Original article

Greater trochanteric pain syndrome (GTPS): updated multifactorial approach

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Summary

Introduction: Greater Trochanter Pain Syndrome (GTPS) is an ill-defined clinical pathology. Advances in imaging tests coupled with the interest in sports medicine could lead to a better understanding of predisposing factors and in choosing the most effective treatment.
Objective: Given its etiological variability, this study proposes an updated review of the main etiological factors linked to the development of this multifactorial pathology that occurs with pain in the lateral aspect of the thigh and hip.
Material and method: We conduct an unrestricted electronic search by language and date to the end of September 2022 for studies related to etiological factors in the SDTM. We searched Cochrane Library and databases EMBASE, MEDLINE and PUBMED. We analyze 9 original articles, 1 multicenter study and 1 observational study, 6 reviews (analyzing a total of 648 articles), 3 RCTs and 4 case-control studies.
Results: Of the etiological factors found, 47.8% of articles indicate that the most important is the morphological factor, followed by biomechanical factors in 30.4% and muscular factors in 21.8%.
Conclusion: The need to recognize the possible etiological factors that allow designing an effective individualized treatment according to the etiological factor prevalent in each patient is evident.

Key words:
Greater trochanteric pain syndrome (GTPS). Etiology. Treatment.

Síndrome doloroso del trocánter mayor (SDTM): enfoque multifactorial actualizado

Resumen

Introducción: El Síndrome Doloroso del Trocante Mayor (SDTM) es una patología clínica mal definida. Los avances en pruebas de imagen junto al interés de la medicina deportiva podrían conducir a una mejor comprensión de los factores predisponentes y en la elección del tratamiento más efectivo.
Objetivo: Dada su variabilidad etiológica, este estudio plantea una revisión actualizada de los principales factores etiológicos vinculados al desarrollo de esta patología multifactorial que cursa con dolor en la cara lateral de muslo y cadera.
Material y método: Se realiza búsqueda electrónica sin restricciones por idioma y fecha hasta finales de septiembre de 2022 para estudios relacionados con factores etiológicos en el SDTM. Se realiza búsqueda en Cochrane Library y bases de datos EMBASE, MEDLINE y PUBMED. Se analizan 9 articulo originales, 1 estudio multicéntrico y 1 estudio observacional, 6 revisiones bibliográficas (que analizan un total de 648 artículos), 3 ECA y 4 estudios de caso-control.
Resultados: De los factores etiológicos encontrados, el 47,8% de artículos señalan que el más importante es el factor morfológico, seguido por los factores biomecánicos en el 30,4% y musculares en el 21,8%.
Conclusión: Se evidencia la necesidad de reconocer los posibles factores etiológicos que permitan diseñar un tratamiento eficaz individualizado según factor etiológico prevalente en cada paciente.

Palabras clave:
Síndrome doloroso del trocánter mayor (SDTM). Etiología. Tratamientos.

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Introduction

Greater trochanteric pain syndrome (GTPS) is a multifactorial pathology which is a painful condition on the outer side of the hip and thigh[1,2], with an annual incidence of 1.8 percent[3], and a prevalence of 23.5% among women and 8% among men aged between 50 and 75 years old[2].

This is a complex syndrome, and its symptoms are largely superimposed on other types of pathologies. Until the early 2000s, it was known as greater trochanteric bursitis, although later with the use of imaging studies, it was shown that only 20 percent is due to bursitis, and the remaining 80 percent was due to an alteration in the gluteus tendons[4] (enthesopathy, tendinitis or tears) or without significant anatomic alteration. Stegemamm described it as "the great simulator"[5].

Although GTPS is an eminently clinical and poorly defined pathology, progress in imaging tests (ultrasound and resonance scans) and interest from sports medicine have led to a better understanding of symptoms and care for these patients[6].

Material and method

An electronic search was made with no language or date restrictions to the end of September 2022 for studies related to GTPS aetiological factors.

A search was made in the Cochrane Library and databases such as EMBASE, MEDLINE and PUBMED. The search terms used were greater trochanteric pain syndrome (GTPS), outer side of the hip, gluteus tendinopathy, aetiology, biomechanics, morphology and muscle-tendon strain.

Duplicated articles were eliminated from the searches, leaving a total of 23 articles with an impact factor range between 0.84 and 6.6 according to Journal Citation Indicator (JCI) (Figure 1).

Inclusion criteria

Aged over 16 years old, diagnostic criteria for GTPS, subjects might have co-morbidities with lumbar and/or hip pathology.

Exclusion criteria

Severe traumas, neurological or neoplastic diseases. Recently surgery on spine or hip.

Main aetiological factors involved in the greater trochanteric pain syndrome (GTPS)

There are three main aetiological factors of GTPS, listed below.

