Musculoskeletal adaptations and consequences related to pain during pregnancy

Abstract

Pregnancy is a period characterized by numerous alterations of the body, to provide a proper environment for newborn development and growth and optimal conditions for the natural delivery. The changes that take place at the musculoskeletal system are subsequent to the increase in the ligament laxity secondary to hormonal changes, especially relaxin, and due to weight gain, which is predominantly distributed at the abdominal level, with the anteriorly movement of the center of gravity. The curvatures of the spinal column changes, with the accentuation of the lumbar lordosis and compensatory modifications at cervical and thoracic levels in order to facilitate the ambulation of the pregnant woman with a minimum risk of falls. The pelvic girdle adapts for natural delivery, with higher diameters due to an increased mobility in the sacroiliac and pubic articulations. Hydro saline retention may be accompanied by edema and secondary compression of the nervous structures, determining paresthesia and pain. It is important to know how these mechanisms work, because the common element is pain, which leads to invalidation and a decrement of the life quality, to provide with an adapted management, especially because the therapeutic resources are limited in pregnancy.

Keywords: *musculoskeletal system, hormonal changes, weight gain, ligamentous laxity, pregnancy, pain*

Rezumat

Perioada sarcinii este caracterizată de numeroase modificări la nivelul întregului organism, având drept scop oferirea unui mediu propice de dezvoltare și creștere pentru produsul de concepție și condiții optime pentru nașterea naturală. Modificările care au loc la nivelul sistemului musculoscheletal sunt secundare creșterii laxității ligamentare generate de hormoni, în special de relaxină, și creșterii greutății, care este distribuită predominant la nivel abdominal și care modifică centrul de greutate spre anterior. În cazul coloanei vertebrale, se produc modificări la nivelul curburilor, cu accentuarea lordozei lombare din cauza greutății crescute de la acest nivel și cu modificarea compensatorie la nivel cervical și toracal, pentru a-i putea permite gravidei deplasarea cu un risc cât mai mic de cădere. La nivelul centurii pelviene, se produc modificări pentru a putea face față nașterii naturale, cu creșterea diametrelor, pe seama creșterii mobilității de la nivelul articulațiilor sacroiliace și articulației pubiene. Retenția hidrosalină poate fi însoțită de edem și de compresie la nivelul anumitor structuri nervoase, fiind responsabilă de parestezii și durere. Este important să fie cunoscute și înțelese aceste mecanisme, deoarece elementul comun este durerea, care este invalidantă și duce la o scădere a calității vieții, necesitând un management adaptat situației, avand în vedere resursele terapeutice limitate în contextul sarcinii.

Cuvinte-cheie: *sistem musculoscheletal, schimbări hormonale, creștere în greutate, laxitate ligamentară, sarcină, durere*

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Introduction

Pregnancy is a challenge for women because of the anatomical and physiological changes due to the hormonal shift. The body is adapting in order to host the fetus and to be able to provide the larger number of metabolic requirements. The changes influence all the organ systems, but with a major impact on the musculoskeletal system. The most frequent symptoms that pregnant women can develop, related to the musculoskeletal system, are back pain, tendinitis, generalized arthralgias, transient osteoporosis, or even separation of the pelvic bones. The total weight gain during pregnancy has a major impact on the biomechanical changes that take place in a pregnant woman and the average recommendation for weight gain during pregnancy in a healthy female with a Body Mass Index (BMI) between 18.5 and 24.9 kg/m^2 is, on average, 11.5-16 kg[(1)].

During pregnancy, the joints' laxity is increased due to the relaxation of the connective tissues of the ligaments, but it is not clear yet if laxity increases because of the higher levels of progesterone and/or estrogen; there are many studies that show that relaxin, a hormone secreted by the *corpus luteum*, placenta and decidua, is largely involved in the composition of the connective tissue during pregnancy[(2)]. There are many physiological changes that occur during pregnancy in order to give birth in a natural way to a healthy child.

Abdominal wall adaptation

During pregnancy, intraabdominal pressure is significantly higher than normal, leading to a strain in the abdominal and paraspinal muscles[(3)]. The length, the angles of insertion and the width between the *rectus abdominis* muscles increase as pregnancy progresses and

lead to a decrease in the ability of the muscles of stabilizing the pelvis against the exposed resistance. The reversal of separation between *rectus abdominis* muscle is seen after four weeks postpartum, but the ability to stabilize the pelvis remains compromised for at least eight weeks[4].

