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SHOULD WE MEASURE PELVIC INCIDENCE MANUALLY OR WITH COMPUTER ASSISTANCE?

PELVİK İNSİDANS ELLE Mİ, BİLGİSAYAR YARDIMLI MI ÖLÇMELİYİZ?

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SUMMARY

Objective: To assess whether computer-assisted measurement or manual measurement of pelvic incidence is superior.

Study Design: Standing antero–posterior and lateral radiographs of the entire spinal column of 30 patients between 20–40 years of age were included in the study. The sacral slope, pelvic incidence, and pelvic tilt were evaluated to measure the sagittal balance. The measurements were done both manually and using a computer-assisted method by two spinal surgeons and one orthopedic surgeon. Statistically, an intra-class correlation coefficient method was used.

Results: An almost perfect agreement was found between surgeons with the computer-assisted measurements. Moderate to strong agreement was found between the measurements taken manually.

Conclusion: The use of computer-assisted programs will improve the accuracy of measurements, especially for measurements which are difficult to calculate, such as the sagittal balance.

Key words: Pelvic incidence, sagittal balance, radiographic measurement

Level of evidence: Retrospective clinic study, Level III

ÖZET

Amaç: El ile ya da bilgisayar yardımlı yapılan pelvik insidans ölçümlerinin birbirine üstünlüğünün karşılaştırılması.

Hastalar ve Metod: Ayakta tüm spinal kolon anteroposterior ve lateral radyografileri olan otuz 20-40 yaş arası yetişkin örneklem olarak seçildi. Sagital balans için sakral slop açısı, pelvik insidans ve pelvik tilt açıları ölçüldü. 2 spinal cerrah ve 1 ortopedi uzmanı tüm ölçümleri yaptı. Ölçümler hem el ile röntgen üzerinden, hem bilgisayar yardımlı yapıldı. İstatistik olarak grup içi korelasyon katsayısı (Intraclass correlation coefficent) uygulandı.

Bulgular: Cerrahların bilgisayar yardımı ile yaptığı ölçümlerde mükemmele yakın uyum bulunurken el ile yaptıkları ölçümlerde orta ya da güçlü derecede uyum bulundu.

Sonuç: Özellikle sagittal balans gibi nispeten zor açıların hesaplanmasında bilgisayar yardımlı programların kullanılması ölçüm doğruluğunu arttırır.

Anahtar Kelimeler: Pelvik insidans, Sagital balans, radyografik ölçüm

Kanıt Düzeyi: Retrospektif klinik çalışma, Düzey III

INTRODUCTION:

Today, the evaluation of sagittal balance is very important for the treatment of lumbar degenerative pathologies[3,6,8,9,10,13-18,22]. Sagittal balance can be maintained by pelvic, hip and knee accordance[1,4-5,13,14,20,21,25]. When this balance is maintained, the body spends minimal energy. Knowing the sagittal balance is very important for surgical planning. There are three important parameters of the sagittal balance: pelvic incidence (PI), pelvic tilt (PT), and sacral slope (SS)[20,22,25]. PI is a morphological parameter that is not affected by pelvic posture and position and does not change after growth and development is over. The orientation of the pelvis is defined by two positional parameters, PT and SS [20,25].

The relationship between the pelvic incidence, sacral slope and sagittal tilt is very well documented in a normal population[5,15,25]. With regard to this information, Roussouly described four types of lumbar lordosis[20]. However, calculation of the angles is hard and confusing. In daily practice, a computerized archiving system (PACS) is frequently used, allowing physicians to make the measurements with computer assistance. The credibility of these measurements, particularly measurements of sagittal tilt, has not before been questioned.

The aim of this study is to evaluate whether manual or computer-assisted measurements show less user-dependent variability for sagittal balance measurements.

PATIENTS AND METHODS:

X-rays taken in our clinic in the last year were sorted retrospectively. The inclusion criteria were patients between the ages of 20–40, without deformity, degenerative spondylosis, herniated discs, or fractures. 30 patients with lateral X-rays clearly showing the C7 vertebra, thoracolumbar region, sacrum and femur head were included in the study.

Two spinal surgeons and an orthopedic specialist conducted all the measurements. All measurements were conducted manually from X-rays and also performed using computer assistance. All the X-rays were evaluated with the same computer program (http://www.surgimap.com; Nemaris Inc, New York, ABD) and from X-rays of the same quality.

In the manual measurements, the middle point of the two femur heads was accepted as the rotation center of the hip. The angle between the line from the middle point of the line connecting both femur heads and the rotation center, perpendicular to the line from the middle point of the S1 vertebra to the S1 endplate, made the pelvic incidence (PI) angle. The angle between the line perpendicular to the line connecting the rotation center from both femur heads to the middle point of the S1 vertebra made up the pelvic tilt (PT). The sacral slope (SS) angle was calculated from the angle between a line parallel to the S1 end plate and the horizontal plane. (Figure-1).