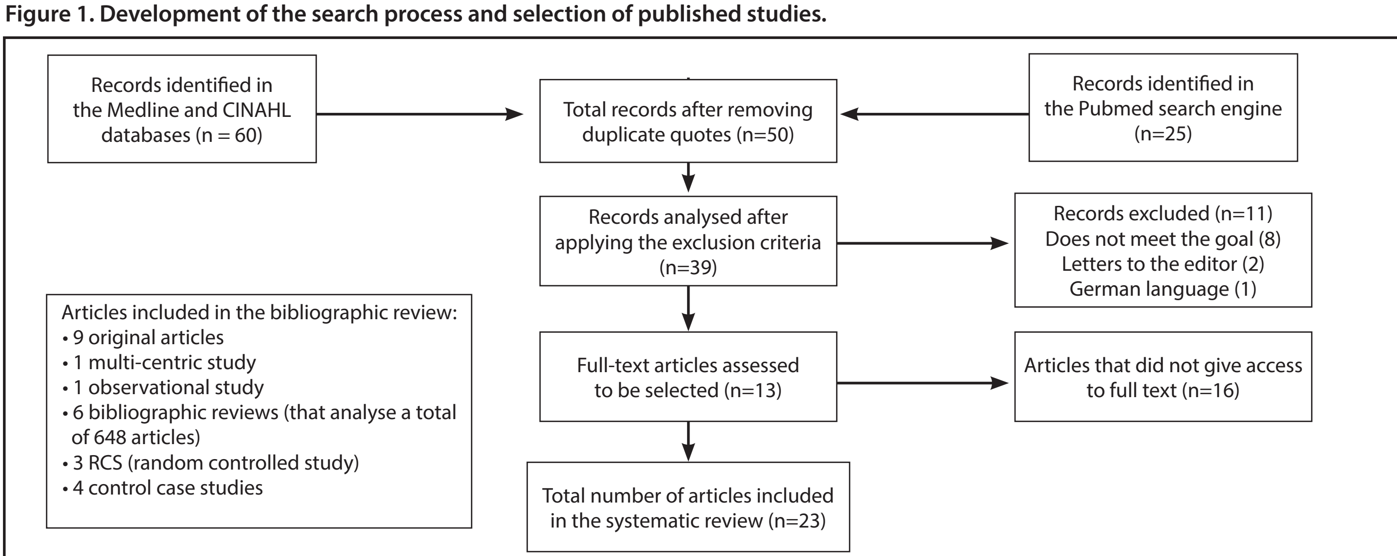
Associated muscular factors

One of the causes involved seems to be a tendinopathy of the gluteus medius and minimus tendons at the point where they are inserted in the greater femur trochanter[2]. At this level, the iliotibial band seems to be involved, as it passes over these tendons and compresses them significantly during the maximum hip adduction[7]. Some authors consider both gluteal tendons as part of the same muscle[8], as they both have the same function and innervation (Table 1).

The gluteus medius is injured by micro and/or macro traumas to the hip and pelvis[9], while the gluteus minimus is injured as the consequence of the loss of function of the gluteus medius. The cause of these injuries is unknown, although it is believed that they are the product of degenerative changes in the muscle-tendon unit and if not treated, this might lead to degenerative tendinopathy, chronic pain on the outer side of the hip and possibly, retraction of the tendon towards the trochanter zone[10].

Other factors involved in GTPS might be failed repair processes at tendon level (fibrosis), increased adiposity in the muscle, sedentary

Figure 1. Development of the search process and selection of published studies.



RCS: random controlled study.

Table 1. Anatomical reminder of the gluteal muscles and fascia tensor.

		Origin	Insertion	Function	Innervation
Gluteus	**Maximus**	Fascia that covers the gluteus medius, the outer surface of the ilium behind the posterior gluteal line, spine erector fascia, dorsal surface of the inner portion of the sacrum, side edge of the coccyx and outer surface of the sacrotuberous ligament.	Outer side of the fascia lata iliotibial band and the gluteal tuberosity of the proximal portion of the femur.	Powerful extension of the thigh with the hip flexed. Side stabiliser of the hip and knee. Abduction and external rotation of the thigh.	Lower gluteal nerve L5,S1,S2
	Medius	Outer surface of the ilium between the anterior and posterior gluteal lines	Extended articular facet over the side surface of the greater trochanter.	It abducts the thigh. It holds the pelvis stable over the limb in support. It stops the counter-lateral pelvis dropping in swing phase and rotates the thigh medially.	Upper gluteal nerve L4,L5,S1
	Minimus	Outer surface of the ilium between the inferior and anterior gluteal lines	Linear articular facet located on the anterolateral side of the greater trochanter.	It abducts the thigh. It holds the pelvis stable over the limb in support. It stops the counter-lateral pelvis dropping in swing phase and rotates the thigh medially.	Upper gluteal nerve L4,L5,S1
Fascia tensor		Lateral side of the iliac crest between ASIS and the crest protuberance.	Iliotibial band of the fascia lata	It flexes, abducts and medially rotates the thigh. It tenses the fascia lata and stabilises the knee	Upper gluteal nerve L4,L5,S1

Taken from: Drake Rl, Vogl AW, Mitchell AWM. Chapter 6: lower limb. Gluteal region Basic Gray's Anatomy, Barcelona: Elsevier; 2013. 2nd edition 281-3.

lifestyle, increase in the Body Mass Index (BMI), scoliosis, dysmetria and in sporting practice, errors in high intensity training[11] (Table 2).

Associated morphological factorss

Being a woman and middle aged are two risk factors related to GTPS.

Several biomechanical and morphological factors can be bound to their prevalence in women. One of them is the increase in the Q angle (Figure 2). Its increase produces a rise in tension and compression in the gluteus tendon during repetitive movements, as seen in many sporting disciplines[12].

