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Original Article

Accurate calculation of limb length discrepancy using scoliosis radiography

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Abstract

Aim: When we want to determine the difference in leg height by using only scoliosis radiographs in patients with scoliosis; we have looked for answer to the question of where should be the accurate measurement point for values that are closest to reality.

Material and Methods: In this study 129 patients of our hospital between December 2016and 2018 with scoliosis radiography and leg height graphies were detected.. The actual leg height difference was calculated on leg height graphies. Afterwards, the right and left femoral head top points were determined on scoliosis graphy. A parallel line was drawn from the top of the right femoral head. By measuring the distance of this line to the top point of left femur; difference between right and left legs was calculated. The same procedure was repeated after determining the right and left acetabulum top points and right and left iliac wing top points

Results: A total of 129 patients, including 45 male and 84 female patients, were evaluated. Significant results were obtained from the correlation analysis between the leg length difference of the total patients and the distance between the acetabulum (p<0,0001). Statistically significant correlation was found between iliac wing distance and femur length difference measurements (p<0,0001).A significant correlation was detected between Femur head top spot difference measurements and length differences that were measured with orthoroentgenogram (p<0,0001).

Conclusion: The difference between the top point of the femoral head, the acetabulum or the iliac wing can be used on scoliosis graphy which was taken during the follow-up of leg length discrepancy in scoliosis patients.

Keywords: Scoliosis; limb length discrepancy; radiography; osteogenesis.

INTRODUCTION

The incidence of limb (leg) length discrepancy is 3-15% in population (1). Leg length discrepancy often accompany curvature of the spine. In patients with scoliosis who are also diagnosed with leg length discrepancy; leg length radiographs should be taken in addition to scoliosis radiographs during treatment and follow-up stages. Leg length difference can be calculated by leg length radiographs or physical examination. Leg length discrepancy should be followed after treating the leg height difference as it may cause posture deformity, low back pain, joint osteoarthritis, scoliosis, gait abnormalities and joint contractures (2).

In our study, only scoliosis radiography was performed instead of requesting leg length radiography for the follow-up of the leg height difference in the follow-up of patients with scoliosis. When we want to determine the difference in leg height by using only scoliosis radiographs in patients with scoliosis; we have looked for answer to the question of where should be the accurate measurement point for values that are closest to reality. We also wanted to know if it is reliable to perform measurement in scoliosis patients. So we will be able to do a more accurate and quick evaluation with less radiation exposure and less cost.

MATERIAL and METHODS

In this study, 129 patients who were admitted to the orthopedics outpatient clinic of our hospital between December 2016 and December 2018 with scoliosis radiography and leg height graphies were detected.

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Patients, with/without scoliosis, who had leg length discrepancy were included in this study. Patients who underwent spinal, pelvic or lower extremity surgery for any reason, those with congenital spine pelvis or leg deformity and patients without appropriate radiographs were excluded. Measurements were conducted by two orthopedists on K-PACS (Turkey) system. The actual leg height difference was calculated by measuring the difference between the mid-point of the right and left upper femoral head and the right and left tibia distal joint face (Figure 1).

Figure 1. distance between XY: right leg length, distance between ZQ: left leg length, distance between XY-ZQ: actual leg height difference

Afterwards, the right and left femoral head top points were determined on scoliosis graphy (Figure 2: A and B points). A parallel line was drawn from the top of the right femoral head. By measuring the distance of this line to the top point of left femur; difference between right and left legs was calculated (Figure 2). The same procedure was repeated after determining the right and left acetabulum top points (Figure 3) and right and left iliac wing top points (Figure 4).

Figure 2. The shortest distance between the parallel line drawn from point A and the B point

Figure 3. C and D points, the shortest distance between point D and the parallel line drawn from point C

Figure 4. F and G points, the shortest distance between the parallel line drawn from point F and the G point

Statistical analysis; SPSS 22.0 software package (IBM Corporation, Armonk, NY) was used. Intraclass Correlation Coefficient (ICC) analysis was performed to measure the correlations between the measurements. Inter-assay variability was evaluated with Cohen Kappa statistics. Independent t-test and Spearman correlation analysis were performed. Statistical significance was determined as p <0.05 (3).

RESULTS

A total of 129 patients, including 45 male and 84 female patients, were evaluated. While 60 patients were considered to have no scoliosis; 69 patients had scoliosis. The mean age of the patients was 17.4 (11-46). According to Cohen kappa statistics used in the analysis of variability between measurements; all parameter measurements were evaluated as excellent (0.81 to 0.99).

The mean length in right leg measurements was 94.3 cm (+/- STD 13.9); The mean length of the left leg length measurement was 94.4 cm (+/- STD 14.0). The mean length difference between the legs was measured as 6.4 mm (+/- STD 5,6). Distance between the upper ends of the femur was measured as 5.35 mm (+/- 4.92 STD). The difference between the two sides of iliac wings was measured as 6.25 mm (+/- 5.57 STD). The distance between two acetabulum was measured as 5.44 mm (+/- STD4.94).

