

# A comparison of the semiflexed (MTP) view with the standing extended view (SEV) in the radiographic assessment of knee osteoarthritis in a busy routine X-ray department

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**Objective.** To compare the reproducibility of the standing extended view (SEV) (also known as the standing anteroposterior view) with the semiflexed, postero-anterior view [the ‘metatarsophalangeal’ (MTP)] view for assessing joint space width (JSW) and osteophytes in osteoarthritis of the knee when used in a busy routine X-ray department.

**Methods.** Forty-seven patients (24 men) had both SEV and MTP views taken on the same day in a busy National Health Service radiography department. Repeat views were taken as entirely separate procedures some time over the following 2 weeks, in the same department and with no special arrangements for the selection of radiographers, time of day, or X-ray machine. The first 24 patients had second views in the SEV position whilst the remaining 23 had second MTP views. Radiographs were read independently by two experienced observers who measured JSW with a transparent ruler to the nearest 0.5 mm at the narrowest point in both medial and lateral compartments of the tibiofemoral joint in both knees. Osteophytes were graded 0–2 according to a standard atlas. Ten SEV and 10 MTP radiographs selected randomly were re-read by one observer.

**Results.** Mean (95% confidence interval) JSW in the medial compartment measured on SEV radiographs was 3.54 mm (3.08, 3.99) and on MTP radiographs it was 2.80 mm (2.37, 3.23); in the lateral compartment it was 6.04 mm (5.71, 6.37) when measured on SEV radiographs and 5.47 mm (5.09, 5.85) on MTP radiographs. The estimated variances for the medial compartment were 2.0 mm<sup>2</sup> for SEV and 0.2 mm<sup>2</sup> for MTP ( $P < 0.001$ ) and for the lateral compartment 1.4 mm<sup>2</sup> for SEV and 0.5 mm<sup>2</sup> for MTP ( $P < 0.001$ ). The proportion of radiographs for which there was disagreement between observers regarding osteophyte grade was not statistically different between SEV and MTP views (SEV, medial 40%, lateral 44%; MTP, medial 39%, lateral 39%).

**Conclusions.** Even when radiographs are taken in a busy National Health Service radiography department, measurement of JSW from the MTP view is more reproducible than from the SEV view, the MTP view gives a slightly lower measurement of JSW, and there is no advantage in using either view in recording osteophyte grade. We recommend the wider adoption of the MTP method.

KEY WORDS: Osteoarthritis, Knee, Joint space width, X-ray.

Osteoarthritis (OA) of the knee joint is expensive in human and socio-economic terms [1–3] and is a major burden on public health-care resources in both the developed [4] and the developing world [5]. Effective appraisal of the severity and rate of progress of the disease is consequently important in both clinical management and research. These parameters are frequently measured by change in radiographic features.

Joint space width (JSW) is a widely used surrogate measure of cartilage thickness which typically decreases as cartilage is lost as a consequence of disease progression. Osteophyte assessment has been shown to be more reproducible than other radiographic features both within and between observers [6]. These features were employed in this study to examine reproducibility and systematic measurement bias.

Assessments should be based upon radiographic techniques that are the most accurate and reproducible. Until recently, weight

bearing anteroposterior X-rays of the tibiofemoral joint using the standing extended view (SEV) (also known as the standing anteroposterior view) have been preferred to adequately measure JSW [6, 7]. The semi-flexed, postero-anterior view [the ‘metatarsophalangeal’ (MTP) view] has been reported to give more accurate and more reproducible assessments than the SEV under controlled conditions [8–10]. However, it would be valuable to know if this benefit was maintained when the MTP view is used in a busy routine X-ray department, where most knee radiographs will be obtained in clinical practice. We therefore compared these two methods in such a department in patients with knee OA.

