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**by N. Tardy, C. Steltzlen, N. Bouguennec, J.-L. Cartier, P. Mertl, C. Bataillé, et al. published in Orthop Traumatol Surg Res 2020;8S:S231-S236.**

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Letter to the editor

**Comments on: “Is patient-specific instrumentation more precise than conventional techniques and navigation in achieving planned correction in high tibial osteotomy?” by N. Tardy, C. Steltzlen, N. Bouguennec, J.-L. Cartier, P. Mertl, C. Bataillé, et al. published in *Orthop Traumatol Surg Res* 2020;8S:S231–S236**

“A goal without a plan is just a wish”  
A. St-Exupéry

We read with great interest the article “Is patient-specific instrumentation more precise than conventional techniques and navigation in achieving planned correction in high tibial osteotomy?” by Tardy et al. accepted in RCO-OTSR in July 2020 [1] and based on the 2019 French Society of Arthroscopy (SFA) Symposium. The authors assessed procedural precision, comparing lower limb alignment after osteotomy between 3 planning approaches:

- conventional cable, Miniaci or Hernigou table methods;
- navigation;
- patient-specific instrumentation (PSI).

Their multicenter prospective series was a large one, including 126 patients at 1 year’s follow-up. The study hypothesis, that PSI improves precision compared to the other two options, was not borne out. Several comments emerge from reading the article.

The first concerns indications for the surgical correction site: i.e., the importance of preoperative radiographic analysis.

Table 3, presenting the pre- and postoperative radiographic data, shows, in the “conventional” group, global varus assessed on HKA angle ( $174^\circ$ ) and a degree of tibial deformity very close to the normal values reported in the literature. In recent reports, mean medial proximal tibial angle (MPTA) in an asymptomatic population is  $86\text{--}87^\circ$  [2,3]: i.e., normal constitutional varus of  $3^\circ$  in the proximal tibial metaphysis. In this group, mean preoperative MPTA was  $84.9^\circ$ , with some extreme values within the normal range. Likewise, the question arises as to the origin of the deformity in this group, with  $6^\circ$  global deformity, only  $2^\circ$  of which involved the tibial metaphysis; the other  $4^\circ$  varus in the initial mean HKA was thus probably of femoral origin or intra-articular or both ( $180^\circ\text{--}174^\circ$  [mean HKA] –  $2^\circ$  [tibial varus to be corrected]).

Similarly, the “navigation” group showed  $174^\circ$  mean HKA angle and  $86^\circ$  mean MPTA: i.e.,  $1^\circ$  of tibial correction to achieve a “normal” tibia, leaving  $5^\circ$  “non-tibial” varus.

In the “PSI” group, deformity was more severe, with  $173^\circ$  mean HKA angle and  $84^\circ$  mean MPTA: i.e.,  $3^\circ$  tibial correction to restore “normal” anatomy, leaving  $4^\circ$  outside the tibia.

These data suggest that indications for tibial correction were excessive in some cases, perhaps due to:

- incomplete analysis of segmental deformity;
- aiming exclusively to correct the HKA angle without screening for any femoral and/or intra-articular component (Fig. 1).

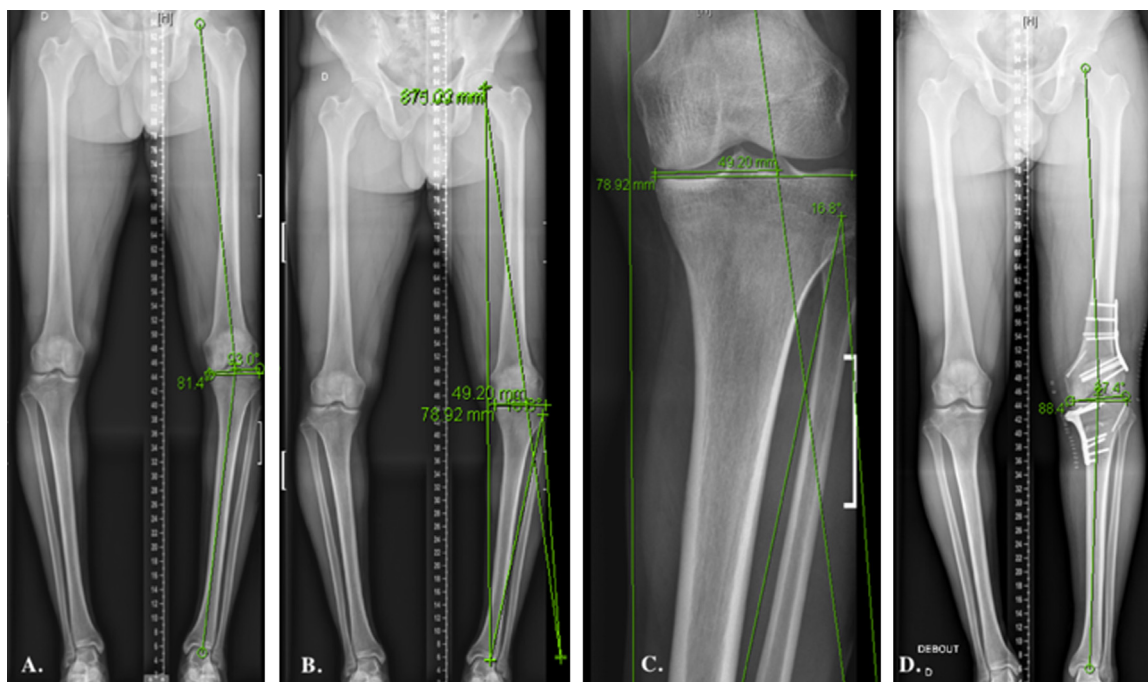
Did planning seek to take account of postoperative tibial morphology rather than HKA angle? Large-scale correction involving only the tibia, targeting a certain HKA angle, may lead to an oblique joint-line, vitiating functional outcome [4,5]. Preoperative data for femoral metaphysis varus (mLDFA) and intra-articular varus (JLCA) were lacking to explain the basic indications for the osteotomies performed in this series: significant tibial metaphysis deformity, or (in some cases) global varus deformity without tibial deformity?