Significant results were obtained from the correlation analysis between the leg length difference of the total patients and the distance between the acetabulum ($p<0.0001$). Statistically significant correlation was found between iliac wing distance and femur length difference measurements ($p<0.0001$). A significant correlation was detected between Femur head top spot difference measurements and length differences that were measured with orthoroentgenogram ($p<0.0001$).

DISCUSSION

When evaluating spine deformities or diseases, leg length discrepancy should also be considered. Scoliosis due to leg length discrepancy is called functional scoliosis (1). In a study of Papaioannou et al., it was shown that leg length discrepancy causes scoliosis at lumbar region (4).

Leg height difference can be measured by physical examination and radiological methods (5). Both iliac crests were palpated while the patient was standing upright, and shorter sides were determined by placing certain blocks under the foot (6). Another method is to measure the distance between anterior superior iliac crest (ASIS) and the distance between the internal or external malleolus by means of meters (7). With these measurement methods, functional shortness (angle deformities, joint contractures) is indistinguishable. The most commonly used radiological examination is leg length graphy (orthoroentgenogram). Other than these, there is a measurement method with computed tomography (CT) (8). However, the method with CT is expensive and the patient is exposed to excessive radiation during the examination. Considering these methods; we suggest that physical examination should be done in scoliosis patients and leg length difference should be determined by scoliosis AP / LAT graphy and Leg length graphy. In the follow-up, we say that only the scoliosis radiography will be sufficient and that the difference between the upper extremities of the iliac crest on the scoliosis X-ray, the difference between the upper extremities of the acetabulum or the difference between the upper end points can be used safely.

In the first evaluation, only the scoliosis radiographs will be sufficient in the follow-up because congenital deformities, previous surgeries, ankyloses and contractures are excluded. Since the physical examination has taken time and does not meet the standard of personal measurement decisions; measurement with graph will be a more objective approach. In a study of Sekiya et al., using the EOS imaging system is recommended to distinguish between functional and structural leg height differences (9). As we made this distinction with physical examination and x-rays during the first evaluation; scoliosis radiographs will be sufficient for follow up in appropriate patients. Besides, we have shown that the results of the measurements are correct without being dependent on the curvature

after including leg length discrepancy patients without any curvature of the spine. In the other hand, because of treatment of scoliosis aims to perform physically normal, balanced, painless and a stable backbone, we have to correct the leg length discrepancy(10). Finding the right length difference is important in surgery as well as in non-surgical treatments (11).

CONCLUSION

In conclusion, the difference between the top point of the femoral head, the acetabulum or the iliac wing can be used on scoliosis graphy which was taken during the follow-up of leg length discrepancy in scoliosis patients.

Competing interests: The authors declare that they have no competing interest.
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REFERENCES

1. Raczkowski Jan W, Barbara Daniszewska, Krystian Zolynski. Functional scoliosis caused by leg length discrepancy. Arch Med Sci 2010;6:393-8.
2. Łabaziewicz L, Nowakowski A. Scoliosis and faulty posture [Polish]. Chir Narz Ruchu Ortop Pol 1996;61:247-50.
3. Mary L, McHugh. Interrater reliability: the kappa statistic. Biochem Med (Zagreb) 2012;22:276-82.
4. Papaioannou T, Stokes I, Kenwright J. Scoliosis associated with limb-length inequality. J Bone Joint Surg Am 1982;64:59-62.
5. Stricker Stephen J, Terrance Hunt. Evaluation of leg length discrepancy in children. Int Pediatrics 2004;19:134-46.
6. Woerman AL, Binder-Macleod SA. Leg length discrepancy assessment: accuracy and precision in five clinical methods of evaluation. J Orthop Sports Phys Ther 1984;5:230-9.
7. Aguilar EG, Domínguez ÁG, Peña-Algaba C, et al. Distance between the malleoli and the ground: a new clinical method to measure leg-length discrepancy. J Am Podiatr Med Assoc 2017;107:112-8.
8. Aaron Alan, Weinstein D, Thickman D, et al. Comparison of orthoroentgenography and computed tomography in the measurement of limb-length discrepancy. J Bone Surg Am 1992;74;897-902.
9. Sekiya T, Aota Y, Yamada K, et al. Evaluation of functional and structural leg length discrepancy in patients with adolescent idiopathic scoliosis using the EOS imaging system: a prospective comparative study. Scoliosis Spinal Disord 2018;13:7.
10. Korkmaz MF, Sevimli R, Selcuk EB, et al. Three-dimensional spinal deformity: scoliosis üç boyutlu omurga deformitesi: Skolyoz. Med Sci 2015;4:1796-808.
11. Korkmaz MF, Erdem MN, Ozevren H, et al. Determining the Optimal Length and Safety of Pedicle Screws in the T12 Vertebra: A Morphometric Study. Cureus 2018;10:2156.