Hip abductor and adductor activity during Duchenne-Trendelenburg gait in persons with osteoarthritic hip

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Hip abductor and adductor activity during Duchenne-Trendelenburg gait in persons with osteoarthritic hip

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Abstract

PURPOSE: To find out cause(s) of the Duchenne-Trendelenburg (D-T) sign exhibited by persons with osteoarthritis (OA) of the hip. RELEVANCE: This study would be of value in deciding which physiotherapy modality takes priority for acquisition of normal walking. PARTICIPANTS: Participants were 10 women with bilateral OA and 11 women with unilateral OA, both in the terminal-stage, and 9 healthy women as controls. The OA participants exhibited either a unilateral or bilateral positive D-T sign. METHODS: Surface electromyography (EMG) was employed to record activity of the gluteus medius (GM) and hip adductors (HA) during walking. The D-T sign was identified, followed by the measurement of the angles of lateral pelvic tilt, trunk lateral lean and trunk lateral flexion. Three trials of isometric maximum volitional contractions (MVCs) were performed for the hip abductors and adductors. DATA ANALYSIS: Parameters included: 1) EMG activities of GM and HA during early and mid stance phases of walking; 2) ratio of EMG activities of GM to that of HA; and 3) strength, per kg of body weight, of GM and HA during MVC. Tukey's quick test and t-test were used for the calculations. RESULTS: The mean EMG activities of GM in the unilateral and bilateral OA women who exhibited a positive D-T sign were significantly greater than those of the controls during the early and mid-stance phases of walking, while there was little EMG activity of HA. Ratios for activity of GM to that of HA were more than 10 times larger in the controls and 9 times larger in OA women, and the GM and HA strength of OA women was significantly smaller than that of the controls. There was a negative relationship between the angle of trunk lateral lean and GM strength in all of the groups. DISCUSSION AND CONCLUSION: The coefficient of determination was 0.32 for the abductor strength and angle of trunk lateral lean and, therefore, weakness of GM could be related to a positive D-T sign, not HA. Since EMG activity of GM in OA women was greater than that in the controls, the central nervous system might have been stimulated in response to GM's weakness, consequently, providing sufficient hip stability. These findings necessitate further analysis of factors other than the abductor strength. IMPLICATIONS: The findings could provide us with the most efficient treatment modality for attainment of a normal walking pattern. Further evidence-based client-centred practice of physiotherapy should be carried out to elucidate the cause for the positive D-T sign.

Key words

Duchenne-Trendelenburg sign, hip adductors, electromyography, hip abductors, osteoarthritis

Introduction

Freidrich Trendelenburg invented a test in 1895 to examine hip abductor dysfunction, which became known as the Trendelenburg (T) test[1]. Trendelenburg (T) gait is defined as pelvic ascent on the side of the swing leg[2,3], and Duchenne (D)

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gait is said to occur when the trunk leans laterally towards the side of the supporting leg[2,4], both of which are frequently seen in persons with osteoarthritic (OA) hip[5]. The Duchenne (D) and Trendelenburg (T) signs may develop simultaneously in such persons and are collectively known as the Duchenne-Trendelenburg (D-T) sign[6]. In other words, the Trendelenburg sign is said to be positive when there is ipsilateral flexion of the trunk with simultaneous contralateral ascent of the pelvis during stance phase of the gait cycle[7], which is due to weakness of the hip abductors. This abnormal gait exhibiting this sign is called the D-T or T gait[7,8].

It is generally believed that the T gait is due to weakness of the gluteus medius (GM)[1,9]. However, some researchers have stated that, in spite of recovery of the GM strength in full, the T sign still persists during walking[5,10]. Contrary to this, the T sign may still be negative during walking even if the GM strength is insufficient[11]. In fact, the EMG activity of GM in some OA persons has been found to be greater than that in normal volunteers[12]. Watanabe et al reported that the EMG activity of GM during the mid stance phase of gait of OA persons with a positive T sign was significantly greater than that in healthy volunteers and OA persons with a negative T sign[13]. However, Nagai disagreed with Watanabe et al stating that the D sign was the result of a compensatory movement that reduced the activity of the hip abductors[3]. However, it is a conclusive fact that the T sign appears during free walking in all cases of OA persons even if the EMG activity of GM is greater than that found in normal persons.

