

QUANTITATIVE VALUE OF MEDIAL FEMORO-TIBIAL WIDTH WITH WEIGHT-BEARING TECHNIQUE. OUR EXPERIENCE WITH A MODIFIED LYON-SCHUSS VIEW.

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Abstract

In the period between September 2008 and February 2009, we evaluated with knee radiography a group of 30 patients with known knee osteoarthritis (OA). For each patient, two weight-bearing views of the knee were acquired, the first with a standard antero-posterior (AP) technique, the latter with a postero-anterior (PA) technique with a 10° skull-caudal incidence. The radiographs obtained were evaluated blinded by two radiologist who assessed the medial femoro-tibial width (FTW). Statistical analysis of the results, carried out with the "t" Student test, showed a statistically significant difference about FTW values between the two radiographic views ($t = 5.2331$ for reader 1 and $t=5.1970$ for reader 2). In conclusion, we believe that the dedicated PA view of the knee is better than standard AP view for a correct assessment of medial FTW.

Keywords: Knee; Radiography; Weight-bearing.

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Introduction

Knee osteoarthritis (OA) is a very common disease which affects both sexes with greater prevalence in women, and which increases gradually until it reaches 25-37% of subjects with more than 50 years of age [1]. For its treatment there are required increasingly important economic costs, since the elderly population will increase significantly in the coming decades in relation to the total population [2,3].

At present, there are several radiological methods for its assessment: conventional radiology (CR), ultrasound (US), computed tomography (CT), magnetic resonance imaging (MRI) [4-7].

Even today, however, CR assessment is the first method, and, therefore, more widespread and requested for the assessing of knee OA, since it allows the identification and evaluation of semiological signs typical of this disease, including the presence of marginal osteofitosis, subchondral sclerosis and thinning of femoro-tibial width (FTW). In particular, CR allows to measure precisely the FTW, that is an indirect way of measuring the thickness of articular cartilage and therefore predictive of the pattern of the arthritic disease [8,9].

The purpose of our study is to assess the medial FTW of knee joint using a specific PA projection, with the patient in weight-bearing position. Based on the assumption that for a proper assessment there have been used different methods of CR, with different postures and different geometries of X-ray beam incidence, we compared, in the same group of arthritic patients, the effectiveness of this specific projection versus the standard AP view in weight-bearing position.

Material and methods

In the period between September 2008 and February 2009, a group of 30 patients (18 males, 12 females, mean age 56 years) suffering from known knee OA, classified according to the ACR (American College of Radiology) parameters, was included in our study. All patients were required informed consent to the radiological study, in compliance with the rules of the Helsinki Declaration. For each patient two knee radiographs in weight-bearing position were acquired, the first with a standard AP view and the second with a dedicated PA view with skull-caudal beam incidence of 10°. For the acquisition of radiographic images we used two remote-conventional equipment without use of fluoroscopy.

Standard AP view [Fig.1]: patient in weight-bearing position, with knees extended, supported on X-ray table with feet slightly intrarotated. The incident X-ray beam is centered perpendicular to the radiologic



Fig. 1: standard AP view acquisition protocol and patient positioning (line = direction of x-ray beam).

table with appreciable impact at the patella, in the middle of the articulation of the knee (distance fire-film about 1 meter) with anterior-posterior direction.

Dedicated PA view with 10° skull-caudal incidence [Fig.2]: patient in weight-bearing position and bipodalic support with the hallux of both feet slightly extrarotated, in contact with the radiologic table, and the knees flexed 20-30° to reach the table with the front of the knees and thighs. The incident X-ray beam is centered at the level of the articular rim and tilted 10° skull-caudal, with postero-anterior direction.

All radiographs obtained were sent to the PACS system (Elefante5, Med2rad, Italy / Impax CS5000, Agfa, Belgium) of our Department for subsequent digital storage of still images and for the eventual re-elaboration (zoom, gray levels control, measurements, negative/positive inversion), and were then examined by two radiologists with experience in musculoskeletal radiology (RS, FC), who made blinded, independent measurements of the positioning markers and of JSW on radiographs in which all identifying information and dates were masked. The measurements



Fig. 2: modified Lyon-Schuss view acquisition protocol and patient positioning (angle between the two lines = tilting of x-ray beam).

were made manually, placing a digital ruler embedded in the PACS software with the help of the mouse.

Finally, each radiologist identified, among acquired radiographs for each patient, which of those allowed a better assessment of degenerative articular processes of the knee.

Results

The assessment of the FTW through the conventional technique has enabled an adequate measurement in 23 patients (76.3%); major limitations of this projection were non-alignment of femoral condili in respect to tibial plates in 5 cases (16.7 %), and wrong knee positioning, extrarotated in 2 cases (7%).

