HIP ELECTION RADIOGRAPHIC PLANE 
IN TOTAL HIP PROSTHESES WITH 
FEMORAL NECK PRESERVATION

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Abstract

Background: In the preoperative planning of the hip prosthesis the radiography of the pelvis on which to plan the surgery remains the routine exam which helps the surgeon to make a correct implant; however, in some institutes, there are 2D-3D instruments and computerized navigators, which are able to plan the surgery. Dedicated radiographs can show the neck, on which to plan the level of subcutaneous resection (isthmus), the size of the component, the correction of the leg lengthening.

Material & Method: the Hip Election Radiographic Plane (HERP) of the hip is a particular radiographic projection "dedicated" to the best view of femoral neck, important for a correct planning of the implant with neck preservation. The x-ray, performed with a device that links the pelvis and not only the lower limb with the rigid hip, allows the entire femoral neck to be extracted in its chosen plane. A sample of 20 patients underwent standard X-ray and HERP X-ray, and then compared the planning data with the implant.

Results: the result concerning preoperative planning on standard X-ray and on HERP X-ray highlights the greater reliability of the second about the identification of the isthmus and the choice of the size.

Conclusions: the research of the HERP is the "dedicated" planning for the wnp prostheses, but useful for every other type of prosthetic femoral component, to make a plant as correct as possible.

Keywords
planning, election x-ray plane, magnification, total hip prosthesis

Introduction

Preoperative pelvic radiography is essential for preoperative planning of total hip replacement. It is easy to make compared to 2D or 3D computer evaluations¹. With radiographs and with known magnification (average magnification of 15%) is possible to evaluate different parameters: limb heterometry, acetabular and especially femoral dysmorphism, to foresee possible complementary surgical times²; with the templates then you can choose the type and size of the prosthesis. In prostheses with neck preservation (wnp) a complete visualization of the femoral neck is essential to confirm either the correct indication of prosthesis or the correct size of the stem³⁻⁵. The anteversion of the femoral neck is difficult to radiographic evidence with the simple intrarotation of the lower limb, especially when the arthrosic hip is rigid. The Hip Election Radiographic Plane of the hip (HERP) and of the proximal third of the femur allows the complete radiographic view of the neck of the femur⁶ and supports the standard radiography of the pelvis for the preoperative planning. A sample of patients operated on wnp hip arthroplasty was studied, using for planning the standard X-ray of the pelvis and the HERP projection and comparing the data with those of the realized implant.

Material and Method

The HERP X-ray is the radiographic projection in anterior-posterior and in internal rotation of the full hip, which allows the best possible visualization of the femoral neck, in its morphology and morphometry; it has a particular importance in the wnp stems, such as the CFP (Link) prosthesis, used by us. These stems are indicated if the femoral neck has normal morphology and morphometry; the arthrosic hip is rigid or subanchilotic in extra rotation and it is not possible to highlight the neck well in the standard radiographs of the pelvis²⁻⁵,⁶. Therefore the patient is positioned with an indifferent and therefore not painful rotation, and the inclined plane achieves an internal rotation of the hip in a "programmed" way, for values of 30⁰ (Fig.1). Increasing the distance of the pelvis from the X-ray film can result in an enlargement of the image, evaluated by means of a metal plate of known dimensions placed on the radiograph⁶. The X-ray of the HERP highlights all the femoral neck on its frontal plane of choice, allowing to identify well the isthmus of the neck, that is the point of passage between the cortical of the femoral head and the cortical of the neck laterally. From this point a line is drawn perpendicular to the neck of the femur, that is the subcapital resection line. The collar of the stem coincides with the resection line and the correspondence of the medial curvature rays and the central position of the tip of the stem in the femoral canal are evaluated (Fig.2,3). This confirms the correct indication to the implant of the wnp prosthesis, evaluates the appropriate choice of the size of the stem,
always considering the radiographic magnification due to the presence of the inclined plane. On the standard X-ray of the pelvis, the heterometry of the hips, the center of rotation, the choice of the cup size and the length of the head for the compensation of the leg lengthening can be evaluated; moreover, the cortical-index\(^7\) and the flaire-index\(^8\) can be evaluated.

**Case Material**

On 20 patients, who underwent total hip replacement with a stem with neck preservation (CFP-Link), between the ages of 50 and 70, the radiographic procedure described was applied. Patients with dysplastic, post-traumatic and post-arthritic coxarthrosis were excluded for a possible alteration of the neck morphology and therefore for an imperfect indication of this prosthesis. The patients performed the standard x-ray of the pelvis, with the intra-rotation of the limb to be operated and the radius? HERP with an angular thickness of 30°.