## Patients and methods

Following approval by the Local Research Ethics Committee and with informed consent, 47 patients (24 men) who were already

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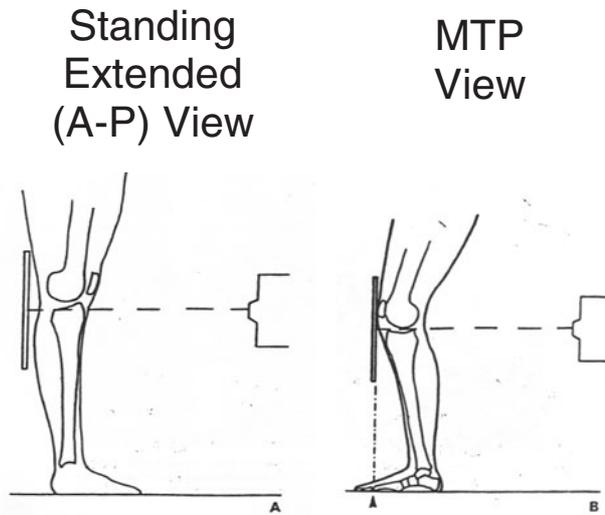


FIG. 1. Diagram provided by C. Buckland-Wright to illustrate positioning in (A) the SEV and (B) the MTP view.

undergoing radiographic assessment of knee OA as part of another study using the SEV were invited to take part in the comparative study. Each patient had both SEV and MTP views taken on the same day in the routine radiography department. Repeat views were taken as entirely separate procedures some time over the following 2 weeks, again in the routine radiography department and with no special arrangements for the selection of radiographers, time of day, or X-ray machine. The first 24 patients had second views in the SEV position whilst the remaining 23 had second MTP views.

The SEV was taken with the patient standing upright in front of the film cassette, facing the X-ray beam with the back of the thighs touching the cassette. The beam was aimed horizontally at the joint line as identified by the radiographer (Fig. 1A).

The semiflexed (MTP) view was taken as originally described [9]. The X-ray tube was positioned so that the central beam was horizontal and perpendicular to the X-ray film. (Fig. 1B) The radiographic technician identified the position of the tibiofemoral joint space located midway between the inferior border of the patella and the superior margin of the tibial tuberosity. The line of the joint space is traced around to the side of the knee and the skin marked with a felt tip pen. This mark is used to help align the centre of the X-ray beam with the joint space. The patient stands with both knees facing the film cassette, with the feet slightly externally rotated at about 15°. The first metatarsophalangeal joint of each foot is positioned immediately below and in line with the front edge of the film cassette. The patient bends the knees at about 7–10° so that the anterior surface of each knee touches the middle and front of the film cassette. The tube is positioned so that the X-ray beam is directed midway between the popliteal surfaces of the knees and the positioning light is aligned with the horizontal plane of the joint space (described above). The plane lies above the horizontal skin crease of the popliteal fossa.

After all patients had completed the study, radiographs were read independently by two experienced observers (JRK, BS) in random order and with all identifying marks obscured. JSW was measured with a transparent ruler to the nearest 0.5 mm at what was judged to be the narrowest point in both medial and lateral compartments. Occasionally JSW differed by 2 mm or more between observers. In these cases there was usually disagreement about which lines on the radiograph to use for the measurement of joint space width and the measurements were replaced by those of a third observer (SC), who was unaware of the original measurements. Osteophytes were graded 0–2 according to a standard atlas

[11]. Ten SEV and 10 MTP radiographs selected randomly were re-read by one observer (JRK).

In the statistical analysis, knees have been considered independent. For each compartment in each knee, measurement variance was calculated by first estimating the real value of JSW using an algorithm which uses all available observations to estimate the true value of JSW for each knee, based on a weighted mean of the SEV and the MTP methods and employing an iterative procedure to converge on the best estimate of variance (supplementary data available at *Rheumatology Online*) [12]. Estimates of variance were compared using the Fisher test. The  $\kappa$  statistic was used to assess osteophyte grading between observers for each radiographic technique. The  $\chi^2$  test was employed to determine whether the proportion of osteophyte observations varying by 1 grade or more was different between the techniques.