The dedicated technique has enabled an adequate assessment of the FTW in 26 patients (86.6%) [Fig.3]. In the remaining 4 patients, excessive knee flexion in 3 cases (10%) and knee extrarotation in one case (3.3%) did not allow a proper view of



Fig.3: modified Lyon-Schuss view with correct alignment of tibial plateau which allows a proper assessment of FTW (arrow and line).

articular width.

Table 1 shows the FTW values assessed using the conventional technique and the dedicated technique. Table 2 shows the mean FTW, the relative standard deviations (SD), the maximum and minimum values, in millimeters.

Statistical analysis of the values of FTW measured by the two readers in the two radiographic views, carried out using the Student t test, showed no significant inter-observer difference in measurement, and a significant difference between the two techniques (reader 1: $t= 5.2331$; reader 2 $t= 5.1970$ for $p < 0.05$).

Each radiologist identified, in 93.3% of patients, the dedicated PA view as better than conventional AP view.

Discussion

The knee is a typical site of OA, more frequently interested since the second decade of life, and often CR is the first diagnostic imaging method used. CR is a diagnostic tool largely used for the study of bone diseases thanks to its high spatial and contrast resolution, besides the low cost and the large diffusion worldwide. However, it is not possible to diagnose ligamentous and cartilaginous pathology with CR only; furthermore, the incorrect alignment of the articular heads and the possible geometric magnification or the overlapping of different anatomical structures can lead to a distorted representation of articular width, preventing the proper assessment. In particular, while the tibial plateau is subject to positioning variation because of changes of flexion angle of the knee, the femoral compartment varies significantly even for small degrees of flexion of the knee, affecting the correct evaluation of the FTW and the degenerative changes typical of OA [10].

Joint space width (JSW) measurement is a method of assessing knee OA with both good reproducibility and sensitivity to change, and, up to now, there have been used several radiological techniques, with different postures and different geometries of the incident x-ray beam [8,9,11-13].

The first used technique was the standing AP view, where the knee are extended, supported on the X-ray table with feet slightly intrarotated. Next, some authors have proposed a PA view (the so called "Lyon-Schuss view"), where the patient is

positioned with the tips of both great toes, the knees, and the pelvis coplanar and in contact with the examination table, with a knee flexion variable from 20 to 30 degrees [8-13]. In all cases fluoroscopy is used for proper knee positioning and to assure correct alignment of the tibial plateau, that is to say, a precise superimposition of the anterior and posterior rims of the plateau.

In our study, in order to avoid use of fluoroscopy and to reduce the concern for excessive exposition of patients to ionizing radiations, we used a modified "Lyon-Schuss view", proposed by Peterfy et al. [14], where the incident X-ray beam is centered at the level of the articular rim and tilted 10° skull-caudal.

In the scientific literature it has been stated by other authors that the PA view has many advantages over the standing AP view: 1) the knee is in contact with the examination table, and so the effects of radiographic magnification are minimal in the PA view [15]; 2) magnification in the standing AP view has been reported to be as great as 34% [16]; 3) in the PA view there is a fixed degree of flexion of the tibio-femoral angle it provides (because the patient is positioned with both knees and

the pelvis in contact with the table), and a good alignment of the tibial plateau with the central X-ray beam (which is achieved by use of fluoroscopy) [11-16].

The results of the our study showed a good inter-observer reproducibility and confirmed that PA views of the knee afford better alignment of the tibial plateau (86.6%) than conventional AP views (76.3%). Moreover, the FTW values measured in the standard AP views were greater than in the corresponding PA views, and it can be explained by the fact that OA cartilage destruction occurs in a posterior site of the femorotibial joint, and this is better assessed with the knee flexed 20-30° than full-extended [9]. The importance of the change observed with the PA view, relative to the standard view in extension, was demonstrated by a significant change in joint space narrowing (JSN) scores in respect to the standard AP views (at least 3 mm, and up to 1.9 mm).

Several authors have reported that flexion of the knee enhances the radiographic demonstration of JSN in OA, and that reduction of FTW values in flexion is specific to knee OA since they did not change in the PA views of normal control knees [8-14].

