Clinical Radiology xxx (2018) 1–9

Contents lists available at ScienceDirect

Clinical Radiology

journal homepage: www.clinicalradiologyonline.net

Validity and reliability of different techniques of neck–shaft angle measurement

A.J. Bizdikian [a], A. Assi [a,b,*], Z. Bakouny [a], F. Yared [a], E. Saghbini [a], G.E. Bakhos [a], S. Esber [a], N. Khalil [a], J. Otayek [a], J. Ghanimeh [a], C. Sauret [b], W. Skalli [b], I. Ghanem [a,c]

[a] *Laboratory of Biomechanics and Medical Imaging, Faculty of Medicine, University of Saint-Joseph, Beirut, Lebanon*
[b] *Institut de Biomécanique Humaine Georges Charpak, Arts et Métiers ParisTech, Paris, France*
[c] *Hôtel-Dieu de France Hospital, University of Saint-Joseph, Beirut, Lebanon*

ARTICLE INFORMATION

Article history:
Received 1 November 2017
Accepted 5 June 2018

AIM: To determine a valid and reliable neck–shaft angle (NSA) measurement method while rotating the pelvises in increments of 5° in order to simulate patient malpositioning.

MATERIALS AND METHODS: CT images of 17 patients were used to produce digitally reconstructed radiographs in frontal and lateral views and three-dimensional (3D)-reconstructions of the femurs, considered to be the reference standard. Malpositioning was simulated by axially rotating the frontal radiographs from 0° to 20°. Three operators measured in two-dimensions the NSA using four different methods, three times each, at each axial rotation (AR) position. Method 1 (femoral neck axis drawn by joining the centre of the femoral head (CFH) to the median of the femoral neck base; femoral diaphysis axis drawn by joining the median of two lines passing through the medial and lateral edges of the femoral axis below the lesser trochanter) and method 2 (femoral axis taken as the median of a triangle passing through base of femoral neck and medial and lateral head–neck junction; femoral diaphysis as previous) were described for the first time; method 3 was based on a previous study; method 4 was a free-hand technique. Reliability, validity, and global uncertainty were assessed.

RESULTS: Method 1 showed the best reliability and validity. The global uncertainty also showed minimal values for method 1, ranging from 7.4° to 14.3° across AR positions.

CONCLUSION: Method 1, based on locating the CFH, was the most reliable and valid method and should be considered as a standardised two-dimensional NSA measurement method for clinical application.

© 2018 The Royal College of Radiologists. Published by Elsevier Ltd. All rights reserved.

Introduction

The neck–shaft angle (NSA), also known as the caput–collum–diaphyseal angle, is the angle formed by the intersection of a line passing through the femoral shaft and a line passing through the femoral head and neck. It is an important parameter to assess the geometry of the proximal femur,[1] as well as pathologies in adult and paediatric

* Guarantor and correspondent: A. Assi, Laboratory of Biomechanics and Medical Imaging, Faculty of Medicine, University of Saint-Joseph, Campus of Innovation and Sport, PTS, Damascus Street, Beirut, Lebanon. Tel.: +961 1421676; fax: +961 1421681.

E-mail addresses: ayman.assi@gmail.com, ayman.assi@usj.edu.lb (A. Assi).

https://doi.org/10.1016/j.crad.2018.06.006
0009-9260/© 2018 The Royal College of Radiologists. Published by Elsevier Ltd. All rights reserved.

Please cite this article in press as: Bizdikian AJ, et al., Validity and reliability of different techniques of neck–shaft angle measurement, Clinical Radiology (2018), https://doi.org/10.1016/j.crad.2018.06.006

patients, such as hip dysplasia,[2] osteoarthritis,[3] and the risk of femoral neck fracture.[3,4] NSA is also related to other hip parameters, including femoral head offset, femoral neck length,[5] and acetabular version,[6] and is commonly used in pre-surgical planning of the proximal femur.

Although there are a variety of methods for the measurement of NSA on an anteroposterior radiograph, there is currently no consensus on the optimal technique to use. Some methods require radiographs of only the proximal femur, while others require radiographs of the entire femur.[7] The latter are often impractical as frontal hip radiographs generally only include the proximal femur. Furthermore, the accuracy of NSA measurements depends on the correct positioning of the patient during X-ray acquisition,[7] and particularly, on the axial rotation (AR) of the hip.[8,9] This issue is very common in pelvic radiographs where spinal deformities are known to affect pelvic AR,[10] and consequently, hip and proximal femur parameters.

