profiles are similar in Bilat-IC patients and Controls. Both present a Forefoot-profile during all periods of the gait. This suggests that these two groups develop the same strategy during walking: more push-off to propel the lower limb forward and reduce the energy cost of walking (Huang et al., 2015). However, Δ peaks values tend to be lower in Bilat-IC than in Controls, suggesting that Bilat-IC patients have more difficulties in producing propulsive force because of the presence of ischemic pain in plantar flexor muscles. The fact that pain was present in both legs does not allow implementing a compensatory strategy to redistribute load in a non-painful area, as in case of Unilat-IC. Consequently, Bilat-IC patients distributed the forces equally between legs and therefore did not show any imbalance during gait and retained a Forefoot-profile, despite the pain sensation. These results partly agree with those of Scott-Pandorf et al., (2007) indicating that PAD-IC patients present Peaks 1 and 2 similar to Controls and that the onset of pain does not impact these peaks. Furthermore, peaks or Δ peaks were not compared but their results indicate that Peak1 is higher than Peak2, corresponding to a Rearfoot-profile, contradictory with our results. This discrepancy can be explained by the fact that Unilat-IC and Bilat-IC were not differentiated, and only “claudicating limbs” were analysed (14 patients for 20 limbs studied). To our knowledge, the comparison between Unilat-IC and Bilat-IC has never been made before. Our study is the first to demonstrate that they induce different consequences and that Bilat-IC should not be considered as a “double” Unilat-IC. Future studies on gait parameters in patients with IC should clearly differentiate the unilateral or bilateral character of ischemia.

Our method requires additional validation studies, still our first results and observations support this functional profile to characterize unilateral vs. bilateral PAD-IC patients.

Furthermore, it appears to be simple, with a good repeatability associated to VGRF measurement (Nüesch et al., 2018) and easy to interpret especially in clinical routine in comparison with kinematics and other kinetics analysis which required in-depth analysis. Knowing how Unilat-IC affects patients could be useful to facilitate assessments and adapt care. Indeed, physical rehabilitation can be used with these subjects to improve VGRF by using real-time biofeedback (Browne and Franz, 2018; Luc-Harkey et al., 2018). Effectiveness of exercise therapy has been widely described for PAD-IC patients (Baker et al., 2017; Treat-Jacobson et al., 2019). Schieber et al., (2020) observed that, after supervised walking exercise therapy, the second peak of VGRF is decreased and that exercise does not improve it contrary to others parameters such as power generation at the ankle and hip, even without hemodynamic improvement (ABI rest values remain unchanged). Therefore, it would be of interest to implement a physical rehabilitation program in PAD-IC patients focused on the Rearfoot-Forefoot profile improvement. Indeed, Awad et al., (2014) have shown that the development of the propulsive capacities in the paretic limb in stroke patients improves their functional balance. Moreover, energy cost is increased in PAD-IC patients in level walking only (0% slope) and not in uphill walking (7 or 12% slope) compared to controls (Marconi et al., 2003). This is related first to the deficiency in push-off in PAD-IC patients. This induces greater demand for work in other muscles and a higher energy cost. Second, to the fact that uphill walking is more energy efficient (reduced lift of the body mass center) (Huang et al., 2015). Thus, in a future investigation, it would be interesting to determine if a physical activity program using uphill walking, allowing not to increase the energy cost, and focused on strengthening of the plantarflexor muscles to improve the Forefoot-profile could be effective for PAD-IC patients in improving their walking capacities and in reducing asymmetry.

Limitations

The “laboratory conditions” and “ecologic conditions” are often considered different suggesting that our results could be different in overground conditions. Walking on an instrumented treadmill may be different from daily walking (de Müllenheim et al., 2016). Indeed, the imposed speed, the “moving” ground, the slope, the difficulty to stop or slow down “on demand” could possibly affect neuromuscular activation and the ability to compensate between legs. Studies comparing VGRF during overground vs treadmill walking found no difference (Brouwer et al., 2009) and we did not observe any difference in the MWD between unilateral and bilateral PAD-IC patients; yet other validation studies are necessary to further validate our method in ecologic situations and for other pathologies. This would allow consideration of the functional profile for treatment/rehabilitation whatever the conditions. Concerning the results of our study, we do not think that the constant speed and the impossibility of slowing down are limits for the interpretation concerning the compensatory strategy highlighted when pain occurs in Unilat-IC since Gardner et al., (2010), in an overground study, showed that Unilat-IC patients demonstrated interleg compensation even when they slow down. The impact of slope could also be addressed, as it can affect VGRF and muscular activation (Alexander and Schwameder, 2016; Franz and Kram, 2012). We recorded all subjects under the same conditions, so that they were similarly affected by slope. Furthermore, Item-Glatthorn et al., (2016) demonstrate no significant difference in the two peaks of VGRF between level and uphill walking in healthy subjects. Consequently, we do not consider that this 10% slope affects our observations. Moreover, we remind that the test applied in this study is regularly used as a constant-load procedure to evaluate PAD-IC patients walking capacity. To standardize speed walking and slope allows for measurements comparison unlike free walking. Thus, having results in this condition will allow to implement this method by clinicians using this routine.