Patients	Reader 1		Reader 2	
	Conventional AP	Dedicated PA	Conventional AP	Dedicated PA
1	3,2	2,2	3,1	2,2
2	3,1	2,1	3,1	2,1
3	1,7	0,4	1,6	0,4
4	3,2	1,3	3,1	1,3
5	2,5	2,1	2,5	2,2
6	3,4	2,4	3,3	2,4
7	4,2	2,8	4,2	2,9
8	3,3	1,7	3,4	1,7
9	3,7	2,1	3,7	2,1
10	3,5	2,4	3,5	2,4
11	2,6	1,2	2,7	1,2
12	3,1	2,4	3,1	2,4
13	3,7	2,6	3,5	2,5
14	2,2	1,3	2,2	1,4
15	1,8	0,9	1,8	0,9
16	2,1	1,5	2,1	1,5
17	2,4	1,8	2,5	1,8
18	3,7	2,4	3,7	2,4
19	2,3	1,6	2,4	1,6
20	3,8	2,6	3,8	2,7
21	2,4	2,1	2,4	2,1
22	2,2	1,7	2,3	1,7
23	3,8	2,4	3,8	2,4
24		2,9		2,9
25		2,4		2,4
26		1,2		1,2

Table 1: FTW values (in mm) measured by the two readers in the standard AP and modified Lyon-Schuss views.

The importance of the changes in JSN and JSW induced by the flexion of the knee may question the value of epidemiological and follow-up studies previously made with the extended knee view. Moreover, a flexum of the knee is a common finding in a late stage of knee OA and the related decrease in JSW in the Lyon-Schuss view was found to vary in parallel with OA severity.

Therefore, the Lyon-Schuss view could be the most appropriate view for an accurate evaluation of the progression of JSN in knee OA, and it can be made without use of fluoroscopy as proposed by us.

Conclusions

The assessment of articular width with a dedicated weight-bearing technique, in PA projection with knees flexed 20-30° and beam incidence tilted 10° skull-caudal, allows a better assessment of degenerative changes in knee osteoarthritis compared to conventional AP technique, gathering even greater reproducibility. In the present work, the decrease in FTW was considerably greater with the modified Lyon-Schuss view than with the standard AP view. It is therefore our opinion that the radiographic examination of the knee required for OA should always be completed with the weight-bearing projection using this modified Lyon-Schuss PA view than with the standard AP view.

References

- Punzi L, Canesi B, Carrabba M, Cimmino MA, Frizziero L, Lapadula G, Arioli G, Chevallard M, Cozzi F, Cricelli C, Fioravanti A, Giannini S, Iannone F, Leardini G, Mannoni A, Meliconi R, Modena V, Molfetta L, Monteleone V, Nava T, Parente L, Paresce E, Patrignani P, Ramonda R, Salaffi F, Spadaro A, Marcolongo R: Italian consensus on Euler 2003 recommendations for the treatment of knee osteoarthritis. *Reumatismo* 2004; 56:190-201.
- Corti MC, Rigon C: Epidemiology of osteoarthritis: prevalence, risk factors and functional impact. *Aging Clin Exp Res*. 2003; 15:359-363.
- Eckstein F, Mosher T, Hunter D: Imaging of knee osteoarthritis: data beyond the beauty. *Curr Opin Rheumatol*. 2007; 19:435-443.
- Grassi W, Filippucci E, Farina A: Ultrasonography in osteoarthritis. *Semin Arthritis Rheum*. 2005; 34:19-23.
- Conaghan P, D'Agostino MA, Ravaud P, Baron G, Le Bars M, Grassi W, Martin-Mola E, Wakefield R, Brasseur JL, So A, Backhaus M, Malaise M, Burmester G, Schmidely N, Emery P, Dougados M: EULAR report on the use of ultrasonography in painful knee osteoarthritis. Part 2: exploring decision rules for clinical utility. *Ann Rheum Dis*. 2005; 64:1710-1714.
- Cicuttini F, Hankin J, Jones G, Wluka A: Comparison of conventional standing knee radiographs and magnetic resonance imaging in assessing progression of tibiofemoral joint osteoarthritis. *Osteoarthritis Cartilage* 2005; 13:722-777.
- Bruyere O, Genant H, Kothari M, Zaim S, White D, Peterfy C, Burlet N, Richy F, Ethgen D, Montague T, Dabrowski C, Reginster JY: Longitudinal study of magnetic resonance imaging and standard X-rays to assess disease progression in osteoarthritis. *Osteoarthritis Cartilage* 2007; 15:98-103.
- Vignon E, Piperno M, Le Graverand MP, Mazuca SA, Brandt KD, Mathieu P, Favret H, Vignon M, Merle-Vincent F, Conrozier T: Measurement of radiographic joint space width in the tibiofemoral compartment of the osteoarthritic knee: comparison of standing anteroposterior and Lyon schuss views. *Arthritis Rheum*. 2003; 48:378-384.
- Piperno M, Hellio Le Graverand MP, Conrozier T, Bochu M, Mathieu P, Vignon E: Quantitative evaluation of joint space width in femorotibial osteoarthritis: comparison of three radiographic views. *Osteoarthritis Cartilage* 1998; 6:252-259.
- Conrozier T, Favret H, Mathieu P, Piperno M, Provvedini D, Tacoen A, Colson F, Conrozier S, Vignon E: Influence of the quality of tibial plateau alignment on the reproducibility of computer joint space measurement from Lyon schuss radiographic views of the knee in patients with knee osteoarthritis. *Osteoarthritis Cartilage*