As for the reasons for the positive T sign other than the strength of GM, the following explanations have been proposed: a relative increase in the strength of the hip adductors (HA)[14,15], shortening of the time to reach peak HA strength[16] and spasticity of HA[17]. Satsuma et al. demonstrated that a relative increase in the strength of HA was related to a positive T sign because the torque value of HA of persons with the positive T sign was significantly greater than that of those with the negative T sign[14]. In addition, according to a study by Maesawa et al, in which a Biodex Isokinetic Dynamometer was used for the measurement of the hip muscle strength, the hip abductor strength of persons with OA was found to have become significantly smaller with the progression of the disease, consequently increasing the relative strength of HA by 130 per cent, which would consequently result in instability of the hip because of an imbalance in the hip abductor and adductor strength[15].

Normally, there is no activity of HA of the supporting leg during the mid stance phase in free walking[17], and also there is hardly any activity of HA of the supporting lower limb in one-legged stance in healthy persons[18]. However, Nagai reported that the EMG activity of HA of the supporting lower limb in the Duchenne position in one-legged stance was greater than that in the normal position[19].

The literature review revealed that there have been few EMG studies on the D-T sign exhibited by persons with OA during free walking, except for those studies that have only analysed the EMG activity of GM[9,11-13]. Furthermore, there have been no studies carried out analysing the EMG activity of HA, together with GM. Thus, it is still unknown whether or not the weakness of HA is one of the causes of the D-T sign in a typical gait. Therefore, the purpose of this study was to investigate differences in the EMG activities and strength of GM and HA of persons with OA exhibiting the positive or negative D-T signs and to compare them to those of healthy volunteers. This study would be of value in deciding which physiotherapy modality takes priority for acquisition of normal walking.

Methods

Participants

The participants consisted of 10 women with bilateral OA in the terminal stage, 11 with unilateral OA who were also in the terminal stage and 9 healthy women volunteers as a control group (Table 1). According to the clinical criteria for determination of the D-T sign, the bilateral and unilateral OA participants were subdivided into 2

Table.1 Participants' characteristics.

	N	Joint	Age (years)	Standing Height (cm)	Body Weight (kg)	Walking Speed (m/s)
Bilateral OA	10	15	52.2±7.4	153.7±4.1	54.5±7.8	0.9±0.3
Unilateral OA	11	22	53.1±5.0	152.2±4.8	54.5±6.2	1.1±0.2
Healthy	9	9	48.9±4.2	156.5±5.2	54.1±6.4	1.4±0.1

*: p<0.05, **: p<0.01

Table. 2 Lateral pelvic tilt, trunk lateral lean and trunk lateral flexion during one-legged stance.

	Bilateral OA		Unilateral OA	Unilateral normal	Normal
	D-T (+) n = 10	D-T (-) n = 5	D-T (+) n = 11	D-T (-) n = 11	D-T (-) n = 9
Lateral pelvic tilt	2.0±5.3	0.9±1.3	1.0±4.7	2.6±2.9	2.3±1.4
Trunk lateral lean	7.3±3.3	1.9±1.6	7.3±2.5	0	1.5±2.8
Trunk lateral flexion	5.4±4.1	1±1.7	6.3±4.7	−1.2±2.3	−0.8±3.4

D-T: Duchenne-Trendelenburg sign; (+): positive; (-): negative; n: number of hip joints

*: p<0.05, **: p<0.01

groups each (Table 2). The participants had no history of any other neuromuscular condition, and all of them consented to participate in the experiment after having been informed of the methods of measurement involved. Based on the findings from bilateral hip roentgenograms, the diagnosis for OA in the terminal stage was determined by an orthopaedic specialist at the Medical College of Kanazawa Hospital, Uchinada, Ishikawa Prefecture, Japan.

In order to avoid the influence of EMG activity during walking due to the discrepancy in leg length[20], the author selected participants whose discrepancy in leg length from the anterior superior iliac spine (ASIS) to the medial malleolus was equal to or less than 1 cm.

