

Study on X ray imaging for the sacroiliac joint at subluxation

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Abstract. Aiming at the difficulty in X ray diagnosis for the sacroiliac joint's subluxation, the sacroiliac joint images for a patient's physiological state and pathological state are analyzed in this paper. We find that the image of the iliac pro-up shift 7mm is similar to that of the pelvic rotation 10° around the Y axis, and the image of the iliac external rotation 5° is similar to that of the pelvis rotation 5° around the Z axis. These results may easily lead to a massage doctor's misdiagnosis or leak-diagnosis.

Introduction

The sacroiliac joint is not only a bridge connecting the human torso to the lower extremities but also a transmission of gravity link which the pressure of the human weight and the external impact more focus on this site. Thus there is more risk of injury. Generally due to the ligament's mechanical strength decrease and relaxation, the sacroiliac joint's auricular face will move pro-up and post-down, as well as rotate internally and externally under abnormal displacement. Furthermore it can't reset by itself after this abnormal moving and rotation. These cause the partial pain or the lower limb pain and the sacroiliac joint being dysfunction even subluxation [1, 2]. Its clinical manifestation is characterized by sudden onset. Before the onset, there are a history of trauma, acute pain, much more pain when body position change or coughing and sneezing. The pressing pain and acid bilges unwell on the affected lateral of the sacroiliac joint more focus on the iliopsoas while the lower back to shoulder pain presents urgent spasm and sciatica, and the lower limb half appears buckling shape, feels cool, active or passive extending and flex is significantly limited as well as feels severe pain [3,4]. In traditional Chinese medicine the sacroiliac joint's subluxation (SJS) is also known as the dislocation of sacroiliac joint [5, 6]. Diagnosis of SJS mainly adopts the following method: The bilateral iliac crests are not as high as each other, furthermore the affected lateral lower limb's straight-leg-raising test or knees and hip flexion test is positive; Patrick sign is positive; The bedside test can appear positive; The pelvic distractions and compression tests are positive; The lower limb percussion pain alone longitudinal axis test will be positive. According to its moving direction, the sacroiliac joint falls into two kinds, or buckling subluxation and extending subluxation [4]. X-ray inspection for SJS adopting generally recumbent position or standing type, the test images show the sacroiliac joint clearance become broad or narrow, the pubic ramus moves forward and backward, the ilium owns bilaterally not the same height and width [7]. Due to the small range of dislocation for SJS, it lacks of obvious deformity and clear imaging change. There are significant differences in both the size and the shape for the individual sacroiliac joint, even for one individual it is not the same bilaterally. A patient pelvic physical rotation and displacement caused by pain or discomfort may also affect the X-ray imaging [8, 9]. Thus all of these will increase the difficulty of X-ray diagnosis of the SJS, reduce the accuracy. Furthermore it will cause the patients injury or even death during the process of massage if the massage doctors misdiagnose and apply unsuitable massage for the patients, as it is well known that clinical treatment of SJS is adopted massage and auxiliary massage.

In this paper, aiming at loading characteristics for the sacroiliac joint movement and the difficulty of X ray diagnosis for SJS, we analyse the sacroiliac joint imaging under its physiological and pathological state.

X ray image analysis of the sacroiliac joint subluxation

A sacroiliac joint is composed of a sacrum auricular articular surface and an ilium auricular articular surface, with an angle of about 30° relating to the sagittal plane and a narrow space about 1-2mm. The auricular joint surface coated by the joint cartilage, while the sacral lateral (about 2-4 mm) composed of hyaline cartilage is slightly thicker than that at the iliac lateral (about 1mm) composed of fibro-cartilage usually. The sacrum auricular surface facing posterolateral is located at the lateral of 3 sacral vertebrals, while its front is wider than the back. The iliac auricular surface faces anteromedial. Totally the whole sacroiliac joint looks like posterior apophysis. The cuneiform sacrum is located at the sacroiliac joint center, embedded between double skeletons bone, connecting six joints surfaces directly. There are strong ligaments between both the sacrum and the sacral, and the sacral and the sciatic to strengthen the joint fastness [10]. In image analysis of SJS, the bilateral iliac crests are not in the same level in x-ray plain film while the sacroiliac joint space is broadening or narrowing on the lateral view. By means of image analysis of a variety of SJS, the iliac displacement relative to the sacrum is mainly divided into four kinds. First, the iliac crest shifts pro-up. In the X-ray imaging, the iliac crest length decreases, the obturator foramen's height shorten, the affected lateral caput femoris is higher than that of the contralateral, and the physiological curvature of the lumbar vertebra decreases. Second, the iliac crest shifts post-down. In the X-ray imaging, the iliac crest length increases, the obturator foramen's height increases, the affected lateral caput femoris is lower than that of the contralateral, the physiological curvature of the lumbar vertebra increases. Third, the ilium rotates internally. In the X-ray image, the affected lateral ilium's width increases, the obturator foramen diagonal decreases, the center of the pubic symphysis moves to this affected side. Forth, the ilium rotates externally. In the X-ray image, the affected lateral ilium's width decreases, the obturator foramen diagonal increases, the pubic symphysis center moves to the alternative side.