		Mean	SD	Maximum	Minimum
Reader 1	Conventional AP	3 mm	0,73 mm	4,2 mm	1,7 mm
	Dedicated PA	1,9 mm	0,61 mm	2,9 mm	0,4 mm
Reader 2	Conventional AP	2,9 mm	0,71 mm	4,2 mm	1,6 mm
	Dedicated PA	2 mm	0,63 mm	2,9 mm	0,4 mm

Table 2: Mean, standard deviation (SD), maximum and minimum values of FTW, measured by the two readers in the standard AP and modified Lyon-Schuss views.

2004; 12:765-770.

11. Radiography Working Group of the OARSI-OMERACT Imaging Workshop, Le Graverand MP, Mazzuca S, Lassere M, Guermazi A, Pickering E, Brandt K, Peterfy C, Cline G, Nevitt M, Woodworth T, Conaghan P, Vignon E: Assessment of the radio-anatomic positioning of the osteoarthritic knee in serial radiographs: comparison of three acquisition techniques. *Osteoarthritis Cartilage* 2006; 14 Suppl A:A37-43.

12. Merle-Vincent F, Vignon E, Brandt K, Piperno M, Coury-Lucas F, Conrozier T, Mathieu P, Hellio Le Graverand MP: Superiority of the Lyon schuss view over the standing anteroposterior view for detecting joint space narrowing, especially in the lateral tibiofemoral compartment, in early knee osteoarthritis. *Ann Rheum Dis.* 2007; 66:747-753.

13. Wolfe F, Lane NE, Buckland-Wright C: Radiographic methods in knee osteoarthritis: a further comparison of semiflexed

(MTP), schuss-tunnel, and weight-bearing anteroposterior views for joint space narrowing and osteophytes. *J Rheumatol.* 2002; 29:2597-2601.

14. Peterfy CG, Li J, Duryea J, Lynch JA, Miaux Y, Genant HK: Nonfluoroscopic method for flexed radiography of the knee allows reproducible joint space width measurement. *Arthritis Rheum* 1998; 41 Suppl 9:S361.

15. Mazzuca SA, Brandt KD, Buckwalter KA, Lequesne M: Pitfalls in the accurate measurement of joint space narrowing in semiflexed, anteroposterior radiographic imaging of the knee. *Arthritis Rheum.* 2004; 50:2508-2515.

16. Buckland-Wright JC, Macfarlane DG, Williams SA, Ward RJ: Accuracy and precision of joint space width measurements in standard and macroradiographs of osteoarthritic knees. *Ann Rheum Dis.* 1995; 54:872-880.

VALUTAZIONE QUANTITATIVA CON TECNICA ORTOSTATICA DELLO SPAZIO ARTICOLARE FEMORO-TIBIALE (SAF-T) MEDIALE. NOSTRA ESPERIENZA CON UNA PROIEZIONE DI LYON-SCHUSS MODIFICATA.

Nel periodo compreso tra settembre 2008 e febbraio 2009, un gruppo di 30 pazienti affetti da gonartrosi nota è stato sottoposto a valutazione radiografica del ginocchio. Per ogni paziente sono stati acquisiti due radiografie del ginocchio in ortostasi, la prima con tecnica standard antero-posteriore (AP) e la seconda con tecnica postero-anteriore (PA) con incidenza cranio-caudale di 10°. Le radiografie ottenute sono state valutate in cieco da due radiologi che hanno misurato l'ampiezza dello spazio articolare femoro-tibiale (SAF-T) mediale. Dall'analisi statistica dei risultati, eseguita utilizzando il test t di Student, è emersa una differenza statisticamente significativa circa i valori dello SAF-T tra le due proiezioni (t= 5,2331 per il primo radiologo e t=5,1970 per il secondo). In conclusione, riteniamo che la proiezione dedicata PA del ginocchio sia migliore di quella standard AP per una corretta valutazione dello SAF-T mediale.

Parole chiave: Ginocchio, Radiografia, Sotto-carico.

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