Biomechanical factors adaptation

During pregnancy, many changes of the biomechanical factors are secondary to weight gain, the additional weight seen in pregnancy being preponderantly placed anterior due to amniotic fluid, the fetus and the enlarged uterus. These changes develop during the pregnancy, but are intensified in the last semester. The adaptation of the spinal curvature consists in increasing angles of thoracic and lumbar spine curvature and anterior tilt of the pelvis. It is important to mention that the gravity center is displaced forward from the normal line. In order to maintain the stability of the pregnant women gait, there is a postural compensation with exaggeration of the lower back lordosis, downward movement of the shoulders and flexion of the neck[5].

Sacroiliac joint adaptation

A safe delivery of the newborn requests the adaptation of sacroiliac joints and pubic symphysis, with a growth in their mobility and the widening of the pelvic bone aperture. In order to accomplish this necessity, the extracellular matrix of the pubic symphysis and sacroiliac joints changes, being considered that relaxin has a major contribution[6]. The laxity of the sacroiliac joints can be objectively quantified *in vivo* by Doppler imaging of vibration, a noninvasive technique that is easy to apply during the whole period of the pregnancy, without implications on the fetus, with a high reproducibility of the technique[7,8]. It is considered that the laxity of the sacroiliac joints is not a predictor for pelvic pain during pregnancy, but the asymmetrical laxity of the sacroiliac joints is correlated with moderate or severe pregnancy-related pelvic pain. Pregnant women with severe pelvic pain have the same sacroiliac joint laxity with pregnant women without or with mild pelvic pain[9].

1. Low back pain during pregnancy

Low back pain affects more than 60% of pregnant women and, because it is so common, it is often viewed as a normal fact in the physiological evolution of a pregnant woman. The pain is preponderantly nocturnal and causes sleep disturbance; one third of pregnant women consider it as a severe impediment, because it interferes with normal daily living activities[10]. In some studies, 30% of pregnant women stopped performing at least one daily activity because of the pain, but it is considered that the average pain has a moderate grade of severity[11].

It is important to know the pathogenesis of gestational back pain to prevent it or to manage the symptoms in such a manner to limit the impact on the life quality of a pregnant woman.

There are some preexisting factors that predispose to back pain during pregnancy, such as history of back pain, multiparity, younger age of pregnancy (due to the higher sensitivity to hormonal changes), high BMI before pregnancy, and fatigue at the end of a working day[12-14].

Changes that are considered physiological for pregnancy and considered causes or alleviators for back pain are changes in posture, in total body water content, endocrine changes and engorgement of epidural veins.

1.1. Posture

One of the main causes of low back pain during pregnancy is the exaggeration of lumbar lordosis, but pain is promoted through different mechanisms that are its consequences. First aspect involved is the abnormal posture that causes inflammation of the synovial facet joints and ligaments involved in the stability of the low back column due to the mechanical stress and the second aspect is the exaggeration of the lumbar lordosis that can lead to disk herniation[10]. The inflammation promotes the production of synovial fluid and, secondary, the distention of the joint capsule that causes pain[10].

1.2. Changes in total body water content

The body composition in water varies during pregnancy, with an increase of water percentage from 72.5% at the 10th week of gestation to about 75% at 40 weeks, retention that seems to be related with the natriuretic properties of estrogen hormones[15]. Because there is a negative balance of sodium, renin and angiotensin II are released and, subsequently, increases the secretion of antidiuretic and aldosterone hormones which absorb the sodium and retain water. Fluid retention is augmented by other changes of the hormonal physiology during pregnancy, like increasing relaxin concentration. Due to the laxity of the joints that sustain the spinal column, the range of motion increases that region, leading to inflammation and pain.

1.3. Endocrine changes

In pregnancy, the composition of endogenous neuropeptides, involved in modulation of afferent and efferent impulses of pain at the spinal cord level, is modified[16]. There are some studies that show that in pregnancy the level of P substance is decreased, and the levels of dynorphin and enkephalin are increased. Dynorphin is associated with the attenuation of the pain during late pregnancy and labor[17,18]. Another hormone that is raised during pregnancy is progesterone, which is considered to modulate pain through sensitization of neurofibril to some local anesthetic agents. Overall, the threshold of pain seems to be increased during pregnancy.