Data collection

For the determination of the T sign the participant's iliac crest was palpated bilaterally for lateral pelvic tilt with the participant in one-legged stance. For the identification of the D sign, trunk lateral lean was also checked in one-legged stance. For determination of the D-T sign, angles of lateral pelvic tilt, trunk lateral lean and trunk lateral flexion were measured using a digital video camera (DCR-TRV900, Sony Corp., Tokyo, Japan). Determination of these angles using a field image restoration program (Dual Stream, IFS-54, DKH Co., Ltd., Tokyo, Japan) was as follows: The amount of lateral pelvic tilt was measured from the degree of angle formed by the Jacoby line (an imaginary line that spans a distance between the right and left iliac crests) and with its deflected line on the central axis at the mid point of the Jacoby line during one-legged stance (Fig. 1). The angle of trunk lateral lean was conceived between the imaginary vertical line that crossed perpendicular to the central axis of the Jacoby line and its deflected line from the spinous process of the seventh cervical vertebra. In other words, the amount of trunk lateral lean was equal to the sum of the degree of contralateral pelvic tilt and the degree of trunk lateral flexion, the terminology of which has been sanctioned by the Japanese

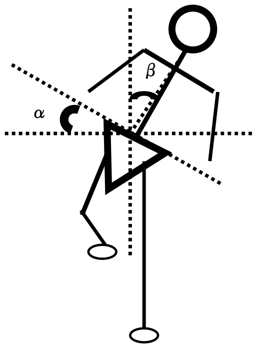

Fig. 1 Measurement of angles of lateral pelvic tilt, trunk lateral lean and trunk lateral flexion. The pelvis on the side of the swing leg may drop in certain individuals with OA as opposed to the depiction shown on this diagram.

Association of Rehabilitation Medicine[21](Fig. 1).

The muscles selected for this study were the bilateral GM and HA. A pair of 1 cm in diameter surface Ag-AgCl electrodes (Nihon Koden, Tokyo, Japan) in a bipolar lead system were applied to the skin over the proximal one third of the belly of GM between the iliac crest and greater trochanter and also over the belly of HA on the proximal medial one quarter of the thigh. This positioning of the electrodes was recommended by Asakawa[22], so that the distance between the electrodes could be kept at its shortest. They were placed parallel to the muscle fibres at 2 cm apart in order to reduce the influence of cross talk as much as possible and were secured to the skin by a piece of tape. The reference electrodes were applied bilaterally to the skin over the ASIS for GM and to the belly of the adductor magnus for HA. The electrode placement was preceded by measurement of the skin impedance using a commercially available electrode tester (DPZ-30E; Dia-Medical, Tokyo, Japan), followed by abrasion of the skin surface with an alcohol swab to reduce its impedance to below 5 to 10 KΩ in a frequency range of 30 Hz to 1 kHz. A total of four pre-amplifiers (AR-C2 EMG1; Teac, Tokyo, Japan) with a resolving power of 100 were used for each channel to identify EMG activities of the muscles.

The participant was instructed to walk freely on a level surface 15 m in length, accompanied with a foot switch attached bilaterally to each foot for synchronization of walking and the EMG recording. Walking speed of the middle 10 m of the 15-m walking length was measured.

As for the measurement of the hip abductor and HA strength during isometric maximal volitional contractions (MVCs), the participant was placed in the supine position with their hands grasping the edge of the plinth. The participant's pelvis and lower limb were fixated by the examiner's hand, and, at the same time, the muscle strength was measured using a hand-held dynamometer (μMF-1, Anima Corp., Tokyo, Japan) that was placed just above the lateral malleolus for GM and above the medial malleolus for HA[23]. The participant was instructed to perform 3 abduction and adduction movements as a warm-up, followed by 3 MVCs each of the hip abductors and adductors for 5 sec in the neutral position of the hip for testing. This procedure was, then, repeated on the opposite leg. The testing of each muscle group was interspersed with a 30-sec rest period to prevent fatigue[24]. The strength value was divided by the body weight of each participant in order to nullify individual differences, and the average value was taken from 3 trials, followed by comparison among the 5 groups[25,26]. No participant complained of coxalgia during the procedure.

Data reduction

Analogue signals from the electrodes were converted into digital signals with a sampling frequency of 5 kHz for every channel by the 16-bit iteration method and, then, stored on a PC card using a Teac PC Card Recorder (DR-C2; Teac, Tokyo, Japan). Signals calculated for a sampling time of 0.2 ms were analysed using high precision non-linear system software (MemCalc[27], Faculty of Engineering, Hokkaido University, Japan). Gmview II software (Signalysis Co., Ltd., Saitama, Japan) was used to analyse the data. Specifically, EMG signals received during the first six steps were discarded and only those during the 3 median gait cycles were categorised into early and mid stance phases by the foot switches (Fig. 2). In order to avoid influence of motion artefacts the frequency band was set in a range from 20 to 1000 Hz by a band-pass filter.