Secondarily, assessing planning precision purely in terms of HKA angle raises several problems. It provides only a partial indirect indication of the precision of tibial osteotomy outcome. HKA angle results from 3 components:

- MPTA, representing proximal tibial deformity;
- mLDFA, representing distal femoral deformity;
- JLCA, representing intra-articular deformity [10].

In the reported study, surgery targeted only MPTA, as correction concerned the tibia; preoperative precision assessment not taking proximal tibial angle as well as HKA angle into account [11,12] was a limitation. Although femoral morphology is unchanged by tibial osteotomy, the preoperative intra-articular deformity can greatly affect postoperative global alignment and cause imprecision. Large preoperative JLCA secondary to soft-tissue laxity may be found in case of Ahlbäck III osteoarthritis, leading to correction error if only preoperative HKA angle is taken into account. Likewise, correction precision cannot be properly assessed by comparing pre- versus postoperative HKA angle. This is clear from the literature, despite the absence of impact on the precision of bone correction performed under good conditions. It is in fact the difference between  $\Delta\text{HKA}$  and  $\Delta\text{MPTA}$  (where  $\Delta$  stands for pre- to postoperative change) that properly assesses soft-tissue correction or degree of intra-articular correction related to soft-tissue effects [13]. This was lacking in the present study, and in some patients articular correction may have modified HKA angle without impact on the precision of bone correction.

The second comment concerns “targeted correction” and “actual correction”. In the “conventional” group, the mean HKA angle correction target was  $8.1^\circ$  ( $182.4^\circ$  [target HKA angle] –  $174.3^\circ$  [preoperative HKA angle]) but the actual correction, which alone



**Fig. 1.** Medial tibial opening-wedge osteotomy associated to lateral femoral closing-wedge osteotomy. A. Double femoral (6°; “normal” LDFA = 87°) and tibial varus (5.6°; “normal” MPTA = 87°); HKA angle is 166.7°. B. Preoperative planning for high tibial osteotomy by Miniaci method; angle between patient’s mechanical axis and target to be used for osteotomy. C. After planning, slightly valgus postoperative mechanical axis leads to 16.8° tibial correction (postoperative MPTA = 98.2°) with 11.2° extra-tibial abnormality (98.2°–87°) and risk of oblique joint-line. D. To avoid this, double femoral and tibial osteotomy is performed to restore neutral mechanical axis and normal postoperative femoral and tibial anatomy.

was studied, was only 4.5° (89.4° [postoperative MPTA] – 84.9° [preoperative MPTA]). Thus, the authors sought a mean 8.1° HKA angle correction by correcting the tibia by 4.5°, and 3.6° are lacking rather than 1.1° as predefined.

Likewise, in the “navigation” group, where a mean 9.2° HKA angle correction was targeted, final mean tibial correction was 6.1°, with 3.1° missing.

In the “PSI” group, a mean 8.2° HKA angle correction was targeted (181.1°–172.9°) and final mean tibial correction was 8.1° (92°–83.9°): i.e., mean 0.1° imprecision.

The last comment concerns the lack of data for the sagittal plane: posterior tibial slope and patellar height. These elements are the subject of controversy, but certainly change with osteotomy [14,15]. To our knowledge, no studies have compared these parameters according to planning technique. Sagittal analysis in the authors’ comparative study could have answered this question.

The present letter to the editor is not intended to cast any doubt on the value of this prospective study by the SFA, which shows great methodological quality and include a large number of patients. The aim is rather to remind surgeons of the possible causes of confusion in measurement, preoperative analysis and data interpretation when only a single global morphological parameter (HKA angle) is used. Finer analysis of preoperative deformity and error in precision, related not only to global alignment but also to bone correction alone being taken into account, would refine and extend the findings of this prospective study.

#### Disclosure of interest

GM, HF, CJ declare that they have no competing interest.

MO: educational consultant for Newclip Technics, AO-Recon, Stryker, Arthrex.

ME: educational consultant for Newclip Technics, Amplitude, Lépine Group.

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