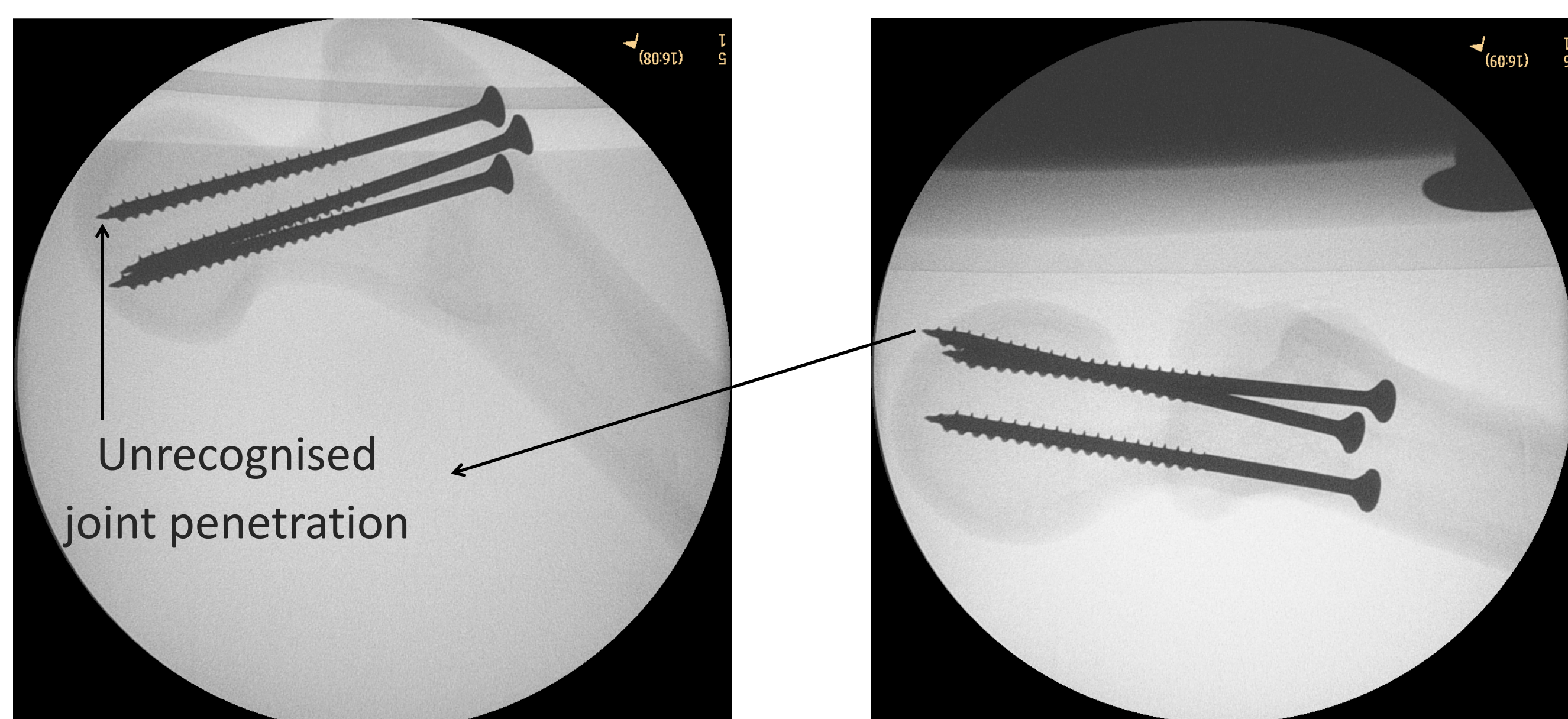


Context

- Internal fixation of femoral head → Screw positions are difficult to assess on standard 2D radiographs
- Femoral head has a spherical shape → Joint penetration could be unrecognised^{1,2,3}



Objective

To propose a new semi-automatic detection method of joint penetration based on standard radiographs

Materials and methods

Our method is based on the Euclidean coordinates of a point in 3D and the computation of the tip-to-surface distance (TSD)¹

1. Feasibility study on simulated 3D cases

- Five 3D simulated cases of internal screw fixation of femoral head from CAD software, with theoretical TSD computed for each case.
- Two perpendicular snapshots of each case → simulate radiographs

Two operators performed manual identification of the screw tips on simulated radiographs :

- TSDs were computed and compared to theoretical TSDs.
- Correlation coefficient between the two operators was computed

We also used MATLAB® to make an easy-to-use graphic user interface for the method

2. Feasibility study on simulated radiographic cases

Internal fixation on two Sawbones orthopaedic models of femur with non-surgical screws.



MicroScribe® 3D digitizer system :
→ 3D geometry

Philips® BV Pulsera mobile fluoroscopy system
→ Radiographs of the femur models.

