



Assisted Preoperative Planning in Total Hip Arthroplasty to Reduce Leg Length Discrepancy

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1. Introduction

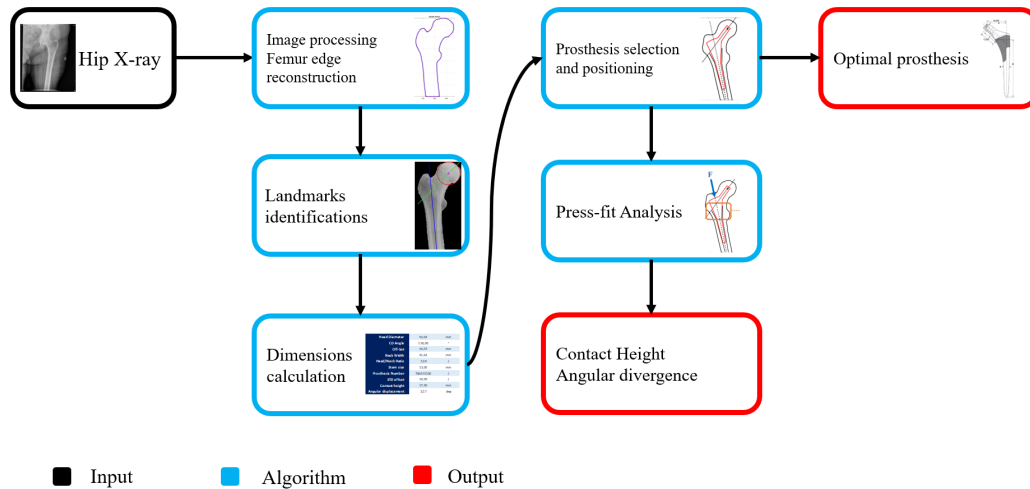
Preoperative planning is an integral part of total joint arthroplasty, aiming to restore the joint mimicking the native functionality (Choplin 2008). Dimensions of bone and prosthetic implants are usually evaluated by preoperative radiographs to restore leg length discrepancy and femoral offset (Amirouche, Solitro e Walia 2015). Nevertheless, even when using dedicated software, the femoral component is precisely selected only in 34% of the cases, resulting in a significant variability in 50% of the patients with 10mm in postoperative leg length discrepancy (Strøm e Reikerås 2018).

With the aim of reducing postoperative complications, in this work a computer algorithm has been developed that uses preoperative x-rays and performs automatic extraction of anatomical landmarks together with an automatic selection of the component that closely restore the native hip.

2. Methods

In a first phase, the Fuzzy logic based algorithm extracts the axis of the femoral neck, the femoral axis of the middle diaphysis, both the trochanters and the center of the femoral head. Then, by checking the geometrical data of commercially available hardware (Zimmer Inc., Warsaw, Indiana, U.S.A.) selects the component closer to the native anatomy. In a second phase, by a kinematic approximation

the algorithm uses the segmentation of the intramedullary canal to position the implant, assuming a press-fit insertion and thus anticipating potential contact region and, consequently, leg length discrepancy and offset.



The algorithm has been tested on a set of x-ray images. The following parameters have been extracted: position of femur axis and neck axis, center of rotation, offset, head dimension, neck dimension and angle cervico-diaphysaire (CD angle), dimensions of optimal implant (slightest difference between CD angle of bone and CD angle of prosthesis), height contact bone-implant and angular divergence of anatomical axis. The correlation diagram is used to determine the femur length by means of the diameter of the femoral head (Noble 1988).

3. Results

A sample of 16 femoral radiographs in Antero-posterior view was used to validate the algorithm. The average femoral head size calculated is 51.32 mm, with a maximum value of 59.27 mm and a minimum value of 47.85 mm. The head size was used to evaluate the error between the dimension calculated and the one manually measured on the radiograph, resulting in the order of ± 2.00 mm. The prediction of the fixation by means of press-fit technique gives an average contact height of 21.49 mm and an angular deviation of 4.13° of the neck axis, applying a force of 9.25 kN (Sakai 2011)

4. Discussion

Compared to existing methods, the proposed algorithm allows to calculate the femoral sizes necessary for dimensioning the implant from 2D radiographs in the frontal view only and to predict the prosthesis-bone contact in terms of height and interference reached after hammering. The algorithm also provides the angular discrepancy generated with the chosen implant, a parameter that indicates the removal from the normal mobility of the limb. The accurate analysis on mobility (ROM) used in other methods (Hsu e Fischer 2018) does not analyze the contact between the femoral stem and the bone, necessary to reach the primary stability of implant.

It has to be noted that the study, based on coronal x-rays, does not actually account for pelvic tilt (Bono 2018), that will be include in a further research.

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