Impacts of coxa valga and coxa vara on the musculoskeletal system: an integrative review[1]

Impactos de la coxa valga y coxa vara en el sistema musculoesquelético: una revisión integradora

Impacto da coxa valga e da coxa vara no sistema músculo-esquelético: uma revisão integrativa

[Research Article]

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Abstract

Coxa valga (CVl) and coxa vara (CVr) are morphological alterations related to the collodiaphyseal angle, which represents the angulation between the femoral neck and the femoral diaphysis. The angle considered normal is 120° to 135°. When the angle is less than 120°, it is called CVr, and when it is greater than 135°, it is called CVl. These alterations affect the musculoskeletal system, impacting the quality of life of those affected. This article aims to highlight the main functional impairments in the skeletal, muscular, and articular systems caused by CVl and CVr. Articles were collected from the MEDLINE and BVS databases, using the descriptors ("coxa valga" OR "coxa vara") in September 2022. Eleven articles were included in the review, with the main results summarized in a PRISMA flowchart. This review highlights the various adverse consequences in the locomotor system associated with the presence of CVl and CVr in affected individuals.

Keywords: coxa valga, coxa vara, femur neck.

Resumen

La coxa valga (CVl) y la coxa vara (CVr) son alteraciones morfológicas relacionadas con el ángulo colodiafisario, que representa la angulación entre el cuello del fémur y la diáfisis del fémur. O ángulo considerado normal es 120° a 135°. Cuando el ángulo es inferior a 120°, se denomina CVr, y cuando es superior a 135°, se denomina CVl. Estas alteraciones afectan el sistema musculoesquelético, impactando en la calidad de vida de los afectados. Este artículo tiene como objetivo destacar los principales compromisos funcionales en los sistemas esquelético, muscular y articular causados por la CVl y CVr. Se recopilaron artículos en las bases de datos MEDLINE y BVS, con los descriptores ("coxa valga" O "coxa vara") en septiembre de 2022. Se incluyeron once artículos en la revisión, con los principales resultados resumidos en un diagrama PRISMA. Esta revisión resalta las diversas consecuencias adversas en el sistema locomotor asociadas a la presencia de la CVl y CVr en individuos afectados

Palabras clave: coxa valga, coxa vara, cuello femoral.

Introduction

The femur is the largest bone in the human body, located in the thigh of both lower limbs of the body. It is divided into a head, neck, and shaft or diaphysis. In its proximal region, the femoral head articulates with the hip through the acetabulum, forming a highly mobile joint, as it is a synovial and multiaxial joint. Consequently, this joint allows for various movements of the thigh. Additionally, this region plays a significant role in supporting and stabilizing the weight of the human body (Sharma et al., 2018).

Furthermore, apart from this joint, other structures contribute to hip stabilization, primarily the ligaments in the anterior aspect and the muscles, which are more relevant posteriorly. Thus, the musculoskeletal system, composed of muscles, ligaments, joints, and bony structures in this location, is of great importance for the functionality of the body's biomechanics, as it is responsible for balancing the applied forces in this area (Varda et al., 2022).

The region that separates the head from the body is the femoral neck, projecting at an angle of approximately 125°, known as the inclination angle or collodiaphyseal angle. However, there is a deformity that results in the distancing of the femoral body from the neck, with a deviation from the midline, referred to as "coxa valga," an angle greater than

135°. Conversely, when this deformity occurs with deviation towards the midline, it is called "coxa vara," an angle less than 120° (Iyidobi et al., 2020).

Therefore, the collodiaphyseal angle significantly participates in the mechanism of force dissipation that the body exerts on the lower limbs, ensuring a distribution of forces according to the capacity of each structure. Consequently, alterations in this angle can lead to biomechanical failures and predispose to osteoarticular and muscular dysfunctions (Murerwa et al., 2021).

The collodiaphyseal angle can be obtained through imaging studies, such as anteroposterior radiography of the pelvis with approximately 15° of internal hip rotation (Faghani et al., 2021). Methods used to measure this angle include computed tomography, magnetic resonance imaging, radiography and measurements of dry bone. Although magnetic resonance imaging and computed tomography are more precise, radiography is generally preferred due to its greater availability (Farcetta et al., 2018).

Both coxa valga and coxa vara are pathologies that can lead to consequences affecting the musculoskeletal system's function, thereby impairing the quality of life of affected individuals. The morphofunctional impairment resulting from these alterations can range from early and evident changes such as altered gait and lower limb disproportion to long-term comorbidities, including fractures, chronic pain, osteoarthritis, among others (Tian et al., 2021).

