

RADIOLOGICAL ASPECTS IN PREOPERATIVE PLANNING AND POSTOPERATIVE ASSESSMENT OF CEMENTLESS TOTAL HIP ARTHROPLASTY

L. LINCLAU¹, G. DOKTER¹, P. PEENE²

Some radiographic aspects in the preoperative measurement of prosthetic component size in cementless total hip arthroplasty were evaluated, primarily the magnification factor of the x rays. The influence of femoral rotation on the assessment of the pre- and postoperative AP x rays was investigated.

Keywords : cementless ; hip ; prosthesis.

Mots-clés : sans ciment ; prothèse ; hanche.

INTRODUCTION

Preoperative determination of optimum implant size is very important in total hip replacement, especially in cementless total hip replacement and particularly in press-fit cementless systems.

For the preoperative assessment of component size, templates are generally used on anteroposterior (AP) and axial x rays. As templates have a standard magnification of 15% or 20%, it is important that the preoperative x rays show the same magnification, principally on the AP x ray.

Furthermore, as many patients with osteoarthritis of the hip have an external rotation deformity, it is helpful to know if the rotational position of the femur may influence the radiological measurement of the femoral component size.

The rotation of the femur might even influence the postoperative radiological assessment of the size and the position of the prosthesis. Finally, it is apparent that on a standard postoperative AP x ray, the seating of the socket is often difficult to estimate (fig. 3).

MATERIAL AND METHODS

In 30 consecutive cementless, press-fit total hip replacements, type Zweymüller (6), we performed measurements on the following pre- and postoperative x rays :

— preoperative :

AP, in neutral rotation and with a magnification of 10%, 15% and 20%.

AP, with 15% magnification in neutral position and in external and internal rotation of 25°.

Axial x ray (frog lateral x ray).

— postoperative :

AP, in neutral rotation and external and internal rotation of 25°.

AP, focused on the acetabular socket, with 15° to 20° of inclination from cranial to caudal (acetabular view).

Axial x ray.

The Zweymüller total hip system includes 12 different femoral sizes. There are 7 acetabular component sizes, 3 head-neck lengths and 2 head diameters of 28 mm and 32 mm. The magnification of the templates is 15%.

The exact magnification of the AP x rays is measured by holding a 10-cm radio-opaque marker at the level of the patient's hip. When this 10-cm marker gives a projection of 11 cm on the x ray, the magnification is 10%, 11.5 cm is 15%, 12 cm is 20%.

¹ Eeuwfeestkliniek, Department of Orthopaedics, Harmoniestraat 68, 2018 Antwerpen, Belgium.

² Eeuwfeestkliniek, Department of Radiology, Harmoniestraat 68, 2018 Antwerpen, Belgium.

Correspondence and reprints : L. Linclau.

If rotation of the hip was not possible, this was simulated by a slight tilting of the pelvis, without changing the distance of the hip to the film.

The axial x ray is important for appraisal of the anterior curvature of the femur. The postoperative acetabular view is made with an inclination of 15° to 20°, as the acetabular component should be implanted with the same degree of anteversion.

RESULTS

It appears extremely difficult to get an x ray with the requested *magnification*. In general there is a strong tendency to over-magnification.

- of the 30 x rays with a desired magnification of 10%, 4 were exact and 26 too large, with a maximum of 20%.
- of the 30 x rays with a required enlargement of 15%, 3 were precise, 3 had less magnification and 24 were too large, with a maximum of 23%.
- of the 30 x rays with a requested magnification of 20%, 4 were accurate, 3 had less and 23

too much magnification, with a maximum of 29% (table I).

Moreover we found that for the Zweymüller prosthesis an enlargement of 5% (0.5 cm on the x ray marker) corresponds to one size difference of the femoral stem.

Concerning the *femoral rotation*, in the pre-operative measurement we found little difference between neutral position and external rotation of the femur. In 26 cases the same size of femoral stem prosthesis was measured. In internal rotation however, we measured larger femoral stem sizes in all cases (table II), as the projection of the femoral canal on the x ray is wider in internal rotation (fig. 1).