## Results

Five knees had undergone total knee replacement surgery at the time of these radiographs, resulting in 89 knees for comparison. Mean [95% confidence interval (CI)] JSW in the medial compartment measured on SEV radiographs was 3.54 mm (3.08, 3.99) and on MTP radiographs it was 2.80 mm (2.37, 3.23), and in the lateral compartment it was 6.04 mm (5.71, 6.37) when measured on SEV radiographs and 5.47 mm (5.09, 5.85) on MTP radiographs. Convergence for calculating the variances in JSW was reached between 12 and 18 iterations. The estimated variances for the medial compartment were SEV 2.0 mm<sup>2</sup> and MTP 0.2 mm<sup>2</sup> and for the lateral compartment SEV 1.4 mm<sup>2</sup> and MTP 0.5 mm<sup>2</sup>. The difference between the reproducibility of assessments made using the SEV and MTP methods is statistically significant for both compartments ( $P < 0.001$ ).

A comparison of the difference between the methods against the best estimation of the real value of JSW is shown in Fig. 2. A linear regression showed that difference was approximately constant since the coefficient was not significant.

There was no significant difference in the reproducibility of observers for detecting osteophytes between the SEV and MTP views, as shown by the  $\kappa$  score (medial MTP,  $\kappa = 0.61$ , SEV  $\kappa = 0.59$ ; lateral MTP,  $\kappa = 0.61$ , SEV  $\kappa = 0.55$ ). The proportion of radiographs for which there was disagreement between observers regarding osteophyte grade was not statistically different between SEV and MTP views. In the SEV view there was disagreement in 40% of medial compartments and 44% of lateral compartments, while in the MTP view these figures were 39 and 39% respectively [medial,  $\chi^2(3) = 5.6$ ,  $P = 0.13$ ; lateral,  $\chi^2(3) = 3.7$ ,  $P = 0.30$ ].

## Discussion

In the setting of a busy National Health Service (NHS) radiology department, the MTP view provides radiographs from which measurement of JSW is more reproducible compared with the standard SEV view. This finding confirms and generalizes similar reports for controlled experimental conditions [8, 9] and for carefully conducted randomized controlled clinical trials [10]. Similar results were achieved in a large cohort study [13], which also found no overall difference in the detection of osteophytes. The implication is that more accurate clinical assessment of JSW will allow better judgement of the stage and progress of knee OA in routine clinical practice.

The importance of comprehensive radiographer training in the use of the MTP view has been vigorously stressed [9, 10]. In their comparison of radiographic methods in 1175 paired radiographs, Wolfe and colleagues noted that 'Careful attention was given to proper positioning' [13]. Whilst it seems obvious that training will underpin accuracy and reproducibility, the practicalities of the conditions relating to this study allowed only minimal training and

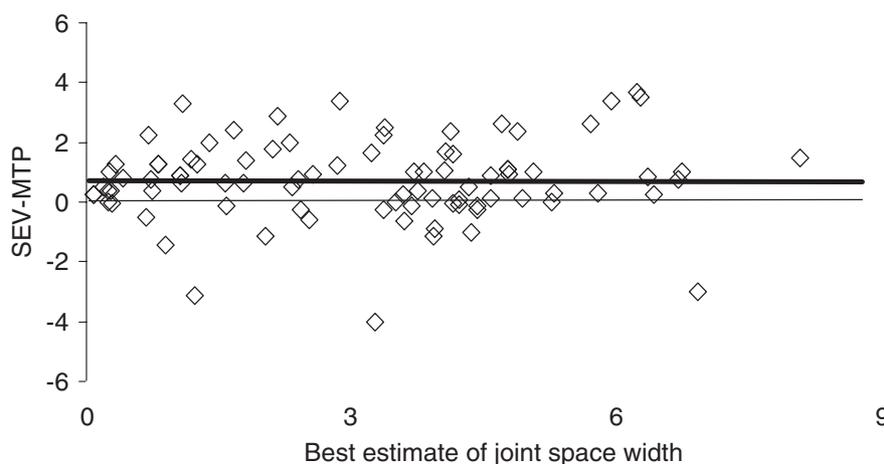


FIG. 2. Bland and Altman plot [14] of differences between MTP and SEV joint space width. The best estimate of joint space width is based on weighted mean value by iterative techniques (see text). Medial JSW measured by MTP is a mean of 0.74 mm lower than that measured by SEV ( $P < 0.001$ ).