This gluteus tendon compression was described by Taylor-Haas *et al.*[13] among young long-distance runners. This author assessed the kinematics of the pelvis and the hip and concluded that the risk of injury is greater among female rather than male runners. Female runners presented greater hip adduction compared to their male counterparts, which caused a possible tendon lesion due to compression in the greater trochanter area. However, Williams and Cohen[14] relate this tendon compression to a morphological difference in the greater trochanter (smaller size), and this compression would be with the iliotibial band and due to pelvic orientation (Table 3).

Woyski *et al.*[15] also consider the trochanter morphology to be relevant and consider that there is a reduction in the insertion area in the greater trochanter in women that generates a shorter power arm, increasing the traction of the gluteus tendons and lower biomechanical efficiency (Figure 3).

Grimaldi and Fearon[1] relate the failure of conservative management in women with a femoral neck angle under 134°, when assessing patients proposed for tendon reconstruction surgery. This finding suggests a greater risk of severity, but not a risk factor for developing injuries. These

Table 2. Selected studies for associated muscular factors

Author(s)	Year	Journal	Quartile (Q)	Conclusions
Reid D.	2016	*Journal of orthopaedics*	Q3	One of its possible causes in sport are errors in high intensity training leading to degenerative tendinopathy of the trochanteric tendons.
Robinson NA, *et al.*	2019	*Gait & posture*	Q4	The iliotibial band compresses the gluteal tendons during maximum hip adduction
Stephens G, *et al.*	2019	*Musculoskeletal care*	Q3	Tendinopathy of the medium and minor gluteal tendons at the point where they are inserted in the greater femur trochanter
Godshaw B, *et al.*	2019	*The Ochsner journal*	Q3	Lack of treatment leads to a degenerative tendinopathy, chronic pain on the outer side of the hip and/or retraction of the tendon towards the trochanter area.
Bajuri MY, *et al.*	2022	*Cureus*	Q3	The gluteus medius is injured by micro and/or macro traumas to the hip and pelvis

Figure 2. Representation of the Q angle. Angle formed between two segments. One from the anterior superior iliac spine (ASIS) to the centre of the ball joint and another from the centre of the ball joint to anterior tuberosity of the tibia (ATT).

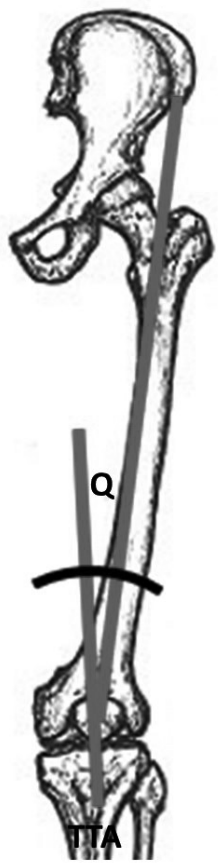


Table 3. Summary of the main pelvic differences between sexes.

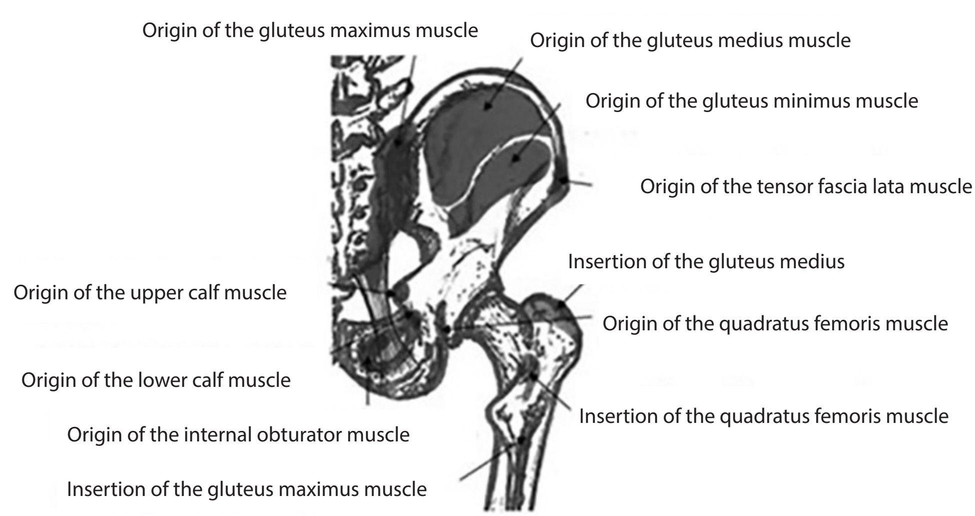
Pelvic characteristics	Women	Men
Size and shape	Wide and slim with separated iliacs	Narrow and thick with iliacs together
Upper opening	Circular	Pyriform (pear-shaped)
Blocking orifices	Oval-shaped	Round
Acetabulum	Small minor cover of femoral head	Large with major co-ver of femoral head
Promontory	Not very prominent and wide wings	Prominent and na-rrow wings
Sub-pubic angle	80º-85º with wide pubis	50º-60º with narrow pubis
Ischial spines	No medial protrusion	Medial protrusion

authors consider that the coxa vara morphology of the female pelvis and its greater trochanter displacement are potential underlying factors for a greater compressive load on the gluteus tendons, via the iliotibial band. However, the study by Santos *et al.*[16] finds no association between this increase and the prevalence of GTPS among women.