In the postoperative assessment of the size and the position of the prosthesis, in external rotation the femoral stem appears in valgus position with the tip of the prosthesis near the medial femoral cortex, while in internal rotation the stem seems more in varus, with the tip of the prosthesis near the lateral cortex (fig. 2). Additionally in internal rotation, in many cases the impression exists that the size of the prosthesis is too small.

Table I. — Percentage magnification measured on the AP x ray (n = 30)

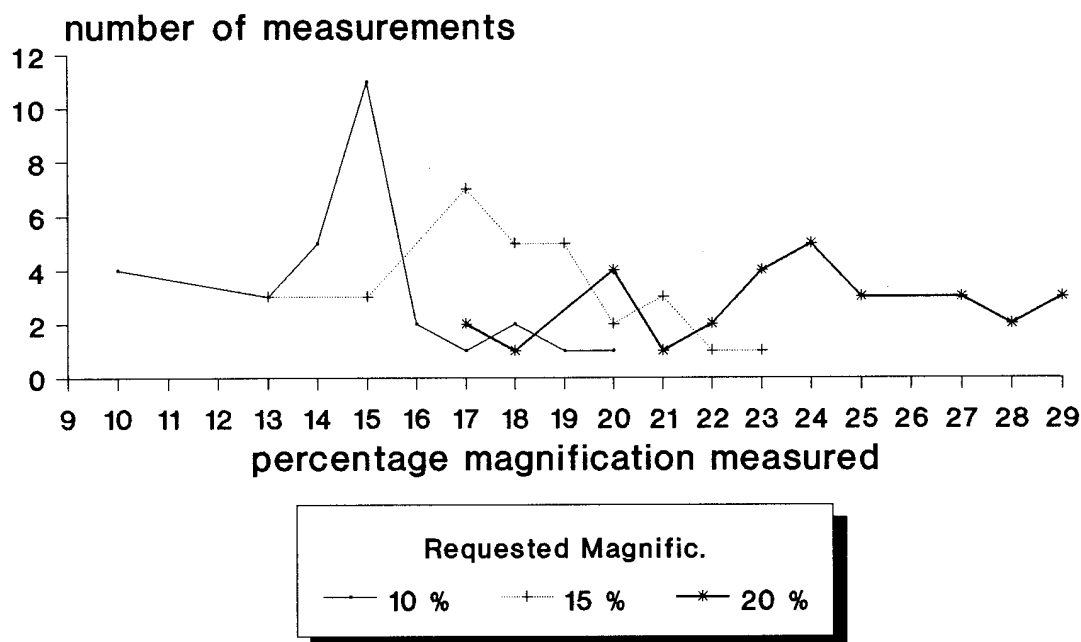
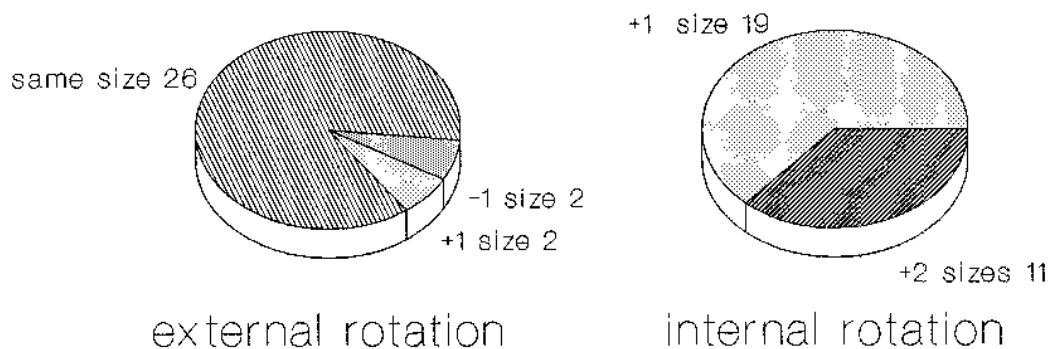