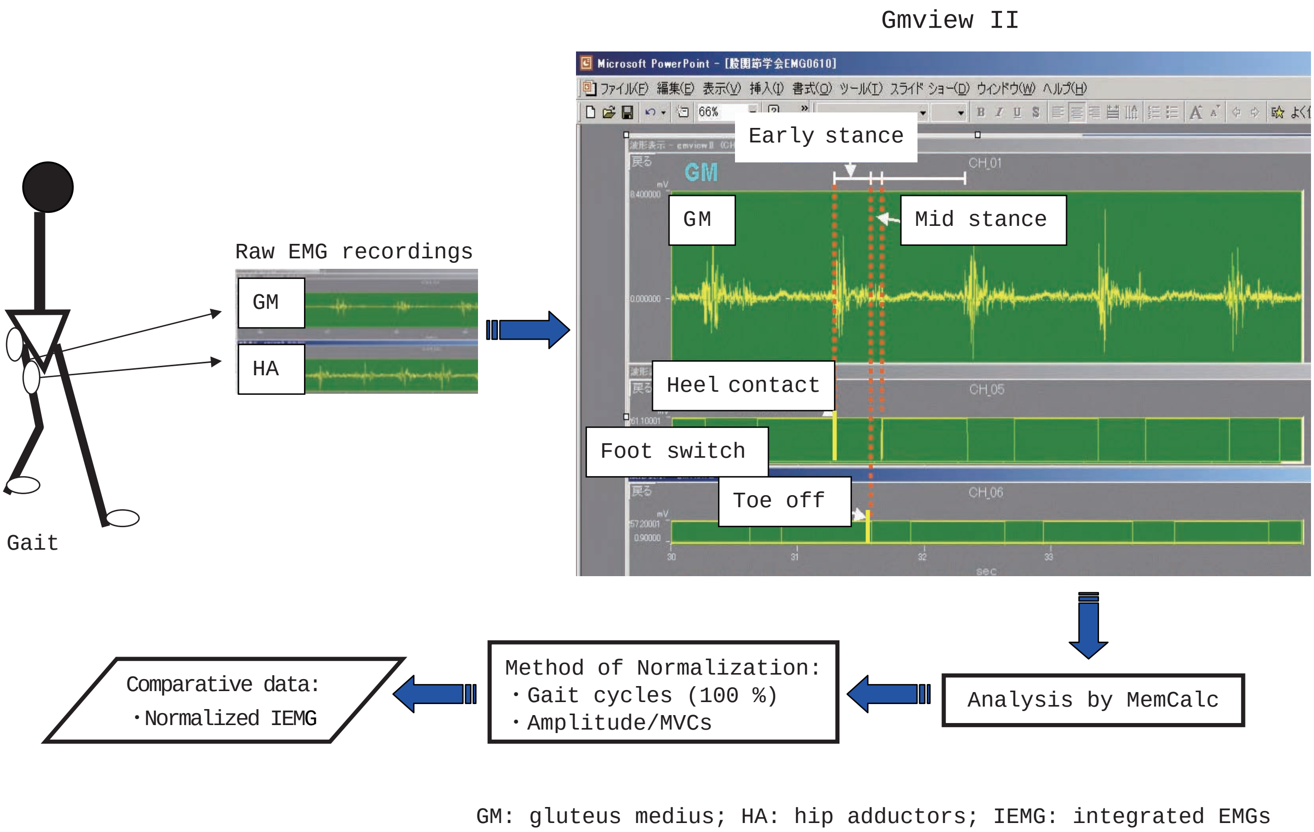

Fig. 2 Measurement procedure for EMG analysis.

Integrated EMG values were normalised with the time required for the entire stance phase deemed as 100 per cent. Also the amplitudes were normalised into integrated values for MVCs[28] of GM and HA so as to be able to compare them. Meanwhile, the EMG recordings from the middle one-second period out of a 5-second period during MVC were utilised, from which the mean values taken from 3 trials for each muscle were used for analysis.