Therefore, understanding this topic is of utmost importance, highlighting the impact that these morphological conditions can have on individuals with these deformities.

Methodology

This article consists of an integrative literature review, a research method used in Evidence-Based Practice, with the purpose of synthesizing data obtained from previous research on a specific question, aiming to guide clinical practice and identify gaps for further studies (Mendes et al., 2008).

The current study is an integrative literature review conducted in six phases: formulation of the research question, literature search, data collection, critical analysis of included studies, discussion of results, and presentation of the review. The guiding question for the review was "What are the consequences for the musculoskeletal system resulting from coxa valga and coxa vara?" (Souza et al., 2010).

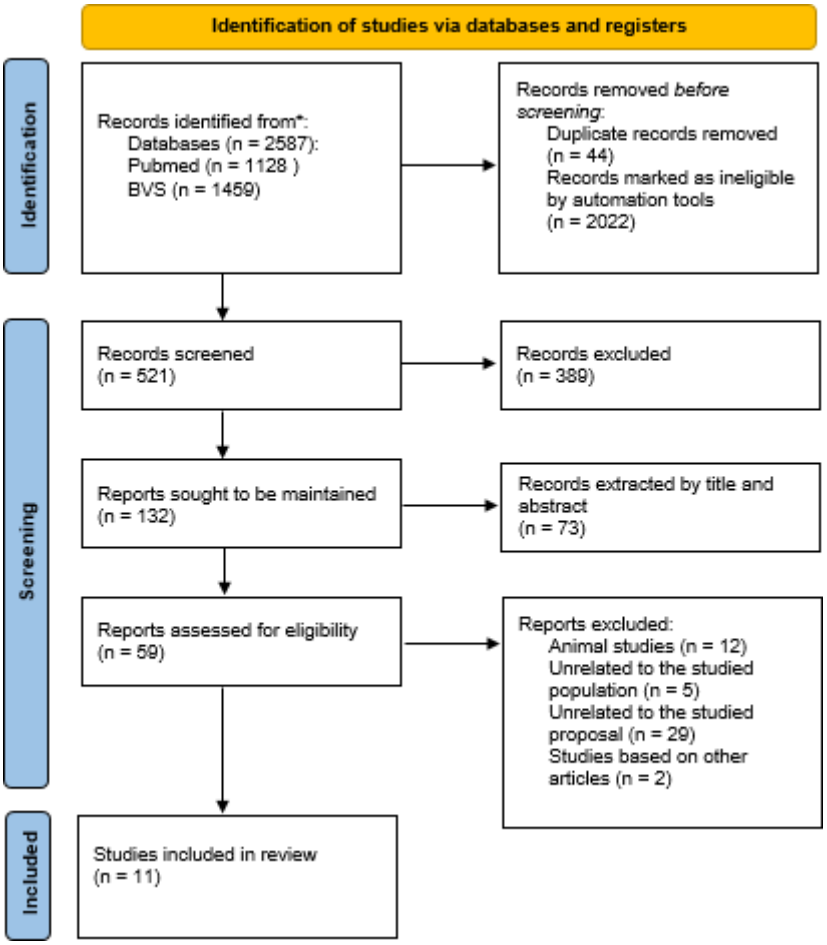
The research was conducted using the Medical Literature Analysis and Retrieval System Online (MEDLINE) database, accessed through the Public/Publisher MEDLINE

(PubMed) and the Virtual Health Library (BVS). The descriptors identified using the Medical Subject Headings (MeSH) tool were ("Coxa Valga" OR "Coxa Vara"), selected based on previous publications related to the research topic. Filters applied included: Full-text, English, Spanish, Portuguese, 2018-2022.

The inclusion criteria included articles published from 2018 to 2022, in English, Spanish or Portuguese, research involving human beings, adult individuals between 18 and 65 years of age, availability of full text and relevance to the research objective. Exclusion criteria included articles published before 2018, research involving animals, research on children, under 18, and the elderly, over 65, titles and abstracts not related to the research topic, doctoral theses and expert opinions.

Using the search strategy, after applying the filters and counting duplicates only once, 521 articles were identified, of which 389 were excluded because the full article was not available free of charge from the databases. Thus, 132 articles were pre-selected and analyzed based on title and abstract, leaving 59 that were read in full and 11 studies were selected, discarding articles outside the age range studied, animal research, texts focusing on other pathologies and studies that were based on other studies already analyzed in this review focusing on the guiding question. As shown in the PRISMA flowchart (Figure 1) (Page et al., 2020).