In the computer assisted measurements, the midpoints of the femur heads and the S1 end plate were taken as a reference (Figure-2). For each patient, the measurements were recorded separately. For statistical analysis, the interclass correlation coefficient was used.

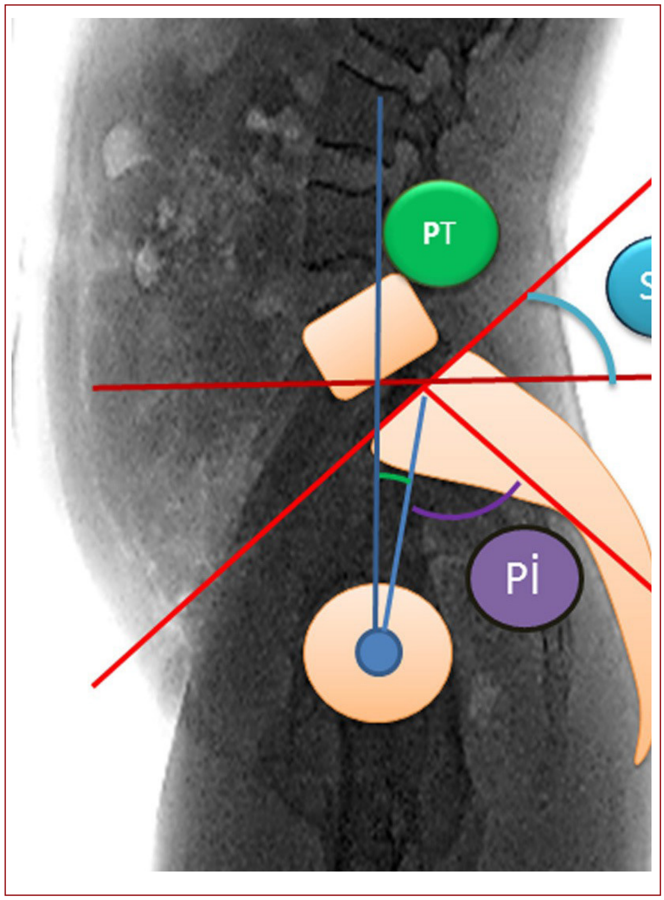

Figure-1. Schematic view of pelvic incidence (PI), sacral slope (SS) and pelvic tilt (PT).

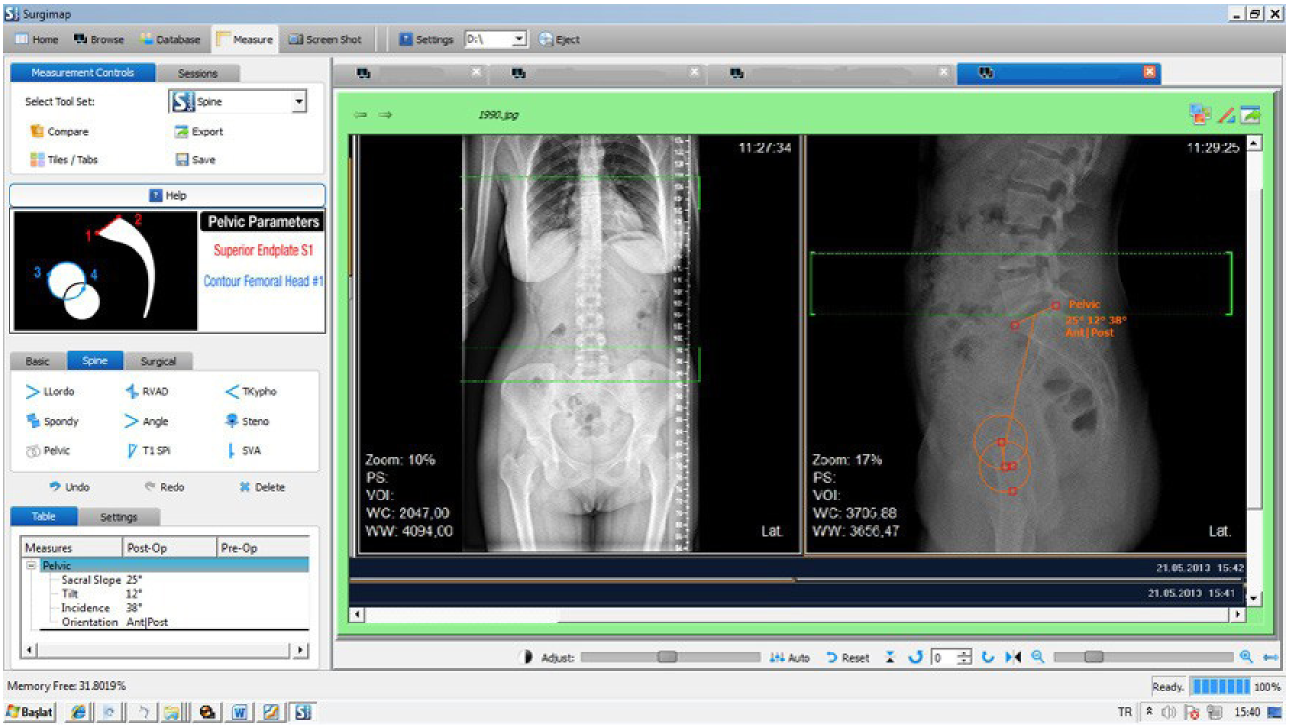

Figure-2. Computerized view of the measurements.