Statistical analysis

Tukey's quick test was used for multiple comparison of the muscle strength and unpaired *t* test for multiple comparison of EMG activities of GM and HA among the 5 groups. Also compared were the EMG activities of GM and HA between early and mid stance phases using paired *t* test. Furthermore, coefficients of correlation (r) and determination (r^2) between the strength of the hip abductors and the angle of trunk lateral lean were calculated to examine whether there was any relationship between the hip abductor strength and D-T sign. The level of significance was set at 0.05, using the computer software *Microsoft Excel 2000* for the data analysis.

Results

There were no significant differences in age, standing height and body weight among the 5 groups. Although the walking speed of the healthy volunteers was significantly faster than that of the bilateral and unilateral OA persons, no significant difference in walking speed between the two OA groups was evident (Table 1).

There was also no significant difference in the angle of lateral pelvic tilt among the 5 groups or for that of trunk lateral flexion between the bilateral OA groups with negative and positive D-T signs. However, the angles of trunk lateral flexion of the groups with a positive D-T sign were significantly greater than those of the other groups with a negative D-T sign. In addition, the angles of trunk lateral lean of the groups with a positive D-T sign were significantly greater than those for the groups with a negative D-T sign. Table 2 shows a summary of the angles of the lateral pelvic tilt, Table.3 Comparison of EMG activities (%) of GM and HA among the 5 groups during the early and mid stance phases of free walking.

		Bilateral OA		Unilateral OA	Unilateral normal	Normal
Stance Phase		D−T (+)	D−T (-)	D−T (+)	D−T (-)	normal
Early	GM	21.7±27.9	16.8±18.0	17.6±12.3	12.0±10.5	4.4±4.4
Mid	GM	11.4±19.4	14.0±21.0	7.0±4.1	3.8±5.2	0.2±0.2
Early	HA	1.6±1.2	6.2±3.2	2.0±2.0	0.9±1.3	0.5±0.5
Mid	HA	1.0±1.2	3.6±7.9	0.7±0.6	0.1±0.1	0.2±0.2

D-T : Duchenne-Trendelenburg sign; (+): positive; (-): negative; GM: gluteus medius; HA: hip adductors

*: p<0.05, **: p<0.01, ***: p<0.005

Table 4. Ratio of EMG activities between GM and HA during early and mid stance phases of free walking.

	Bilateral OA		Unilateral OA	Unilateral normal	Normal
Stance Phase	D−T (+)	D−T (-)	D−T (+)	D−T (-)	Normal
Early	14.5±20.1	18.0±26.5	25.8±28	30.8±27.4	8.8±6.4
Mid	11.1±17.6	13.7±24.7	23.8±26.4	30.2±32.0	9.1±10.0

D-T: Duchenne-Trendelenburg sign; (+): positive; (-): negative; GM: gluteus medius; HA: hip adductors

trunk lateral flexion and trunk lateral lean.

EMG activities of GM during early and mid stance phases of free walking in the healthy volunteers were small and, this was particularly evident during the mid stance phase when compared to the other four groups (Table 3). EMG activities of GM in the two groups with a negative D-T sign tended to be greater than for those in the three groups with a positive D-T sign during early and mid stance phases of free walking. EMG activities of GM in the unilateral OA group with a positive D-T sign were significantly greater than for those in the healthy volunteers (Table 3). In addition, although EMG activities of HA in the 2 groups with a positive D-T sign were greater than those in the groups with a negative D-T sign, there was no significant difference between the groups with positive and negative D-T signs (Table 3). As for the comparison among the 3 groups with a negative D-T sign, EMG activities of GM and HA in bilateral OA persons were greatest during early and mid stance phases, but were smaller in the sound hip joint of the unilateral OA persons, followed by the healthy volunteers, but with no significant differences among the 3 groups.

Furthermore, with the exception of the bilateral OA persons with a negative D-T sign, EMG activities of GM in the 4 groups were found to be significantly greater in the early stance phase than for those during the mid stance phase. Contrary to these findings, EMG activities of HA in bilateral OA persons with positive and negative D-T signs were rare, and there was no significant difference between the two groups. For the other three groups, EMG activities of HA during early stance phase were significantly greater than for those during mid stance phase (Table 3).

The ratio of the EMG activity between GM and HA is shown in Table 4. Regardless of the D-T sign, EMG activities of HA were smaller than those of GM during the stance phase of walking and the ratio for the activity of GM to that of HA was high in all of the 5 groups.