quality control. Although a full protocol was provided, in practice only an abbreviated form of the protocol for the MTP view was pinned to the wall of the radiography rooms, alongside all the other standard procedures. Intermittent incidental observations of the procedure in practice during the study and informal discussions with some of the radiographers after the study had been completed showed that sometimes little attention was paid to the rotation of the feet and that the joint line was infrequently marked on the skin. Nevertheless, the films produced in the MTP view did significantly improve on the measurement characteristics for JSW. It may be that there are factors in the MTP technique itself that make it inherently more accurate and more reproducible than the more usual SEV. There were no differences in the identification of osteophytes between the two radiographic views. This may be because osteophytes are inherently more easily identified than JSW, or because the rating scale was very abbreviated (0–2), or a combination of the two. It is possible that a larger study might detect some differences.

In conclusion, even when radiographs are taken in a busy NHS radiography department, measurement of JSW from the MTP view is more reproducible than from the SEV view, the MTP view gives a slightly lower measurement of joint space width, and there is no advantage to either view in recording osteophyte grade. We recommend the wider adoption of the MTP method.

The authors have declared no conflicts of interest.

### Supplementary data

 Supplementary data are available at *Rheumatology* Online.

### References

- Spector TD, Hart DJ. How serious is knee osteoarthritis? *Ann Rheum Dis* 1992;51:1105–6.
- Leigh JP, Fries JF. Arthritis and mortality in the epidemiological follow up to the National Health and Nutrition Examination Survey I. *Bull NY Acad Med* 1994;71:69–86.
- McAlinden TE, Cooper C, Kirwan JR, Dieppe PA. Knee pain and disability in the community. *Br J Rheumatol* 1992;31:189–92.
- Badley EM. The effects of osteoarthritis on disability and health care use in Canada. *J Rheumatol* 1995;22(Suppl. 43):19–22.
- Murray CJ, Lopez AD. Alternative projections of mortality and disability by cause 1990–2020: Global Burden of Disease Study. *Lancet* 1997;349:1498–504.
- Cooper C, Cushnaghan J, Kirwan JR, Dieppe PA, Rogers J, McAlindon T, McRae F. Radiographic assessment of the knee joint in osteoarthritis. *Ann Rheum Dis* 1992;51:80–2.
- Dacre JE, Cushnaghan J, Jack MJ, Kirwan JR, Dieppe PA. Knee X-rays: Should we take them lying down? *Br J Rheumatol* 1991;30(Suppl. 1):3.
- Buckland-Wright C, Macfarlane D, Williams S, Ward R. Joint space width measured more accurately and precisely in semiflexed than extended view of OA knees. *Br J Rheumatol* 1997;34:232–3.
- Buckland-Wright C, Wolfe F, Ward R, Flowers N, Hayne C. Substantial superiority of semiflexed (MTP) views in knee osteoarthritis: A comparative study, without fluoroscopy, of standing extended, semiflexed (MTP) and Schuss views. *J Rheumatol* 1999;26:2664–74.
- Buckland-Wright JC, Bird CF, Ritter-Hrncirik CA *et al.* X-ray technologists' reproducibility from automated measurements of the medial tibiofemoral joint space width in knee osteoarthritis for a multicenter, multinational clinical trial. *J Rheumatol* 2003;30:329–38.
- Altman RD. Atlas of individual radiographic features in osteoarthritis. *Osteoarthritis Cartilage* 1995;3(Suppl. A):3–70.
- Myers RH. The Gauss-Newton procedure for finding estimates. In: *Classical and modern regression with applications*. Boston (MA): Duxbury Press, 1986.
- 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;29:2597–601.
- Bland M, Altman D. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986;1:307–10.