The age factor, and possible association with sarcopenia, muscular fat degeneration and associated loss of strength, would lead to a progressive break down of the femoral neck as a compensatory biomechanical alternative for the increase in the abductor lever arm[16].

Pelsser *et al.*[17] have demonstrated that the increase in the acetabulum anteversion is associated with gluteal tendinopathy and trochanteric bursitis compared to the controls (18.8º in cases compared to 15.4° in controls). The increase in this anteversion can alter the biomechanics of the gluteus tendons and become a possible link with GTPS[6].

Figure 3. Representation of origins and insertions of the pelvic musculature.



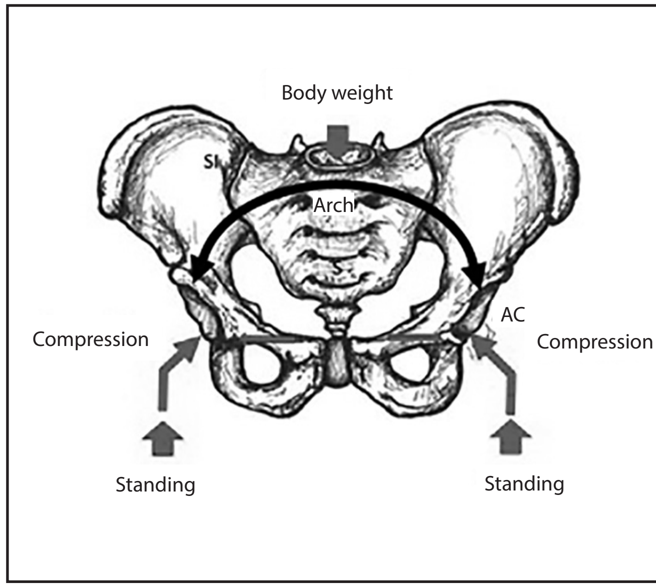
Source: Ruiz ML, Dugnol J. Chapter 13: músculos del miembro inferior. Cuadernos prácticos de anatomía. Aparato Locomotor, Oviedo: Facultad Padre Osso; 2020, p. 76.

Figure 4 shows a black arrow that represents the body weight pressing on the sacrum, distributed through the sacroiliac joints in an arch which then passes to the coxofemoral joints. This is counteracted by the forces exerted from the ground through the femurs during standing. The arrows in the pubis represent neutralisation of loads from the forces exerted on the femurs.

Saltychev *et al.*[18] have proposed that there is a direct relationship between the pelvic tilt in the frontal plane and GTPS. The lumbar alignment and the sacral tilt (horizontalization) would also be related to GTPS[19].

Meanwhile, Canetti *et al.*[20] confirms the association between sacral horizontalization and GTPS and suggests that they cause biomechanical changes in the gluteus tendons due to pelvic retroversion. In turn, if the lumbar spine presents little mobility, the only form of movement is pelvic retroversion[8]. Consequently, pelvic retroversion increases the distance between two points of insertion of the gluteal muscles, which results in an increase in gluteal muscular tension as mentioned above. This increase in tension, particularly in the gluteus medius can trigger insertional tendinopathy and can generate excessive friction with the tensor fascia lata, leading to a bursitis which is secondary to the tendinopathy (Table 4).

Figure 4. Pelvic biomechanics.



Source: Ruiz ML, Dugnol J. Chapter 5: miembro inferior. Cuadernos prácticos de anatomía. Aparato Locomotor, Oviedo: Facultad Padre Osso; 2020, p. 27; and modified from: Caillet, R. Biomecánica. Madrid. Marbán; 2017, p. 248.

Table 4. Selected studies for associated morphological factors.

Author(s)	Year	Journal	Quartile (Q)	Conclusions
Pelsser V, *et al.*	2001	*American journal of roentgenology*	Q1	The increase in the acetabulum anteversion is associated with gluteal tendinopathy and trochanteric bursitis.
Williams BS, Cohen SP	2009	*Anesthesia and analgesia*	Q1	They relate this tendon compression to three conditions: smaller area of the greater trochanter, action of the iliotibial band and pelvic orientation.
Woyski D, *et al.*	2013	*Surgical and radiologic anatomy: SRA*	Q3	The decrease in the insertion area in the greater trochanter among women leads to a shorter power arm and an increase in the traction of the gluteus tendons and lower biomechanical efficiency.
Grimaldi A, Fearon A	2015	*Journal of orthopaedic and sports physical therapy*	Q1	Greater failure of the conservation treatment in women with a femoral neck angle under 134°. These patients are proposed for tendon reconstruction surgery.
Saltychev M, *et al.*	2018	*Acta orthopaedica*	Q1	Direct relationship between the pelvic swing in the frontal plane and GTPS
Canetti R, *et al*.	2020	*Skeletal radiology*	Q3	The association between sacral horizontalization and GTPS causes biomechanical changes in the gluteus tendons due to pelvic retroversion.
Santos L, *et al.*	2021	*Clinics*	Q3	The age factor, possibly associated with sarcopenia, muscular fat degeneration and associated loss of strength, would lead to a progressive break down of the femoral neck compensating for the increase in the abductor lever arm
Sunil K, *et al.*	2021	*Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA*	Q1	The pelvic anteversion can alter the biomechanics of the gluteus tendons.
Miyasaki MR, *et al.*	2021	*International journal of rheumatic diseases*	Q4	Lumbar alignment would be related to GTPS
Taylor-Haas, *et al*.	2022	*Journal of science and medicine in sport*	Q1	A group of female runners presented greater hip adduction compared to their male counterparts, which possible injured the tendon due to compression in the greater trochanter zone
Seidman AJ, Varacallo M	2022	*Clinics*	Q3	The increase in the Q angle in women produces an increase in tension and compression in the gluteus tendon during repetitive movements, as seen in many athletes