The strength of the hip abductors and HA is shown in Figures 3 and 4. The strength of the hip abductors and HA in bilateral or unilateral OA persons with a positive D-T sign was significantly smaller than that of the healthy volunteers, but there were no significant differences in the strength of HA among the OA groups.

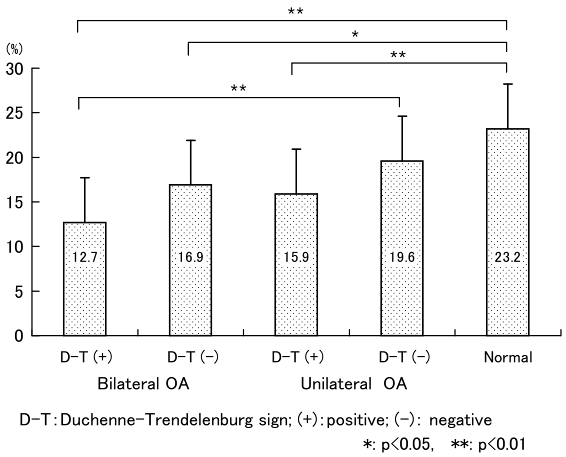

Fig. 3 Strength of the hip abductors.

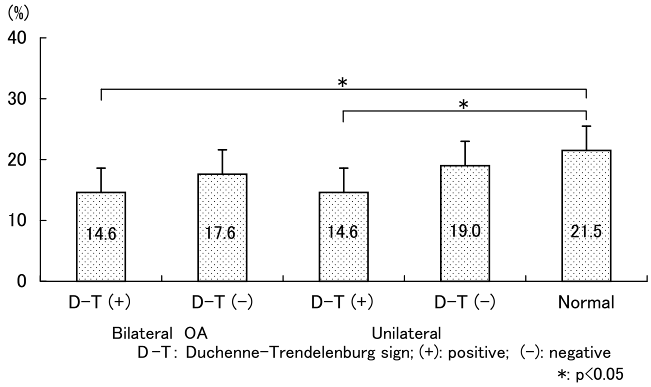

Fig. 4 Strength of hip the adductors.

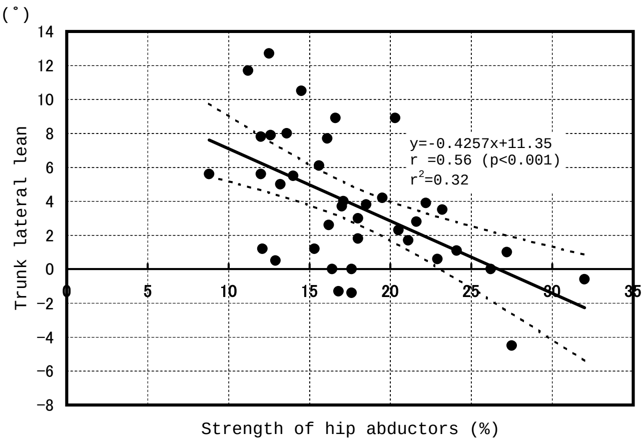

Fig. 5 Relationship between the trunk lateral lean and hip abductor strength.

The abductor strength of the bilateral OA persons with a negative D-T sign was significantly smaller than that of the healthy volunteers. Similarly, the strength of the hip abductors in bilateral OA persons with a positive D-T sign was significantly smaller than that of the unilateral OA persons with a negative D-T sign, but there were no significant differences among other groups.

The r of 0.56 between the angle of trunk lean and hip abductor strength was moderate, but significant, and the rate of contribution (r^2) was 0.32 (Fig. 5).

Discussion

In order to objectively assess an abnormal gait in the frontal plane, it is important to measure the angles of trunk lateral lean, as well as the lateral pelvic tilt. By clinically evaluating the D-T sign the author could significantly categorise the groups with positive and negative D-T signs in terms of the amount of trunk lateral lean and lateral pelvic tilt. The D sign is positive when ipsilateral trunk lateral lean or trunk lateral flexion on the supporting limb takes place. Many researchers prefer to use *trunk lateral lean* rather than *trunk lateral flexion* for this sign[2,4-8]. Therefore, it may be appropriate to use *trunk lateral lean* instead of *trunk lateral flexion* for the assessment of the D sign.