Radiographs were processed with our software and results compared to references from the 3D digitizer

Results

1. Feasibility study on simulated 3D cases

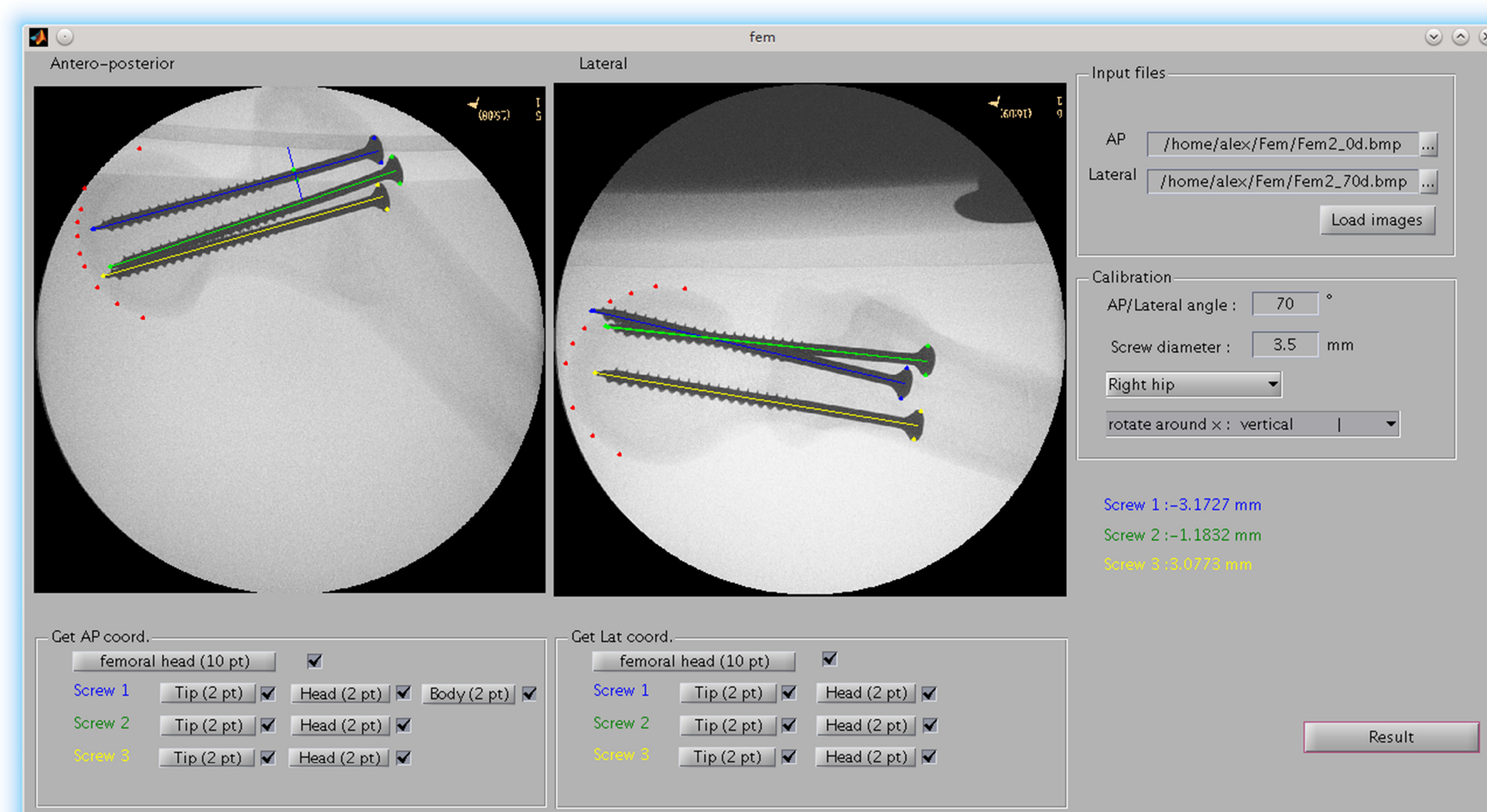
- Correlation coefficient between the two operators was 0.96
- Maximum difference between reference and semi-automatic method was 1.2 mm
- All penetrated screws were detected
- No unpenetrated screw was considered as a penetrating screw

Simulated 3D case	Tip-to-surface distance (TSD)		
	Reference measurements (mm)	Semi-automatic measurements (mm)	Difference (mm)
1	0.5	0.2	0.3
2	-5.5	-5.8	0.3
3	2.3	2.3	0.0
4	-3.0	-3.9	0.9
5	-1.5	-2.7	1.2

2. Feasibility study on simulated radiographic cases

- All penetrated screws were detected
- No unpenetrated screw was considered as a penetrating screw

New software



Discussion

This study showed the feasibility to detect joint penetration during simulated internal screw fixation of femoral neck fracture by using intraoperative 2D radiographs to identify the position of the inserted screw tip and compute the 3D distance relative to the articular surface of the hip joint.

Although these results clearly have to be validated clinically, they may be straightaway useful to assess the level of accuracy that the detection method needs to be provided with, particularly in terms of the screw tip identification performed intraoperatively by the operator.

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