291 The last limit that can be raised is that, in our study, some patients present diabetes, and,
292 with or without neuropathy, diabetes is known to induce gait alterations (Sawacha et al.,
293 2012). However, Toosizadeh et al., (2016) found that diabetes had no influence on gait
294 parameters in PAD patients. Moreover, tests before the inclusion of diabetic neuropathy with
295 medical testing were performed (monofilament, sensibility and reflex testing), and subjects
296 were included only in case of negative results. For these reasons, we did not exclude patients
297 with diabetes.

5. Conclusion

In PAD-IC patients, we can define the Rearfoot-Forefoot profile based on VGRF and depending on ischemia extent and pain intensity during walking. In case of Unilat-IC, we highlight that patients exhibit a Rearfoot-profile in both legs during pain-free, probably to stabilize their gait. The onset of pain until its maximum affects the Rearfoot-Forefoot profile of the asymptomatic leg to compensate for the weakness of the symptomatic leg, leading to an asymmetrical gait. This particular motor adaptation to pain allows reducing the use of the symptomatic leg, but induces an imbalance. In Bilat-IC and Controls subjects, a Forefoot-profile is found, with a symmetrical pattern between legs. However, there is a trend for lower propulsive capacity in case of Bilat-IC due to ischemic pain, but Bilat-IC patients did not have the ability to compensate as in Unilat-IC. Therefore, Bilat-IC should not be considered as a “double” Unilat-IC.

To consider the Rearfoot-Forefoot profile combined to amplitude of VGRF supplies a simple way to identify gait alterations in PAD-IC patients in clinical assessments. In addition, the results provide new insight into the consequences of ischemia extent and pain intensity on gait. Future studies on gait parameters in patients with IC should clearly differentiate the unilateral or bilateral character of ischemia.