Figure 1 - PRISMA Flowchart of Inclusion and Exclusion Criteria for the Research



Results/Discussion

This study included 11 articles that met the study's inclusion criteria and addressed the research question. Table 1 shows the articles selected with the main outcomes addressed.

Table 1: Authors and Titles of Selected Articles

Autor	Outcomes
Dial *et al.* (2018)	These pathologies cause imbalances in the force vectors and biomechanical alterations that impair functionality.
Gautam & Rao (2019)	A relationship between coxa vara and geno valgo and coxa valga and geno varus was demonstrated. Both alterations led to a greater risk of knee osteoarthritis.
Kani *et al.* (2019)	Coxa vara had a higher risk of proximal femur fracture and the Coxa valga had a higher risk of hip and knee osteoarthritis.
Kim & Kim (2021)	The femoral neck stress fracture was associated with the coxa vara and the femoral head stress fracture with the coxa valga.

Palmer *et al.*(2021)	Both alterations, when asymmetrical, were related to lower limb discrepancy and atypical gait (Trendelenburg gait).
Popat *et al*. (2020)	Coxa vara was associated with trochanteric bursitis, chronic pain and gait alteration.
Sharma *et al*. (2018)	The coxa valga promotes a shortening of the adductors and a lengthening of the abductors, which leads to a weakening of the adductor muscles compared to the abductors.
Thielemann *et al*.(2020)	Coxa vara was associated with osteoporosis and osteomyelitis.
Tian *et al*. (2021)	In coxa vara, complaints of chronic hip pain, lameness, muscle weakness and limited hip abduction.
B. Zhang *et al*. (2021)	Individuals with coxa vara had a greater need for total hip arthroplasty.
Y. Zhang *et al*. (2021)	The patients analyzed with a colodiaphyseal angle > 134.4° had an 8 times greater risk of knee osteoarthritis.

The femur, along with the tibia, is responsible for bearing the human body, in addition to the upward force reaction resulting from the contact of the feet with the surface. The tibia is a bone with a straight geometry; thus, forces applied to it are transmitted without force dissipation. Unlike the femur, which has the neck transverse to the femoral shaft, forming an angle between the body and the head, referred to as the collodiaphyseal angle or femoral inclination angle. Because this angle is a point of curvature, it has the ability to dissipate forces applied to it, with greater dissipation occurring as the angle increases. Therefore, pronounced alterations in this angle can trigger imbalances in force vectors and biomechanical changes that can lead to consequences for the lower limb musculoskeletal system, affecting functionality and quality of life in individuals with these alterations (Dial et al., 2018).

The inclination angle or collodiaphyseal angle is the angle between the body or diaphysis and the femoral neck, known as, is approximately 125° during puberty. However, at birth, this angle is around 150°, and it gradually decreases over the years until the end of puberty, at which point it remains stable as growth is completed (Sharma et al., 2018).

Coxa valga, characterized by an angle greater than 135°, causes the femur to tend to be closer to the midline, resulting in a shortening of the adductors and stretching of the abductors, leading to weakening of the adductor muscles in comparison to the abductors. Consequently, it poses a greater risk of proximal femur fractures, arthritis in the medial

portion of the knee, and genu varum, a condition in which the knees project outward and are spaced apart (Sharma et al., 2018).

On the other hand, coxa vara, characterized by an inclination angle less than 120° due to lateral deviation of the neck, leads to shortening of the abductor muscles, favoring weakness in the gluteal muscles and causing greater instability of the hip joint. As a result, it is associated with the risk of osteoporosis, osteogenesis imperfecta, Paget's disease, osteomyelitis, as well as trochanteric bursitis, also known as greater trochanteric pain syndrome, typically manifested by chronic pain in the lateral hip region due to involvement of the iliotibial tract and gluteal tendons (Sharma et al., 2018).

Therefore, the femoral neck angle serves the purpose of preventing overload on the bone structures, dissipating forces in such a way that each structure receives a force proportional to its capacity, particularly in the distribution between the hip and femur. In coxa vara deformity, due to a significant reduction in this angle, there is excessive force dissipation to the lower limbs, resulting in a greater load on the femoral neck, leading to an increased risk of fractures in this region. Conversely, in the presence of coxa valga, with an increased angle, there is low force dissipation and, consequently, significant impact on the hip joint, favoring hip and knee osteoarthritis (Kani et al., 2019).

Both coxa valga and coxa vara have a good prognosis in cases without neuromuscular involvement and can sometimes be present in childhood and normalize during the developmental phase of childhood. However, persistent coxa valga can lead to rotational misalignment of the lower limbs, as it increases external rotation of the lower leg axis. In coxa vara, there is shortening between the rotation center, which is the femoral head, and the insertion of the gluteal muscles stabilizing the hip, which is the greater trochanter (Thielemann et al., 2020).