1.4. Engorgement of the epidural veins

The enlargement of the epidural and paravertebral venous system is a cause of back pain, mainly because of nerve root compression and, secondary, because of the metabolic disturbance caused by hypoxemia[19]. The causes for epidural vein enlargement in pregnancy are hypervolemia and compression of the inferior *vena cava* by the enlarged uterus[20].

2. Pelvic girdle involvement

The incidence of pelvic girdle pain in pregnant women range from 20.1% to 46%[21,22]. This type of pain refers to pelvic joints' conditions such as pelvic girdle syndrome

(pain in all joints of the pelvis), unilateral or bilateral pain of sacroiliac joints, and pubic symphysis pain.

The separation of pubic symphysis in pregnancy has an incidence from 1:300 to 1:30.000 and includes suprapubic pain with radiation to the back of the thigh and difficulties in ambulation, with a major impact in the functioning of the pregnant woman[23]. The pathophysiology of pubic symphysis pain is not fully known, but it is considered that the increased mobility of the pelvic joints during pregnancy is one of the main causes[24].

Sacroiliac joint pain is known as posterior pelvic joint pain, with a stabbing character, localized in the vicinity of sacroiliac joints; it can irradiate to the posterior thigh and can be present alone or in association with pubic symphysis pain[25].

3. Hip pain

Hip pain in pregnancy is associated with preexisting conditions, such as trochanteric bursitis, with temporary pathologies, such as transient osteoporosis of the hip or osteonecrosis of the femoral head, and with orthopedic conditions such as hip labral tear.

Transient osteoporosis of the hip during the last trimester of pregnancy is a rare finding and it was first described in 1959. The diagnosis can be made by plain hip radiography or by hip magnetic resonance imaging examination. The pain is characterized as mechanical pain in one or both hips and the treatment is symptomatic and includes bedrest[26]. This is an autolimiting condition and the recovery is made within a few weeks to several months postpartum.

Osteonecrosis of the femoral neck is a rare pregnancy associated condition, with a not fully known etiology, but the involved hypotheses in case of osteonecrosis of the femoral neck in pregnancy are the elevated levels of glucocorticoids, hypercoagulability status and weight gain[27].

4. Leg and foot pain

Thigh pain. *Meralgia paresthetica* is the most common cause of thigh pain in pregnancy, being a sensory neuropathy characterized by paresthesia and numbness in the region of innervation of the lateral femoral cutaneous nerve[28]. Its etiology in pregnancy is multifactorial and is related to weight gain and increased abdominal pressure and, typically, the symptoms disappear within three months postpartum[29].

Knee pain. During pregnancy, knee pain is a common condition mainly secondary to weight gain and, secondly, due to the increased laxity of the ligaments, mostly of cruciate ligaments; it may cause instability of the knee, with an increased risk of falling[30]. The control of the weight gain during pregnancy is the most effective way to avoid knee pain[31].

Leg cramps. Many women are experiencing nocturnal leg cramps, mainly at calf muscles during pregnancy. The exact etiology of leg cramp is not entirely known, but it is considered to be secondary to a built-up of lactic and pyruvic acid. The treatment of leg cramps is limited, because supplementation with magnesium, calcium, vitamins D and C, as compared with placebo, showed little benefits[32].

5. Hand and wrist pain

Carpal tunnel syndrome. Carpal tunnel syndrome has a high prevalence during pregnancy and is caused by the compression of the median nerve as it travels through the carpal tunnel, due to high liquid retention. The symptoms include paresthesia and pain in the distribution of the median nerve. The diagnosis is confirmed by ultrasonography and electrodiagnostic studies[33]. The severity of symptoms and the functional impairment of carpal tunnel syndrome are generally mild, but they can be more severe in women with more fluid retention during pregnancy[34].

6. Arthritis

The immune system depression specific to pregnancy is a factor that temporarily ameliorates the symptomatology of autoimmune disease, such as rheumatoid arthritis, because postpartum there is a rebound[35].

Discussion and conclusions

The physiological hormonal changes characteristic to pregnancy involve the organisms as a whole, including the musculoskeletal system, where pain is the most frequent symptom, therefore it is important to know its physiology and etiopathogenesis in order to be able to offer an optimal management of the case and to prevent their consequences postpartum.

In conclusion, pregnancy is a challenge for the mother, because she suffers a multitude of musculoskeletal pain conditions secondary to her organism adaptations. ■

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