Table II. — Femoral component size dependent on femoral rotation (n = 30)



(same size = size in neutral rotation)

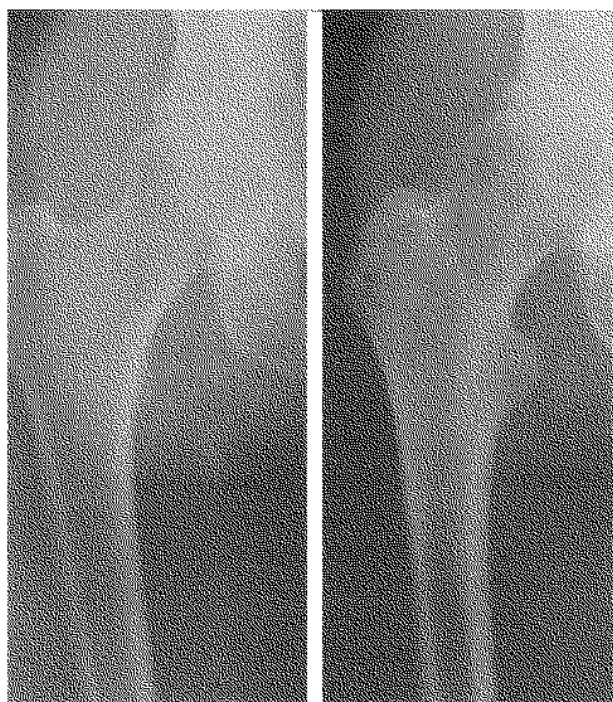


Fig. 1. — The same hip in internal and external rotation. The femoral canal is wider in internal rotation.

At surgery, in all patients the femoral stem size was inserted as measured or calculated pre-operatively. The postoperative x rays showed that the correct stem size was used in all instances.

Finally, the postoperative AP acetabular view gives a much better impression of the implantation and bony covering of the acetabular component than the standard AP x ray (fig. 3).

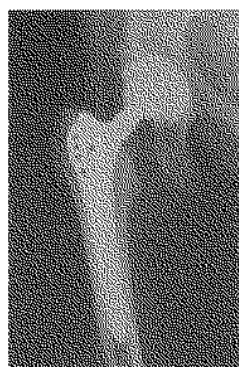


Fig. 2a

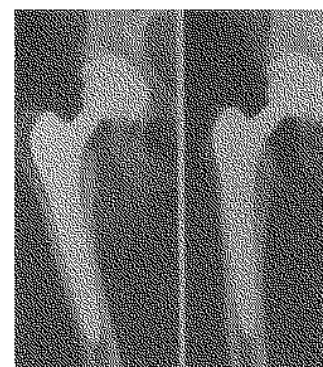


Fig. 2b

Fig. 2a. — Total hip prosthesis in neutral rotation.
 Fig. 2b. — The same hip in internal and external rotation. In internal rotation the stem seems to be more in varus, while in external rotation a valgus position is simulated.

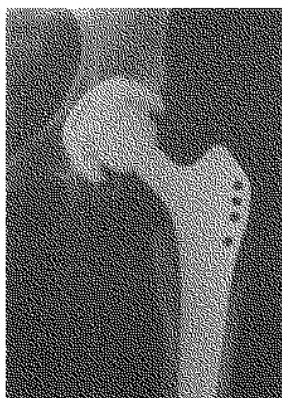


Fig. 3a

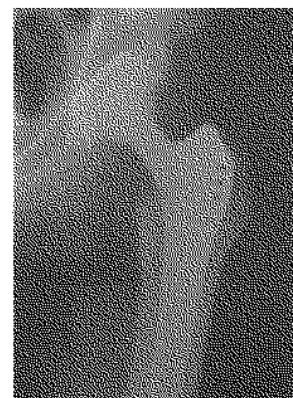


Fig. 3b

Fig. 3a. — standard AP x ray.
 Fig. 3b. — „Acetabular view”, with an inclination of 15° to 20°.