Associated biomechanical factors

The treatment approach should not only focus on recovery from the anatomical injury to the gluteus tendon or the pain on the outside of the thigh, but it should also correct the biomechanical alterations. This should consider which changes might be occurring in those tendons when walking and specifically when initiating monopodal support, which patients refer to as painful (Table 5).

The gait cycle is defined as the sequence of components produced between the same foot making two successive contacts with the ground. The gait cycle is divided into two periods: support and swing[21]. When walking, the body moves its centre of gravity with the greatest possible economy of energy. The main determining factors that help to reduce the displacement of the centre of pressure or CoP during walking are, firstly, the obliquity of the frontal plane pelvis, controlled by the abductors and, secondly, the rotation of the pelvis in the side plane, performed by the pelvic-trochanteric muscles[22] (Figure 5).

Molina and Carratalá[23] consider that the pelvis movements are not wide but are influenced by gender. Women present greater swing in the frontal plane, greater transversal width and greater anteversion that influences the CoP path.

The centre of pressure (CoP) path or gait line can provide useful information to assess or detect the function and the pathology of the foot and the hip (Figure 6). The centre of pressure is the area where an immediate force acts on the sole of the foot. This force is a component of the resulting vertical reaction force from the ground that reacts with the sole of the foot[24,25]. The CoP progression is a path formed by a series of coordinates from the centre of pressure that goes from the heel to the forefoot during the support phase[25].

The first phase of monopodal support in gait is called the loading reception or acceptance, also known as rocker[1]. This phase is divided into two moments, initial contact (IC) and loading response (LR). The hip, that participates in the stability, the forward movement and the support for the weight during gait, is in flex in this phase, with the consequent concentric work of the gluteus maximus and the hamstrings (Figure 7). The hip abductors, gluteus medius and minimus, act eccentrically to counteract the adduction moment created by the body mass on this joint, controlling the sideways displacement of the body and the contralateral pelvic drop in the frontal plane.

The second part, LR, is when the gluteal muscles or hamstrings work concentrically to make the body position vertical, predicting the pelvic anteversion and the flexing of the torso. In a frontal plane, the hip is in a neutral position or with slight adduction in the IC, increasing in LR and MS (midstance). This position is favoured by the valgus knee. It will be found in abduction in the PS and IS. The gluteus medius continues to act here, in fact, Perry and Burnfield[26] consider that this muscle is more intensely activated than the tensor and this activation lasts longer than the gluteus maximus.

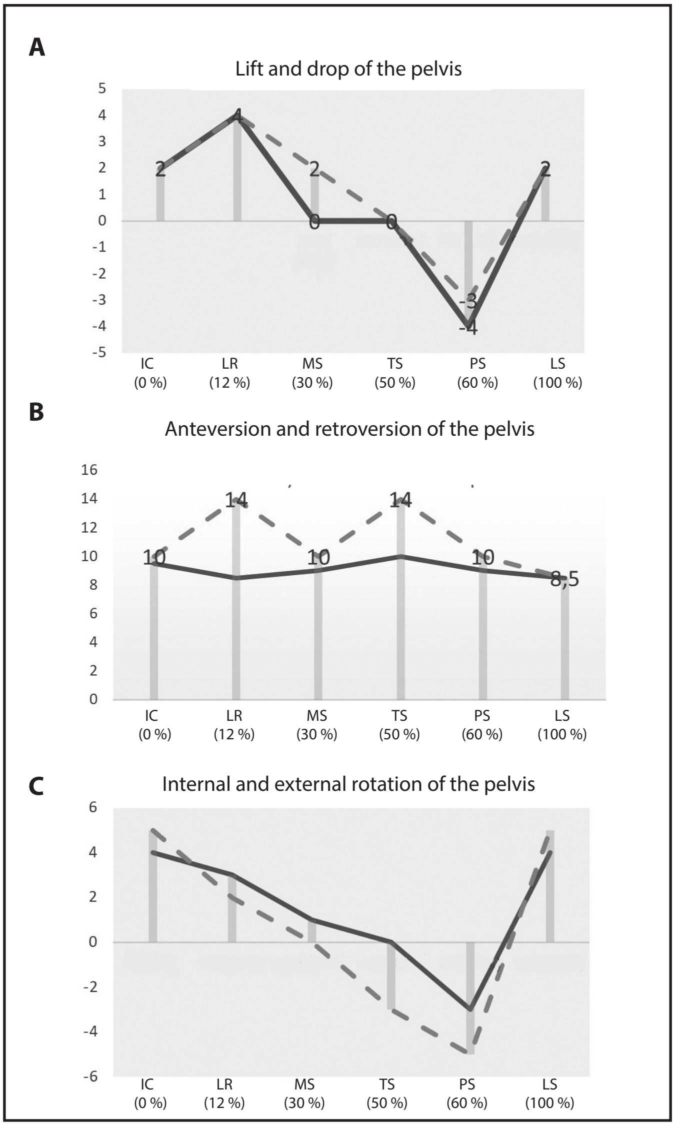
The gluteus medius and minimus participate in the start of the hip abduction and pelvis stabilization during movement and gait. However, they also help to stabilise the femoroacetabular joint. The contraction of the hip abductors not only stabilises the pelvis in relation to the femur in the frontal plane, but also produces compression forces through the femoroacetabular joint, which are 2 or 3 times the body weight. This compression force is inherent to the hip articulation and the deficiency of these abductors is the cause of luxation after total hip arthroplasty. The hip abductors are not only important to initiate movement and pelvic stabilization with the gait, but they can also provide dynamic stabilisation of the femoral head within the acetabulum[27].