Concerning trunk lateral lean, Tanaka defined a positive trunk lateral lean to be 5 degrees or more after measuring the angle of the line between the right and left acromion processes of the scapulae against a horizontal line[29]. However, this line between the acromion processes can easily lead to a calculation error because of the compensatory movement of elevation or depression of the shoulder girdle. In this study, although the measurement method differed from the one by Tanaka[29], the mean (SD) angles of the trunk lateral lean in the positive D-T sign groups were 7.3 (3.3) degrees for bilateral OA and 7.3 (2.5) degrees for unilateral OA persons.

It is generally believed that a positive T sign indicates upward pelvic tilt on the swing leg during one-legged stance. However, it is not clear as to how much downward tilt of the pelvis qualifies for the positive T sign[30]. Nakamura[30] stated that the pelvis on the side of the swing leg is slightly elevated on one-legged stance in healthy persons.

The lateral pelvic tilt of the healthy volunteers and the groups with a negative D-T sign showed no differences compared to that of the groups with a positive D-T sign, and there was no difference in trunk lateral flexion between persons with bilateral OA exhibiting a positive and negative D-T sign. Contrary to these findings, significant differences were apparent for the angles of trunk lateral lean among all of the groups with positive and negative D-T signs. Thus, it is reasonable and valid, as suggested by Tanaka, in assuming to use trunk lateral lean for the assessment of a positive D-T sign[29] whose definition of D sign has previously been described. Watanabe[31] et al found no difference in the angles of the lateral pelvic tilt between the positive and negative T sign groups during the stance phase of free walking. The reason for no differences found in the lateral pelvic tilt of the OA participants in this study between positive and negative D-T signs may be due to the fact that upward tilt contralaterally of the pelvis accompanied with ipsilateral trunk lean may occur during the stance phase or one-legged stance in bilateral OA persons[5].

Some investigators reported that a relative increase in the HA strength could be a factor causing T gait[14-16,19]. Nagai's study revealed that the EMG activity of HA was greater during one-legged stance, resulting in T gait[21]. However, since Nagai[21] did not measure the EMG activity of HA during free walking, it is not known whether HA would be responsible for the T gait. Findings of this study revealed that, as in healthy persons, there was hardly any EMG activity of HA during the mid stance phase of normal walking in OA individuals with a positive D-T sign, but it was accompanied with a high GM/HA activity ratio. Therefore, HA may not be responsible for the positive D-T sign. This conclusion may, at the very least, be reinforced by the fact that the HA strength in the groups with a positive D-T sign was smaller than that found in normal persons. The reason why the HA strength for this study was smaller than that in Maesawa et al's study[15] may be due to the difference in the stages of OA; i.e. OA clients in this study were in the terminal stage contrary to those in Maesawa et al's who were in early and progressive stages. In addition, another factor for the weak HA may have been disuse atrophy due to the severely limited daily living activities of the participants because of pain.

The EMG activity of GM in the group of the unilateral OA persons with a positive D-T sign was found to be large compared to that of the healthy individuals during the stance phase of free walking, which was in agreement with findings of other studies[11-13]. Since the EMG activity of GM in OA individuals was greater than that in healthy individuals, the central nervous system may automatically become mobilised to provide sufficient hip stability to compensate for weak GM[14]. Watanabe et al[31] reported the EMG activity per MVC of GM during the stance phase of free walking to be 6.4 per cent in normal persons, 12.4 per cent in OA persons with a positive T sign and 9.7 per cent in those with a negative T sign. Further, Tsushima et al[32] reported the EMG activities of GM per MVC were 54 per cent during the early stance phase and 36 per cent during the mid stance phases in normal individuals, and 16 per cent during the early stance phase and 38 per cent during the mid stance phases in OA persons. These findings are much larger than those recorded in this study. These differences may be accounted for by the following: the size of the electrodes, placement of the electrode attachment and distance between the electrodes.

Tsushima, et al found that the EMG activity of GM in 2 out of 10 healthy volunteers was small during the mid stance phase of free walking[32], which is in agreement with the finding of this study in which the GM's EMG activity was found to be very small in the healthy individuals. In other words, one hardly requires action of GM to prevent downward tilt of the pelvis on the side of the swing leg during mid stance phase of free walking, if both the hip joint and abductors are functioning normally. However, in OA persons in the terminal stage with acetabular dysplasia, the hip joint of the weight-bearing leg is exposed to an increased load on the joint capsule due to an excessive latero-superior displacement of the femoral head[5] during the early to mid stance phase. Therefore, one factor for the excessive GM activity found in this study may be due to increased contraction. This compensates for the deficient bone-related support by reinforcing stability of the hip joint and, therefore, controlling pain.