3D reconstruction and simulation for the sacroiliac joint

In order to simulate the sacroiliac joint movement and its physiological and pathological image, a three-dimensional (3D) model for the sacroiliac joint is needed to reconstruct. Based on a set of CT slice data for a health digital human, we apply medical image software to build a 3D model for the sacroiliac joint and to draw the pelvis model from it, shown in figure 1.

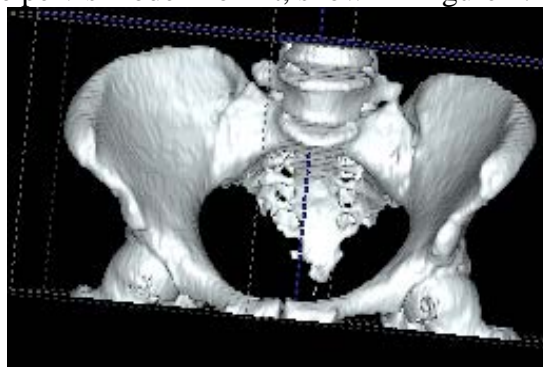


Fig. 1. 3D model for the pelvis

It can be seen in figure 1 that we need partition the sacrum and ilium to simulate and analyse the sacroiliac joint movement. As shown in figure 2, the sacroiliac joint surface appears rough and auricular in the iliac 3D model

We put the sacrum 3D model and the iliac 3D model into the medical software to simulate their motion. The motion coordinate system xyz is established with the sacrum center being as the coordinate origin. First, we simulate the iliac pro-up motion and post-down motion compared to the sacrum. We select the sliding motion pair to simulate the two kinds of motions. We have calculated 200 steps with one step of 0.15 mm. When the iliac moves pro-up 7 mm and moves post-down 7 mm, its images are shown in figure 3 and figure 4, respectively. Next, we select the rotating motion pair to simulate the iliac rotating around the sacrum. We have computed 100 steps with one step of 0.15° .

The sacroiliac joint is shown in figure 5 and 6 when the iliac rotates internal 5° and external 5° around the sacrum, respectively.

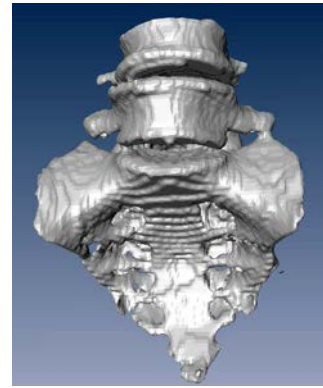
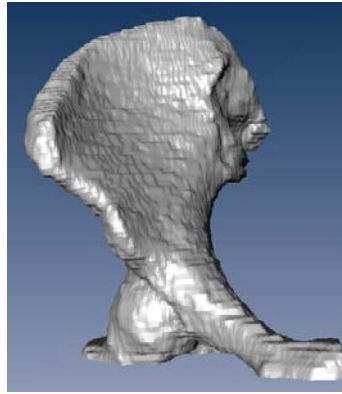