As a result, these alterations can manifest clinically in affected individuals. For example, they may present with an atypical gait, limb length discrepancy, early muscle weakness, and alterations in the lower limb extremities, often expressed as increased lumbar lordosis and genu valgum or genu varum, which are morphofunctional alterations that are more evident and therefore easier to identify early, especially in cases where the condition is unilateral (Palmer et al., 2021). In coxa vara, complaints of chronic hip pain, claudication, muscle weakness and limited hip abduction are common symptoms and signs that significantly affect the quality of life of those with this condition (Tian et al., 2021).

One of the consequences of coxa vara is a reduced resting length of the hip abductor muscles, resulting in clinical findings of reduced strength in this muscle group and the

potential development of Trendelenburg gait, characterized by a tendency to fall to the unsupported side during the stance phase. This is a typical gait in patients with abductor muscle dysfunction, especially of the gluteus medius, which has the greatest abductor function (Popat et al., 2020).

Furthermore, this gait can be observed through a semiological test known as the Trendelenburg sign, where ask the patient to stand on one leg, and the sign is considered positive if the hip on the unsupported side drops. Normally, the contraction of the abductor muscles prevents pelvic tilt, so a positive result indicates weakness or paralysis of this muscle group (Thielemann et al., 2020).

Moreover, coxa vara is part of a spectrum of conditions related to abductor muscle insufficiency, excessive growth of the greater trochanter, and marked discrepancy in lower limb length. This condition can, over time, lead to progressive degeneration of the spinopelvic complex, which may necessitate total hip arthroplasty (B. Zhang et al., 2021).

Both conditions can lead to knee alterations on the ipsilateral side. Coxa valga can result in "genu varum," characterized by knees pointing outward and away from each other. Conversely, coxa vara can lead to "genu valgum," where the knees are directed medially and closer together. Individuals with genu varum may experience overloading on the inner part of the knee, while those with genu valgum may experience overloading on the outer portion, leading to injuries to bone, muscle, and ligament structures, and knee osteoarthritis (Gautam & Rao, 2019).

In line with Zhang et al. (2021), individuals with a collodiaphyseal angle greater than 134.4° have a high risk of developing knee osteoarthritis. Knee osteoarthritis is more common and strongly related to misalignment of skeletal support structures, especially in the lower portions. Therefore, morphological alterations affecting this biomechanics directly impact the prevalence and progression of this disease. Coxa valga leads to this misalignment and is, therefore, a significant risk factor for knee osteoarthritis, associated with disease severity (Y. Zhang et al., 2021).

Additionally, coxa valga is associated with the contracture of the gluteal muscle, also known as gluteal fibrosis. This condition is caused by contracture of the tensor fasciae latae muscle, iliotibial tract, and gluteal muscles, which can manifest clinically with a range of contracture-related symptoms (Y. Zhang et al., 2021).

In a study by Kim (2021), the colodiaphyseal angle was analyzed and revealed that femurs with angles greater than 135º had significantly more stress fractures of the femoral

head than those with angles less than this value. However, there was no statistical difference in relation to femoral neck stress fractures (Kim & Kim, 2021).

Similarly, it was also shown that individuals with femoral neck fractures had a tendency for the angle to be smaller than in femurs without signs of fracture, with a median of 124.3° for femurs with neck fractures and a median of 127.9° in those unaffected. In summary, stress fractures are associated with both abnormalities, with coxa valga strongly linked to femoral head stress fractures, while coxa vara is more associated with femoral neck stress fractures (Kim & Kim, 2021).

Conclusion

In summary, this comprehensive review delved into a wealth of scientific literature to unravel the multifaceted consequences of morphological alterations. Through an exhaustive search strategy, a staggering total of 521 full-text articles were meticulously identified. From this extensive pool, 132 articles were meticulously pre-selected through a rigorous process, closely aligning with the guiding question and providing critical insights into the topic at hand.

The findings underscore the complexity of the issue, with far-reaching implications such as an increased susceptibility to fractures in the head and neck of the femur, heightened risks of degenerative conditions like hip and knee osteoarthritis, and profound effects on gait, muscle strength, genu varum, genu valgum, and other musculoskeletal aspects that significantly constrain functionality.

It is abundantly clear that further research in this domain is imperative, with an emphasis on scrutinizing the physical well-being and quality of life of individuals grappling with these conditions. Moreover, the pursuit of early diagnosis remains paramount, offering a promising avenue to mitigate the adverse outcomes we have discussed.

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