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Intraoperative, fluoroskopiebasierte Planung komplexer Osteotomien des proximalen Femurs

Intraoperative, Fluoroscopy-Based Planning for Complex Osteotomies of the Proximal Femur

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PURPOSE

Intertrochanteric osteotomy of the proximal femur is a procedure which aims at changing the position of the femur head and neck in relation to the femur shaft for a variety of reasons. To accomplish that, the femur is cut in two parts slightly distal of the trochanter minor. Then, a wedge is cut out of one of the two fragments so that the fragments can be tilted and rotated against each other until the desired target position has been reached. Finally, the new shape of the femur is fixed with a metal plate.

Since the femoral head may be translated and rotated in arbitrary directions, this problem possesses six degrees of freedom and therefore requires thorough planning, especially for complex cases in which several combined rotations are to be performed.

We present a simple intra-operative approach for obtaining a description of the femur geometry from two fluoroscopy images, combined with data acquired from a tracking system during the planning phase. The femur geometry, reconstructed in this way, is sufficient for accurately planning the intervention, thus no other modalities (e.g. CT) are not needed.

MATERIAL & METHODS

Two fluoroscopic images of the femur are intra-operatively acquired using an optically tracked c-arm. The surgeon then proceeds to specify features in the 2D images, from which information on their 3D counterparts can be calculated by means of projective geometry.

In the case of proximal femur osteotomy, this approach suffices to obtain all features of the femur which are relevant for planning the intervention, including femoral head, neck isthmus, shaft axis and several auxiliary features.

However, it turns out that the 2D images do not provide enough information to allow for the determination of an optimal plate position, because it is not possible to reconstruct the relevant portion of the femur shaft in the necessary detail. Since a tight fit of the plate on the femur shaft is mandatory for a successful outcome of the intervention, our approach includes a planning step in which a navigated plate stub is placed at the patient.s exposed femur, thereby indicating the exact location at which the actual plate is later to be fixed. The parameters determining the intervention (position of the wedge, direction of the plate canal in the proximal fragment) are adjusted accordingly.

RESULTS

We conducted several studies with sawbones, which showed that
- this approach allows for fast and accurate planning of complex femur osteotomies
- the 2D images in combination with the tracked plate position parameters are fully sufficient for reconstructing all relevant parts of the femur geometry
- the system gives the surgeon a very reliable and intuitive feedback on the expected result of the expected outcome of the current planning situation

The achieved results are very promising. The osteotomies which were performed turned out to be very precise and showed only neglegible deviations.

CONCLUSIONS

The computer-assisted approach to femoral osteotomy improves the accuracy and reproducibility of this intervention. Required changes in procedure compared to the traditional approach are relatively small.