DISCUSSION AND CONCLUSIONS

The primary motive for the development of cementless fixation of implants is to improve the long-term prospects (4). Therefore two prerequisites are essential: intimate apposition and rigid initial fixation.

Noncemented acetabular fixation is accomplished with threaded sockets or with adjunctive fixation such as screws or pegs. At this time, some (1) prefer to use a press-fit socket with no threads or screws, but with the acetabulum underreamed from 1 mm to 3 mm.

Cementless fixation of femoral components is dependent on two factors. The most important is the geometry of the implant, and the second is the surface finish. Two common but quite different designs are: an anatomic-shaped stem and a straight stem. An anatomic-shaped stem is best used with proximal fixation and a straight stem with distal fixation in the femur.

For the successful application of cementless implants, the exact component size is crucial. The exact component size not only determines the appropriate leg length and muscle tension but also the stability of the implant.

Component size selection for the acetabulum is generally rather easy, and the final decision can be made at surgery, when the three-dimensional aspect of the acetabulum is visualized (3). Conversely, the selection of the femoral component largely depends on an accurate preoperative radiological measurement, as intraoperative determination of the „fit and fill” of the femoral component is difficult to perform. Furthermore, the fitting of the femoral component for a cementless hip must be more precise than for a cemented hip. The stem of the femoral component should fill, or nearly fill, the medullary canal on the AP x ray. Therefore preoperative radiological measuring of the component size is very important.

Nevertheless, it is not easy to make an x ray with the exact *magnification*, as the size of the femur will vary depending not only on the distance from the x ray source to the film, but also on the distance from the patient's hip to the film. Large and obese patients will have greater magnification.

In 40% of the preoperative x rays, the desired magnification was exceeded by a minimum of 5%. However, in these cases where the x ray magnification is not correct, it is possible to calculate the precise size of the femoral component on condition that the exact enlargement of the x ray is known by considering that a 5% excess in magnification corresponds to one size of the femoral component, at least for the Zweymüller prosthesis. Therefore the use of a radiopaque x ray marker is indispensable.

Furthermore, the pre- and postoperative x rays should be made in neutral *rotation* and without any tilting of the pelvis. This can best be achieved when the patient's knees are flexed 90° over the edge of the x ray table.

Internal rotation of the femur especially can influence the preoperative measurement. In the postoperative assessment, external rotation gives the impression of a valgus position of the prosthesis. Internal rotation can simulate a varus position of the femoral stem, while in many instances the prosthesis seems too small for the femoral canal.

The determination of anteversion of the acetabular component in cemented total hip arthroplasty, using fluoroscopy and biplanar methods, has been described (2, 5). Nevertheless, the postoperative *acetabular view* is a simple method, which is very useful to estimate the seating and covering of the acetabular component. The degree of tilt necessary to close the open face of the socket on the AP x ray corresponds to the degree of anteversion of the acetabular component.

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SAMENVATTING

L. LINCLAU, G. DOKTER, P. PEENE. Röntgenologische aspecten in de preoperatieve planning en de postoperatieve beoordeling van cementloze totale heup prothesen.

Enkele radiologische aspecten, voor het bepalen van de maat van cementloze heupprothesen, worden besproken. In het bijzonder wordt hierbij aandacht besteed aan de vergrotingsfactor van de röntgen opnamen. De invloed van de rotatie van het femur op de pre- en post-operatieve voor-achterwaartse röntgenfoto's werd onderzocht.

RÉSUMÉ

L. LINCLAU, G. DOKTER, P. PEENE. Aspects radiologiques de la planification pré-opératoire et de l'évaluation post-opératoire des prothèses de hanche non cimentées.

Les auteurs discutent quelques aspects radiographiques de la planification pré-opératoire, destinée à définir les dimensions des différents éléments des prothèses de hanche non cimentées.

On tient particulièrement compte, dans cette étude, de l'agrandissement radiographique.

L'influence de la rotation du fémur sur les images de face, en pré- et postopératoire est analysée.