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320

321 **Competing Interests**

322 The authors declare no competing interests.

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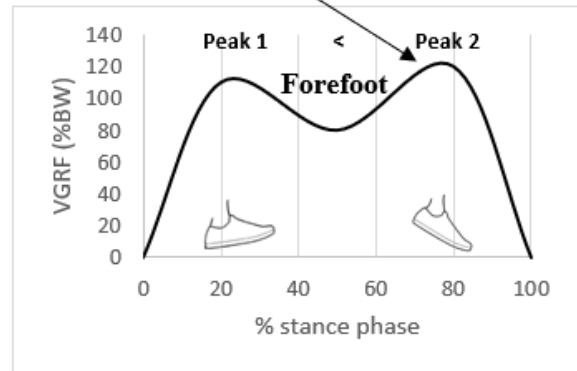
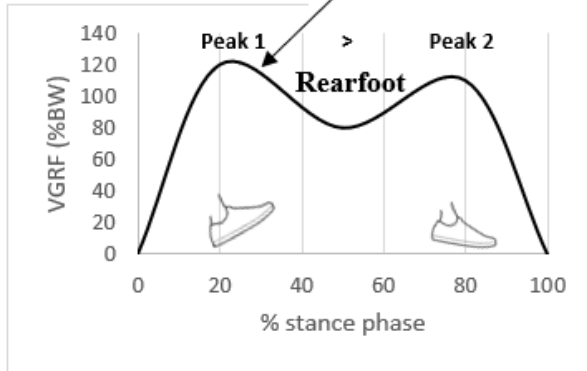
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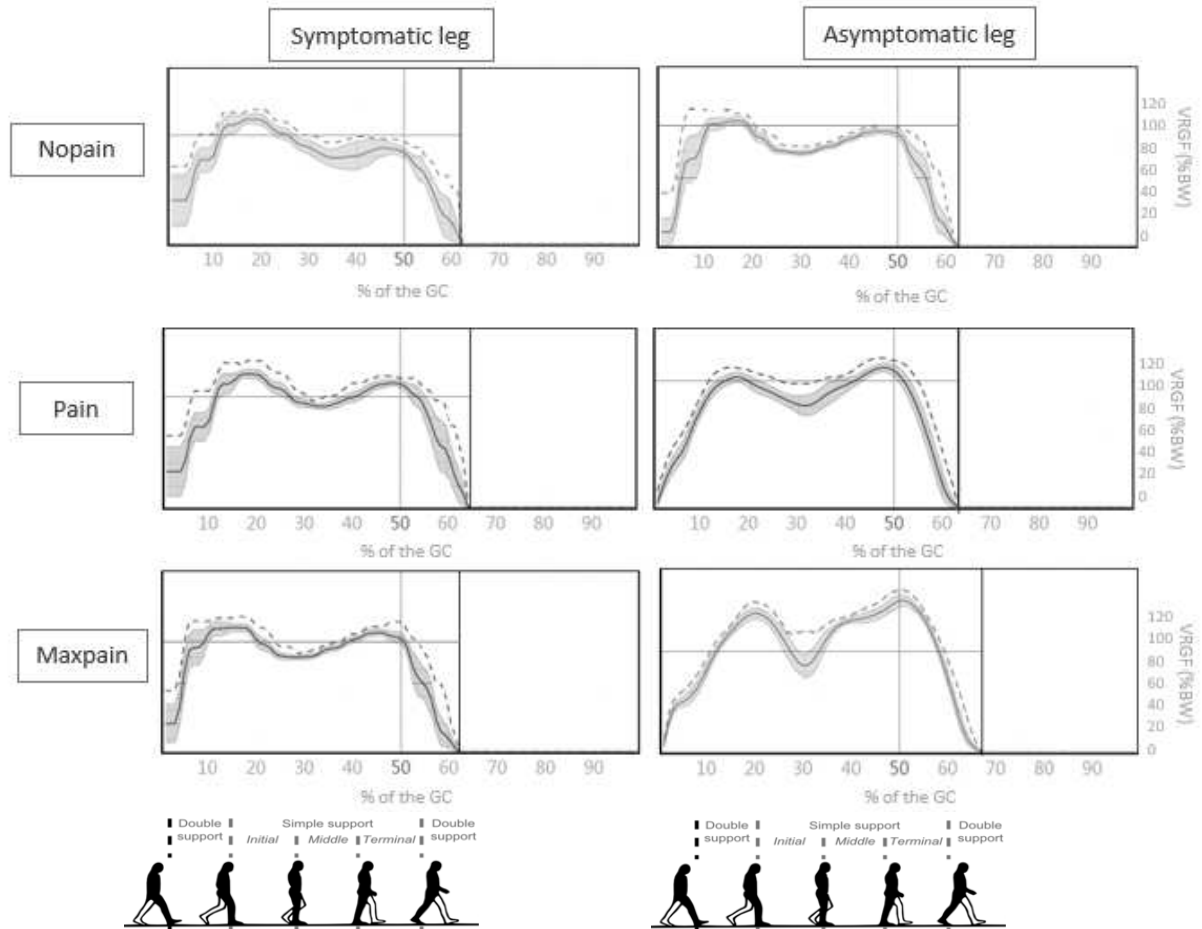
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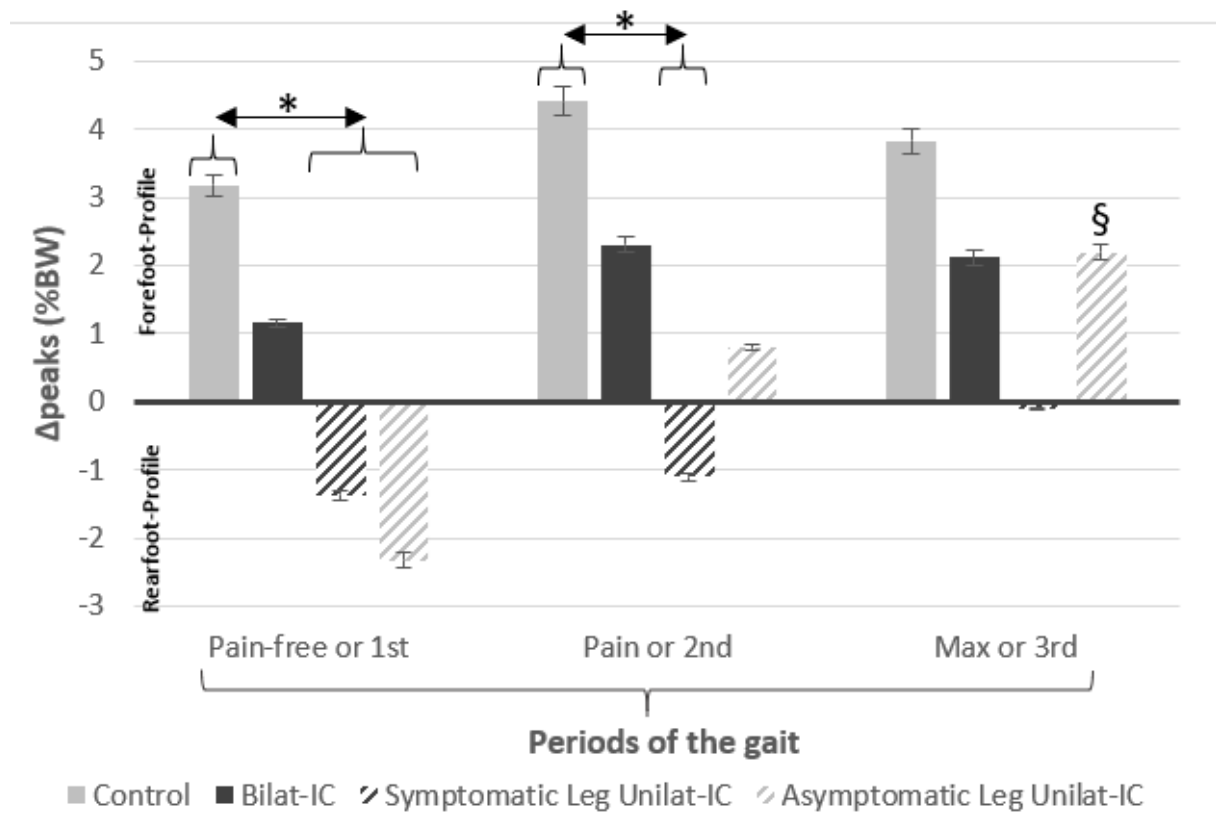