A recent literature review[7] reported that NSA measurement is sensitive to hip rotation and that there is an impairment in the reproducibility of NSA measurement methods due to the lack of consistency in the definition of the methods. Therefore, a consensus on a specific technique should take into account both the reliability of the method and its indifference to pelvic AR. Thus, the aim of the present study was to evaluate the validity (sensitivity to AR position) and reliability of different methods of NSA measurement on commonly used anteroposterior hip radiographs, while simulating patient AR malpositioning.

Materials and methods

Sample

Helical pelvic computed tomography (CT) images of 17 patients, including pelvises and proximal femurs (section thickness: 0.6 mm, resolution: 512×512 pixels, pixel spacing: 0.7675 mm) were extracted from the database of the radiology department of the hospital. All patients had undergone CT in order to investigate pain unrelated to the hip. Only normal hips were considered in this study, with no deformities of the femoral head, femoral neck, or femoral diaphysis. Nine adult patients (four male, five female) with an average age of 55.6 years old (SD: 24.5), ranging from 22 to 80 years old, and eight paediatric patients (five male, three female) with an average age of 12 years old (SD: 2.2), ranging from 9 to 15 years old were included. The design of the present study was approved by the institutional review board.

Frontal and lateral digitally reconstructed radiographs (DRRs) were simulated from each CT dataset in a DICOM format, with squared pixels (pixel spacing = 0.141 mm), using a specific software (Arts et Métiers ParisTech, Paris, France). This technique, which has already been used for the pelvis and the rib cage,[11,12] enables the simulation of the AR of the CT volume:

The generation of frontal and lateral DRRs is based on linear scanning by the X-ray beams from the top to the bottom of the CT volume with cylindrical projections: a collimator is simulated to avoid vertical diversion of the X-rays and to allow only horizontal propagation. In order to measure exact lengths on the radiographs, the horizontal enlargement was corrected by applying a scaling factor on the image.

Radiographic rotation was mimicked by rotating the CT volume around the vertical axis. Thus, five frontal DRRs were generated from each CT series, while introducing an AR from 0° to 20° with increments of 5° (Fig 1). In order to assess the effect of rotational malpositioning in general, the two hips from each patient, at each DRR, were included in this analysis, without distinguishing internal rotation from external rotation between the two hips of each subject.

Radiological parameters

The SterEOS 2D software (version 1.5.1; EOS Imaging, Paris, France) was used in order to digitally measure the NSA in two dimensions. This toolbox allows the user to measure and draw: lines between two points showing their midpoint, perfect horizontal or vertical lines, perpendiculars, an angle between two lines, as well as circles modifiable by their diameters and the centres of which are automatically determined. The NSA was measured bilaterally in two dimensions, on each frontal radiograph, using four different methods based on the determination of the angle between the neck axis and the shaft axis. Two methods, which were developed for the purpose of this study, were measured along with two previously described methods.[13–15] The aforementioned methods were chosen as they require radiographs of only the proximal femur.

Method 1 (Fig 2a)

Neck axis: a circle was drawn by placing three points on the contour of the femoral head, thereby automatically determining its centre (A). The midpoint of the base of the femoral neck was identified (B). The neck axis was then drawn by joining A and B.

Shaft axis: a horizontal line was drawn passing through the caudal end of the lesser trochanter between the edges of the lateral and medial cortices of the femoral diaphysis. The midpoint of this line was determined (C). A second horizontal line was drawn more caudally on the diaphysis and its midpoint was determined (D). The shaft axis was then drawn by joining C and D.

Method 2 (Fig 2b)

Neck axis: a line extending from the greater trochanter at its junction with the femoral neck to the upper head–neck junction was drawn; a second line extending from the lesser trochanter at its junction with the femoral neck to the lower head–neck junction was drawn. The point at which the two lines intersect was determined (A). The midpoint of the base of the femoral neck was identified (B). The neck axis was then drawn by joining A and B.

Shaft axis: identical to method 1.

Please cite this article in press as: Bizdikian AJ, et al., Validity and reliability of different techniques of neck–shaft angle measurement, Clinical Radiology (2018), https://doi.org/10.1016/j.crad.2018.06.006

Download English Version:

https://daneshyari.com/en/article/11013787

Download Persian Version:

https://daneshyari.com/article/11013787

Daneshyari.com