Fig. 2. 3D model for the sacrum and 3D model for the ilium

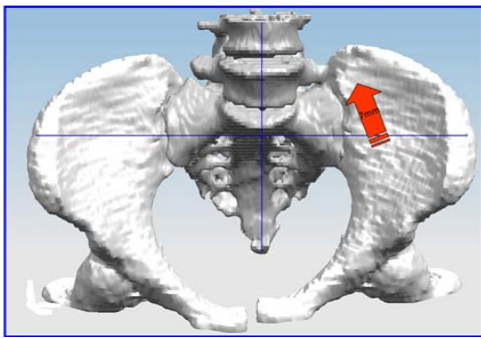


Fig. 3. SJS for iliac pro-up 7mm

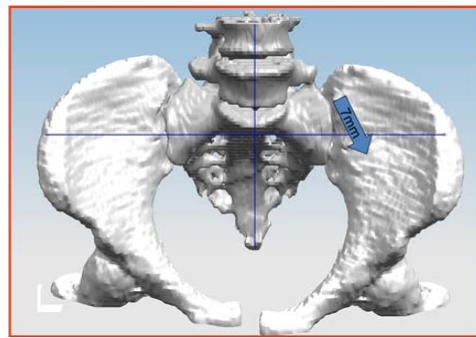


Fig. 4. SJS for iliac post-down 7mm

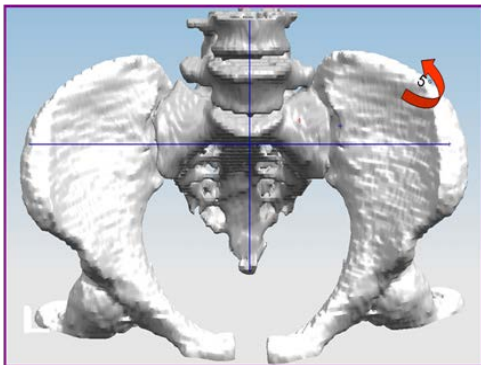


Fig. 5. SJS for iliac external rotation 5°

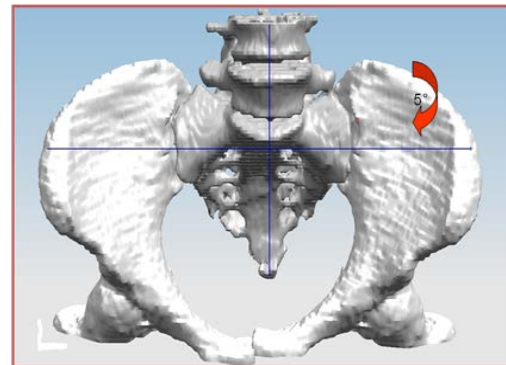


Fig. 6. SJS for iliac rotation 5°

Seen from figure 3 to figure 6, the four x ray images of SJS change little. If plus the ligament in simulation, the differences are even more less. To differentiate the image of SJS from that of a patient physiological displacement, we need to simulate the whole pelvis rotating around the X, Y, and Z axes, and then to analyses, to compare, and to identify the two kinds of images.

We put the pelvis' 3D model into the medical software to simulate and compute by the rotation pair. Comparing the simulation results to that of a patient physiological displacement, we find that the image of the iliac pro-up shift 7mm is similar to that of the pelvic rotation 10° around the Y axis and the image of the iliac external rotation 5° is similar to that of the pelvis rotation 5° around the Z axis, seen in figure 7.

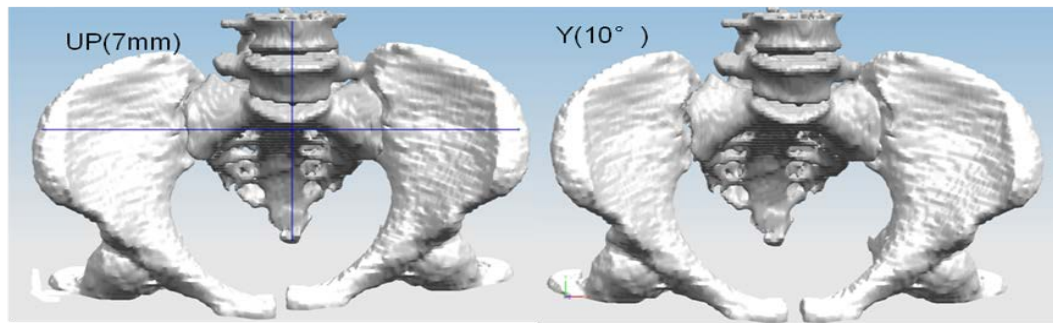


Fig. 7 Diagram for the iliac pro-up shift 7mm and pelvis rotating 10° around Y axis

Because they are confused easily in pathology or imaging between SJS and acute lumbar sprain, traumatic sacroiliac arthritis, sacroiliac joint tuberculosis, early ankylosing spondylitis, and fiber bad fracture of lumbar disc disease. A massage doctor can make the patient great damage and even death if he uses unsuitable massage, especially the wrong pull technique due to misdiagnosis or missed diagnosis. Aiming at misdiagnosis for the patient's physiological movement, we design a special X-ray radiography fixture for the sacroiliac joint.

Discussion

Through imaging analysis of the sacroiliac joint under physiological and pathological states, we find that the image of the iliac pro-up shift 7mm is similar to that of the pelvic rotation 10° around the Y axis, and the image of the iliac external rotation 5° is similar to that of the pelvis rotation 5° around the Z axis. This result will easily lead to a massage doctor's misdiagnosis or leak-diagnosis. In order to solve the diagnostic error brings to the patient's health threat, it is necessary to design special X-ray radiography fixtures for the patient's sacroiliac joint.

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