Table 1: Characteristics of the groups (*mean(SD)*)

<i>Group / Characteristic</i>	<i>Unilateral-IC (n=24)</i>	<i>Bilateral-IC (n=22)</i>	<i>Control (n=24)</i>
Age (years)	67(7)	64(7)	65(7)
Height (m)	1.69(0.09)	1.69(0.06)	1.69(0.10)
Mass (kg)	75(16)	77(16)	75(12)
Body Mass Index (kg/m ²)	26.0(4.5)	26.8(4.9)	26.1(3.6)
ABI (Symptomatic-Unilat-IC or right leg)	0.65(0.18) [¥]	0.70(0.16) [¥]	1.17(0.19)
ABI (Asymptomatic-Unilat-IC or left leg)	1.00(0.10) ^{*,¥}	0.66(0.20) [¥]	1.20(0.19)
Maximal DROP (mmHg) (Symptomatic-Unilat-IC or right leg)	-35.2(16.4) [¥]	-36.0(12.4) [¥]	- 4.6(4.1)
Maximal DROP (mmHg) (Asymptomatic-Unilat-IC or left leg)	-10.7(3.5) ^{*,¥}	-40.0(14.0) [¥]	-5.4(3.7)
Duration of symptoms (months)	14.3(8.4)	17.6(15.9)	/
Smoking (n)	21 [¥]	21 [¥]	14
<i>Active smoker</i>	12	9	8
Hypertension (n)	8	17	13
Diabetes (n)	8	6	4
Hypercholesterolemia (n)	10	16	15
Pain-free walking distance (m)	107(70)	91(60)	/
Maximal Walking Distance (m)	288(175)	244(100)	1133(179) [¥]

^{*}: $P < 0.05$ between unilateral and bilateral claudicants (Unilat-IC and Bilat-IC respectively)

[¥]: $P < 0.05$ with the control group

ABI: ankle brachial index, for the symptomatic and asymptomatic legs in Unilateral-IC, and for right and left leg in Bilateral-IC or control group