In the cases of hip joint laxity, the work increases for the dynamic stabilizing muscles to make sure that the femoral head remains contai-

Table 5. Selected studies for associated biomechanical factors.

Author(s)	Year	Journal	Quartile (Q)	Conclusions
De Cock, A*, et al.*	2008	*Gait & posture*	Q4	The centre of pressure is the area where an immediate force acts on the sole of the foot. This force is a component of the resulting vertical reaction force of the ground that reacts with the sole of the foot
Chiu MC, *et al.*	2013	*Gait & posture*	Q4	The CoP progression is a path formed by a series of coordinates from the centre of pressure that goes from the heel to the forefoot during the support phase
Giordano BD	2014	*Pediatric clinics of North America*	Q2	In the cases of hip joint laxity, the work increases for the dynamic stabilizing muscles to make sure that the femoral head remains contained in the acetabulum during walking
Grimaldi A, Fearon A	2015	*Journal of orthopaedic and sports physical therapy*	Q1	The iliotibial band provides 30% of the abductor force required to keep the pelvis laterally stable in monopodal support and the remaining 70% is supplied by the trochanter abductors
Reimer L, *et al.*	2019	*Danish medical journal*	Q3	The increase in the muscular work and possible dysfunctional patterns of gait and movement might increase tension in the iliotibial band and lead to a tendinopathy and/or bursitis due to compression
Robinson NA, *et al.*	2019	*Gait & posture*	Q4	In GTPS, there is a drop in the abduction force and an increase in the hip adduction angle, the lateral flexion of the torso and pelvic obliquity during gait
Goldman L, *et al.*	2020	*Orthopaedic journal of sports medicine*	Q2	The hip abductors provide dynamic stabilisation of the femoral head within the acetabulum

Figure 5. Representation of the pelvis movements during gait. A) frontal plane, B) sagittal plane, C) transversal plane. This represents both the support phase (from initial contact (IC) to pre-swing (PS) and late swing (LS)).

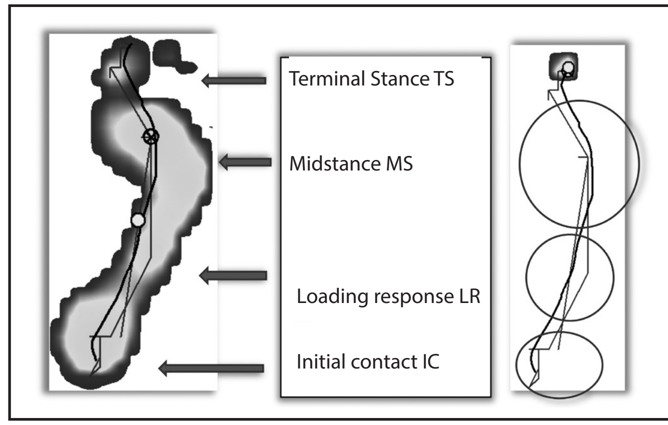


IC: initial contact; LR: loading response; MS: midstance; TS: terminal stance; PS: pre-swing; LS: late swing. This represents values from: Molina F, Carratalá M. Ciclo de la marcha: fases y parámetros espaciotemporales. La marcha humana. Biomecánica, evaluación y patología. Madrid: Medica Panamericana; 2020, p. 13-7, as a solid line; and Perry J, Burnfield J. Gait Analysis. Barcelona. Base; 2015, p. 156-81 as a dotted line.

ned in the acetabulum during gait[28]. For Reimer *et al.*[29], the increase in muscle work and possible dysfunctional patterns of gait and movement might increase tension in the iliotibial band and lead to a tendinopathy and/or bursitis due to compression.

The next gait phase is complete monopodal support, also called rocker[2]. In this phase, both the gluteus maximus and medius are working, while the fascia lata tensor controls the knee and hip movement. In the final phase of the support, the limb accelerates downwards and

Figure 6. Representation of the right monopodal support phases on the sole of the foot and in the line of the CoP.



forwards from the centre of mass, helped by the forward movement of the contralateral leg, which has exceeded the homolateral limb and is getting ready for initial contact. The femur has external rotation of 5º when starting the monopodal support and inversely, it rotates externally as it enters the swing phase (Figure 6). Remember that both the gluteus medius and minimus are medial rotators. The hip flexes in the swing phase and is almost neutral or slightly extended in the support phase. In the frontal plane, the hip abductor muscles continue to stabilise the pelvis.