Tanaka[24] found that an abduction moment of the hip joint in the group with D gait was significantly small compared to the group without it. Among the persons with bilateral OA in this study, the author expected that the EMG activity of GM of the group with a positive D-T sign would be small compared to the one with a negative D-T sign, but there was no significant difference between the groups. The reason for this finding may be that individual differences varied greatly as shown by the large standard deviation. Furthermore, the strength of the hip abductors of the group exhibiting a positive D-T sign tended to be small compared to that of the group exhibiting a negative D-T sign, consequently leading to their excess of activity to compensate for the weakness, and this may be one of the causes for the small abduction moment.

In healthy persons GM is active during the early to mid stance phases and its EMG activity peaks at the early stance phase[19]. This fact is in agreement with the finding of this study and that by Tsushima et al[32]. However, there was no significant difference in the EMG activity of GM in the group of bilateral OA women exhibiting a negative D-T sign between the early and mid stance phases of walking. This finding may be attributed to the fact that the EMG activities of GM during the mid stance phase of the group exhibiting a negative D-T sign in the bilateral OA women were larger in comparison to those of the other four groups. In other words, the group exhibiting a negative D-T sign may have required increased strength from GM to prevent descent of the pelvis on the side of the swing leg, with consequent increase in its EMG activity.

The abductor strength of the group in this study exhibiting a positive D-T sign was small compared to that of the control group, and there was a moderate negative correlation between the abductor strength of all of the groups and the angle of trunk lateral lean. These findings confirm the weakness of GM as a factor for the positive D-T sign. In other words, the angle of trunk lateral lean became greater with decreased hip abductor strength. However, because r^2 (or contribution ratio of the abductor strength to the amount of trunk lateral lean) was approximately 30 per cent there may be another factor responsible for this other than the abductor strength.

In conclusion, HA were not related to a positive D-T sign, but weakness of GM was found to be responsible for it.

The findings could provide us with the most efficient treatment modality for attainment of a normal walking pattern. Further evidence-based client-centred practice of physiotherapy should be carried out to elucidate the cause for the positive D-T sign. In the future, by analysing multiple factors of the D-T sign in detail including quantitative EMG activity and qualitative EMG frequency data[33] we can expect the outcome of these results to be of use in clinical application of physiotherapy treatment procedures.

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変形性股関節症患者におけるデュシャンヌ・トレンデレンブルク歩行時の股関節外転筋・内転筋活動

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要　　旨

目的　変形性股関節症（OA）患者のDuchenne-Trendelenburg（D-T）徴候の原因を探るため。 **妥当性**　正常歩行の獲得に向けた理学療法手段の選択に役立てることができる。
対象と方法　両側または一側に末期OAを有するD-T徴候陽性の患者21名と、健常人９名に対しD-T徴候を判定し、体幹傾斜角、骨盤傾斜角、体幹側屈角を測定した。中殿筋（GM）と股関節内転筋（HA）の表面筋電図（EMG）活動とGM/HA活動比および最大随意等尺性収縮筋力を比較した。 **統計学的検定法**　テューキーのq検定およびt検定を用いた。
結果　立脚相の初期と中期において一側OA患者のD-T徴候陽性群におけるGMのEMG活動の平均値は、健常人のそれに比べて有意に大きかった。HAの活動は立脚相中期でほとんど認められなかった。GM/HA活動比は、健常人で約９倍、OA患者群では10倍以上であった。OA患者群のGMとHAの筋力は、健常人のそれに比べて有意に小さかった。体幹傾斜角とGM筋力には有意な負の相関が認められた。GM筋力と体幹傾斜角の寄与率は0.32であった。 **考察および結論**　HAはD-T徴候の出現に関与していなかった。GMの弱化がD-T徴候の原因であること、およびD-T徴候の程度とGM筋力の相関関係を実証できた。OA患者のGMのEMG活動が健常人のそれに比べて大きかったのは、GMが弱化していたため、中枢神経機構が股関節の安定に必要とされる活動レベルまで代償することが示唆される。D-T徴候の原因にはGM筋力以外の要因も考えられる。D-T徴候を改善させるにはGMの優先的な強化を要する。