On both radiographs the general planning for the implantation of the wnp prosthesis was carried out, first of all evaluating the isthmus for the resection and the size of the stem, in addition to the heterometry, the rotation centre and the cup size. Preoperative data on the measurement of the isthmus and the size were compared with the post-operative radiograph performed in the correct intra-rotation, verifying the correspondence.

Statistical analysis were performed using Graph Pad PRISM version 5.02. Non-parametric tests were used for the statistical analysis. The Mann-Whitney U test was performed to compare unpaired groups of variables and the Kruskal-Wallis test to compare continuous variables with nominal variables with more than two levels. The Spearman rank correlation test was used to search for any relationships between variables, along with linear regression tests. Any p-values lower than 0.05 were considered statistically significant. The results are reported as mean along with standard deviation (SD).

**Results**

Tab. I summarizes the comparison data with the two radiographic procedures versus the characteristics of the intra operative implant with regard to the identification and measurement of the isthmus on the side of the neck and the correspondence of the size of the stem. A constant non-correspondence in the measurement of the isthmus of the femoral neck at the lateral level with respect to the post-operative datum is evident on the standard radiograph. The mean value of the observed isthmus was on average less than the 2-3 mm post-operative data for the incomplete visualization of the lateral side of the femoral neck.

On the other hand, a static significance of the data detected on the HERP X-ray emerged in comparison with the post-operative with discordantly average values of 1 mm. About the size of the prosthesis showed that the choice made in the HERP X-ray and implanted size was equal to 100%, proving that the 30° of hip intra rotation did not involve a distortion and a magnification of the X-ray image. From a statistical point of view, the values related to the Rx Standard Lateral istmus were equal to 1,475 ± 0.323 versus The values of Implant Lateral istmus 1,537 ± 0.0268 (p = 0.0121); The values of Rx PREA Lateral istmus were equal to 1,630 ± 0.262 versus The values of implant Lateral istmus 1,537 ± 0.0268, (p <0.0001); the correspondence between Stem Size in the Rx PREA was equal to 29 ± 0.230 versus the stem size implant values equal to 29 ± 0.230 (p>0.0001).

**Discussion**

In hip prosthesis, neck preservation contributes to the mechanical stability of tri-planar and especially rotational femoral stems, as this simultaneously occupies two non-coaxial bone cylinders (neck and diaphysis)\(^3\)\(^-\)\(^5\). The indication to neck preservation is subordinated to the integrity of the neck itself and to its correct radiographic evaluation.

In order to visualize the femoral neck of a normal hip in the radiograph, it may be enough to intraditate the entire lower limb. Such a maneuver is often not sufficient in the arthritic, rigid or sub-ankylotic hip, and positioning errors and sizing of the stem are possible.
Some authors have chosen the standard magnification radiograph to match the templates. The small trocantere is also considered important for the recognition of the femoral anteversion; Worliceck et al. have documented this correspondence through a CT study, overturned, through a mathematical formula, on pelvic radiographs, of routine use in the operating room.

The proximal epiphysis of the femur presents in the radiograph morphometric variations, depending on the rotation of the femur; the proximal medial curvature radius of the femur, for example, varies according to the 61.6 mm Authors in internal rotation at 73.7 mm in external rotation; the distal femoral canal width is from 9.7 mm in neutral position to 11.0 in internal rotation position. On the contrary, about the correct size of the stem Knight and Atwater they estimated 42% the correspondence between the implanted stem and the stem programmed in the preoperative planning.

3D planning made it possible to choose the stem size more accurately than the 2D model, improving the standard of results, but without finding a routine application and increasing the costs of the preoperative procedure. The reliability of non-cemented THA digital models is good for acetabular and femoral components, provides surgeons with a valuable tool for preoperative planning, but can not replace intraoperative assessment and final decision. The preoperative radiographs of the pelvis remain the basic instrumental examination in the routine; computerized tests or CT are used in special cases to optimize the significance of the results.

The HERP X-ray completes the radiographic set necessary for proper preoperative planning, especially in wnp stem implants. Stigler et al. have corroborated this concept, supporting the radiographic planning of the hip with the addition of a vision of the hip to be operated in addition to the rx of the pelvis. This additional anteroposterior radiograph increases the accuracy of preoperative planning in the total hip prosthesis. Our contribution highlighted the need for a radiograph of the arthritic hip that allows a correct implantation of wnp prostheses, which are peculiar in the design and in the biomechanical concept. These prosthetic stems require a specific X-ray study for proper housing in the femur.

In conclusion, in the implant of a total hip replacement the standard radiographs necessary for preoperative radiographic planning must have technical requirements (quality, enlargement, projections) for the correct planning of the intervention about the implant to be implanted and the surgical times to be performed. The HERP X-ray represents a “dedicated” planning moment for prostheses with wnp, in routine surgery planning.
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