For Grimaldi and Fearon[1], the iliotibial band provides 30% of the abductor force required to keep the pelvis laterally stable in monopodal support and the remaining 70% is supplied by the trochanter abductors. Consequently, the iliotibial band is an essential part of this system, as it has been demonstrated that the gluteus medius alone is mechanically insufficient to generate the right force to withstand all the hip adduction on monopodal load. The weakness and atrophy of the trochanter abductors require the iliotibial band to produce greater force, or there will be an increase in the hip adduction, which increases the compression forces. In subjects with a symptomatic pathology of the gluteus tendon, significant fatty atrophy of the gluteus medius and minimus has been demonstrated.

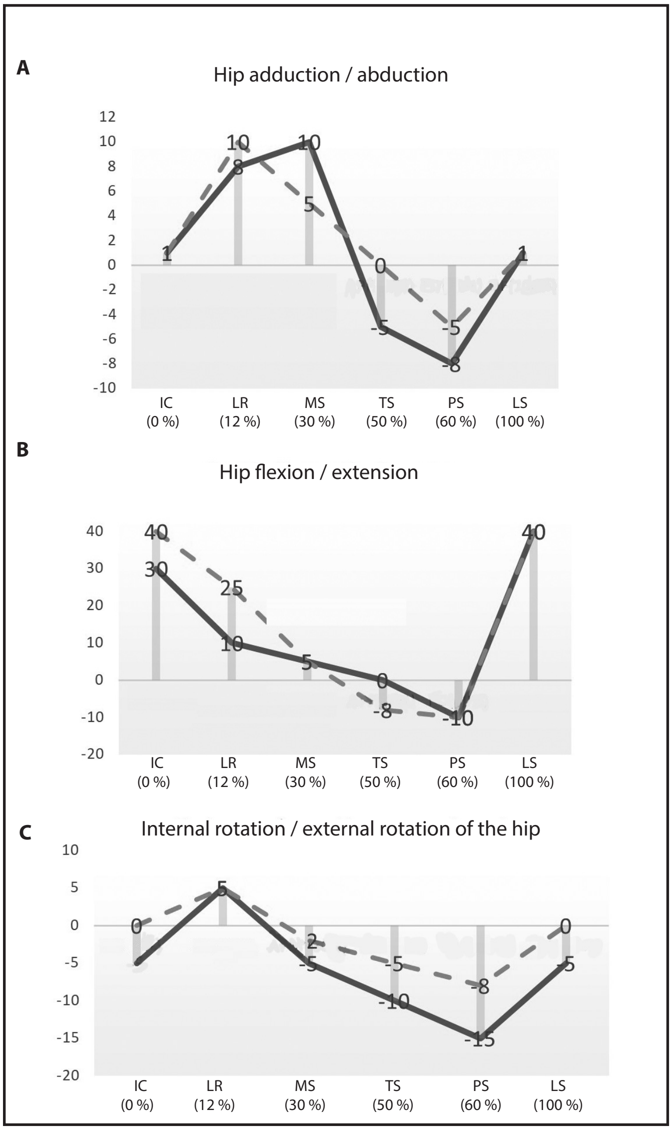
In GTPS, there is a drop in the abduction force and an increase in the hip adduction angle, the lateral flex of the torso and the pelvic obliquity during gait[7] (Figure 8).

Treatments used in the greater trochanteric pain syndrome

All types of anti-inflammatory treatment, including physiotherapy, is the baseline treatment for this syndrome. An international survey on physiotherapy practices in GTPS showed multiple interventions[30]. These interventions are massage (90%), stretching (53%), range of movement (40%), heat therapy (50%), taping (38%) and electrotherapy (25%). Manual therapy focuses on re-educating and strengthening exercises on the gluteal muscles.

There are currently few studies which evaluate the effects of manual therapy, although this treatment is increasingly considered to restore

Figure 7. Representation of the hip movements during walking. A) frontal plane, B) sagittal plane, C) transversal plane. This represents both the support phase (from IC to PS) and swing (LS).



IC: initial contact; LR: loading response; MS: midstance; TS: terminal stance; PS: pre-swing; LS: late swing. This represents values from: Molina F, Carratalá M. Ciclo de la marcha: fases y parámetros espaciotemporales. La marcha humana. Biomecánica, evaluación y patología. Madrid: Medica Panamericana; 2020, p. 13-7, as a solid line; and Perry J, Burnfield J. Gait Analysis. Barcelona. Base; 2015, p. 156-81 as a dotted line.

the three biomechanical alterations as a consequence of the gluteal tendinopathy.

The data provided on applying physical therapy demonstrated that anti-inflammatory treatment is not the most effective. This is because this syndrome (previously called trochanteric bursitis) is multifactorial and it does not seem as though the inflammatory component is its direct cause[3]. Consequently, manipulative therapy must focus on stabilising and normalising the movement while the inflammation is a secondary process (that may or may not be present in patients with GTPS) to a tendon injury. This idea is supported by the studies from Ali *et al.*[31] who concluded that manual therapy, specifically treatment using the Maitland method, is clinically more effective to reduce pain, rigidity and improve knee functionality in osteoarthritis as opposed to using physical agents employed in physiotherapy such as anti-inflammatory methods (Table 6).