FINDINGS:

When the manual and computer-assisted measurements by each surgeon were evaluated, the measurements of the first spinal surgeon were: SS ICC=0.757 (p=0.000), PI ICC=0.729 (p=0.000), and PT ICC=0.720 (p=0.001); the second spinal surgeon: SS ICC=0.634 (p=0.002), PI ICC=0.544 (p=0.001), and PT ICC=0.636 (p=0.000); and the orthopedics specialist: SS ICC=0.765 (p=0.000), PI ICC=0.543 (p=0.022), and PT ICC=0.930 (p=0.000).

When the measurements of all the researchers were evaluated, SS showed a strong correlation (ICC=0.779, p=0.000), PI had an intermediate correlation (ICC=0.547, p=0.001), and PT had a strong correlation (ICC=0.807, p=0.000). In the computer-assisted measurements, the SS (ICC=0.914, p=0.000), PI (ICC=0.908, p=0.000) and PT (ICC=0.892, p=0.000) values showed a perfect correlation (Table-1).

Table-1: Evaluation of the measurements. Computer-assisted measurements show a perfect correlation. (ICC: Intra-class correlation coefficient)

	ICC	p
Computer assisted		
SS	0.914	0.000
PI	0.908	0.000
PT	0.892	0.000
Manual		
SS	0.779	0.000
PI	0.547	0.001
PT	0.807	0.000

DISCUSSION:

This study shows that computer-assisted measurements are more reliable than ones that are made manually. Computer-assisted measurements of the three points showed a perfect correlation. There was not a perfect correlation in the measurements made manually. In some recent studies, computer-assisted measurements have been used, but the reliability of the software has rarely been tested[1,4,19]. There are various methods for planning treatment of ankylosing spondylitis patients. The classical method is to calculate the angle and osteotomy level from X-rays using a template and cutting method. This method is time consuming and difficult[7]. Park et al., in a study that included 18 ankylosing spondylitis patients, determined the osteotomy level using a computer program. They showed that the preoperative computer simulation and the postoperative radiological parameters were coherent[19]. Van Royen planned surgery of ankylosing spondylitis patients and reported good results[24].

During growth, there are physiological and morphological changes, and the harmony between the spine and pelvis is sustained to give minimal energy consumption[3,22]. In patients with spinal deformities that disturb the sagittal balance, postural adaptive changes occur in order to have an appropriate horizontal glance[3,22]. These adaptive changes result in a reduction of pelvic tilt (pelvic retroversion), hip extension, knee flexion, and hyperextension of the cervical vertebrae[3,22].

The PI angle gives information about pelvic compensations, such as the ability for pelvic retroversion. PI determines the relationship between the sacral plane and femur heads. Roussouly et al. found the values of PI within a range from 35° to 85°, with an average of 51.9°, in asymptomatic patients[22]. Labelle showed that PI values were less than 35° for Scheuermann's kyphosis patients, and higher than 85° for isthmic spondylolisthesis patients[14]. Patients with very small PI values also have very small pelvic rings in antero-posterior plans. The femur heads are positioned just underneath the sacral plane. In patients with high PI values, the antero-posterior diameter is high and the horizontal pelvis is large[22]. In the sagittal plane, the femur heads are positioned ahead of the sacral end plate[22]. The relationship between SS and lumbar lordosis was originally described by Stagnara[23]. An increased SS is related to increased lumbar lordosis (dynamic lumbar area), while when SS is horizontal, the lumbar curvature is flat (static lumbar region). In some studies, a strong relationship between lumbar lordosis and SS has been shown[2, 12,13].

The pelvis can be tilted around the femur heads according to the bicoxofemoral axis. When the pelvis is tilted backwards (retroversion), the PT increases. PT is a positional parameter, like SS[2,15]. There is a geometric relationship between these two positional (functional) parameters and the pelvic incidence (morphological parameter): PI = PT + SS[2,15]. Rotation of the pelvis around the femur heads is the best mechanism for regulating sagittal balance[2,15].

There is a small sample size in this study. In conclusion, we determined that computer-assisted measurements of sagittal parameters are more reliable than manual measurements. Particularly for angles that are hard to measure, such as the sagittal balance, errors could be minimized and the measurement efficiency can be maximized by employing computer-assisted programs.

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