Consequently, if the biomechanical conflict is resolved by applying manipulative techniques, this leads to pelvic stabilisation and normalisation of the movement. Working from restoring these altered biomechanical mechanisms, there should be secondary action on reducing the inflammation and pain on the outer side of the thigh.

Table 6. Selected studies for treatment performed on the greater trochanteric pain syndrome.

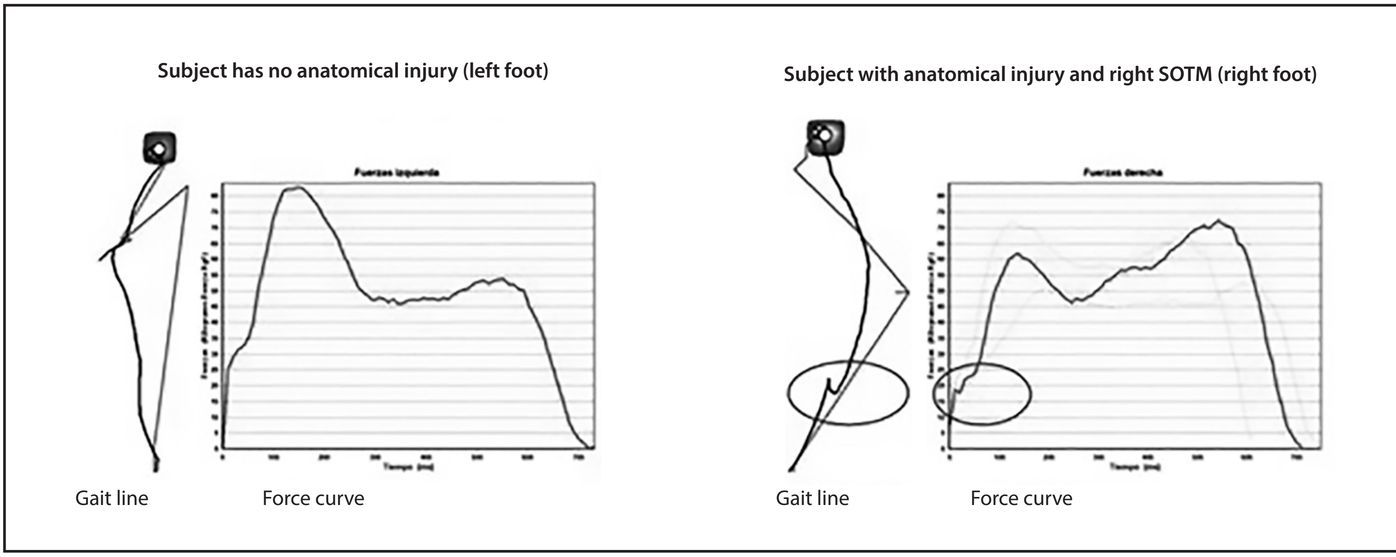
Treatments given				
Authors	**Year**	**Journal**	**Quartile (Q)**	**Conclusion**
French HP, Woodley SJ, Fearon A, O'Connor L, Grimaldi A	2020	*Physiotherapy*	Q1	There are multiple physiotherapy interventions in GTPS: massage, stretching, range of movement, heat therapy, taping and electrotherapy.
Ali SS, Ahmed SI, Khan M, Soomro RR	2014	*Pakistan journal of pharmaceutical sciences*	Q4	The manipulative therapy must focus on stabilising and normalising the movement while the inflammation is a secondary process (that may or may not be present in patients with GTPS) to a tendon injury
Pumarejo Gomez L, Childress JM	2022	*StatPearls*	Book	Application of physical therapy is not the most effective. It does not seem that the inflammatory component is its direct cause.

Conclusions

The morphological factors of the female pelvis, the smaller insertion area in the greater trochanter, the femoral angle under 134º, greater trochanteric displacement towards coxa vara and an increase in the Q angle are related to greater compression of the gluteus tendons on the greater trochanter in middle aged women. Age itself, associated with pathologies such as sarcopenia and muscular weakness, will lead to a progressive varus as a compensatory biomechanical adaptation to improve the function of the gluteus medius and minimus.

Regarding the biomechanical and muscular factors, the gluteus medius and minimus not only participate in the start of hip abduction

Figure 8. Evolution of the gait line and the force curves in a subject with dissymmetry and right GTPS. This marks the alteration in the development of CoP in monopodal support phase.



and stabilisation of the pelvis, but they also provide dynamic stability to the femoral head within the acetabulum during movement and gait. The increased muscular work of the gluteus medius and minimus and possible alterations to gait patterns and dysfunctional movements might increase tension in the iliotibial band and lead to a tendinopathy and/or bursitis due to compression. Consequently, the alterations seen in GTPS might be the consequence of insufficiency in the hip abductor muscles or an altered motor control strategy. The combination of trochanteric abductor insufficiency, increased contribution of the iliotibial band tensors and excessive use of functional adduction might represent a biomechanical factor for the gluteus tendons which are exposed to the combined load of compression and traction in these patients.

From all the above, there is a clear need to recognise the possible risk factors for GTPS to plan effective treatment to restore lost functionality and reduce pain, the quintessential clinical symptom of GTPS.

Conflicts of interest

The authors declare that there is no conflict of interest.

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