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ORIGINAL STUDY

Current opinions about coronal plane alignment in total knee arthroplasty : A survey article

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Purpose : **To survey an audience of international knee surgeons about their current opinions on the analysis of coronal knee alignment and their objectives for postoperative alignment in total knee arthroplasty.**
Methods : **Survey of 300 surgeons from 32 different countries with an audience response system allowing three possible answers being either a positive or negative answer or an abstention.**
Results : **Surveyed surgeons perform rarely preoperative and postoperative full leg radiographs and evaluate radiological outcomes more with short films. The main trend in this survey was towards neutral mechanical alignment, however varus alignment is acceptable in constitutional varus patients. This residual varus should be obtained through a femoral varus cut rather than a tibial varus cut. The valgus knee can remain in slight valgus but most of the correction will be performed at the femoral level. The main objective of postoperative alignment in TKA is a joint line parallel to the floor and a central load-bearing axis through the middle of the arthroplasty. Surgeons prefer unicompartmental arthroplasty more for themselves than for their patients in case of medial bone on bone arthritis.**
Conclusions : **Neutral mechanical axis with a joint line parallel to the floor and a centrally running load bearing axis remains the central scope of the surveyed surgeons. Because of the literature on residual varus it becomes more acceptable for the orthopaedic community to accept this type of outlier before aiming at a surgical correction.**

Keywords : knee arthroplasty ; alignment ; varus ; survey.

INTRODUCTION

Alignment or the relative position of the femoral bone compared to the tibial bone is an important issue in total knee arthroplasty (TKA) (*27*). Alignment in the coronal plane can be expressed as anatomical alignment, measuring the angle between the femoral anatomical axis of the bone and the tibial anatomical axis of the bone (Fig. 1) or as an angle referenced of the vertical axis running through the symphysis of the pubis (Fig. 2). This angle is usually +/- 6° of valgus (*1,7,9*). The same position of the bones or implants can also be evaluated by the criteria of mechanical alignment (Fig. 1). In that case the angle between the centre of the Hip, Knee and Ankle (HKA) is measured as the HKA-angle of the lower limb (*1,6,9*). This angle should be 180° aligning the hip with the ankle creating a mechanically stable situation for the lower limb (*1,8,9*).

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Fig. 1. — Mechanical axis represented as Hip, Knee and Ankle Axis (HKA-angle) on the left hand side of the figure. Anatomical axis as the angle between anatomical axis of femur and tibia on the right hand side of figure.

Fig. 2. — Load bearing axis is at a mean 6° valgus from an axis running through the symphysis of the pubis (vertical axis).

The classic axiom in TKA surgery was that the HKA-angle needs to be 180° and that the longevity of the implant is directly related to its alignment. Outliers would lead to early failure and potentially less satisfied patients (*12,25*). However anno 2010 literature reports appeared, showing that residual varus alignment of the lower limb was not evidently leading to failure of the implant and that undercorrection of a varus deformity could even result in better functional results (*19,20,23,30*). This was potentially explained by the finding that the overall mean alignment of the Caucasian population might be varus anyway. Therefore undercorrection would only align them as before the disease process (*4,31*).

Alignment can be measured according to the Knee Society Radiological Score on short films (*11*) or it can be evaluated on full leg standing radiographs (*21,22*). The advantage of this second option is that the position of the implants is evaluated in a load-bearing position and that the mechanical alignment can be measured as degrees deviating from the neutral 180° axis (*6,9,28*).

The aim of this study was to survey the current opinions of a substantial and geographically diversified group of knee surgeons, attending a knee meeting, on their ideas about coronal alignment and especially the option of keeping an implant postoperatively in varus alignment.

MATERIALS AND METHODS

During the 'Recent Advances in Knee Surgery' meeting in September 2013 in Prague, Czech Republic the attending surgeons were surveyed about their opinions on coronal alignment of the lower limb and knee arthroplasty surgery. From the 650 attendees from 32 different countries, the opinion of 300 surgeons was taken by an Audience Response System (ARS). The surveyed group consisted of 12% orthopaedic residents in their senior year having expressed a clear knee interest, 32% general orthopaedic surgeons, 24% knee surgeons (sports medicine and knee arthroplasty) and 32% knee and hip arthroplasty surgeons.

The questions were presented on screen, read by the moderator and the possible answers were "I do", "I don't" or abstention of an answer. After each question the audience had 15 seconds to answer and during that period only one answer was possible for each respondent. The results of the voting were given only at the end of the session to avoid influencing the audience on the next question by the response on the previous question.

Demographics of the surveyed population

A first multiple choice question was asked about the surgical activity of the survey population with twenty-one percent of surveyed surgeons replying that they performed less than 30 TKA/year, 23% between 30 and 49 TKA/year, 28% between 50 and 99 TKA/year, 12% between 100 and 149 TKA/year, 8% between 150 and 200 TKA/year and finally 8% more than 200 TKA/year.

Two percent of surveyed surgeons performed only sports medicine and 14% only knee arthroplasty, 41% sports medicine and knee arthroplasty equally, 11% performed more sports medicine than arthroplasty and 32% more arthroplasty than sports medicine.

Related to their arthroplasty activity the survey also asked about their practice distribution of primary versus revision arthroplasty. Thirty-nine percent of surgeons performed 95% of primary TKA versus 5% of revision, 23% had a 90% versus 10% distribution, 11% had a 80% versus 20% and 5% a 70% versus 30% activity with finally 11% of surgeons having a 50/50 distribution of primary versus revision.

RESULTS

Since the above questions about their surgical profile and activity could be considered as potentially threatening (*13*), the presentations of the session were given before a new series of questions were proposed to the audience. The following questions were presented with the AR System :

The question was asked if a surgeon would like for himself a unicompartmental knee arthroplasty (UKA) or a TKA if he presented with isolated anteromedial arthritis while showing a typical radiograph of bone on bone medial arthritis and explaining the knee had normal stability. Of the replying surgeons 87% preferred an UKA for their own knee. However when for the same radiographic and clinical situation the question was asked whether they would offer an UKA to their own patient, only 78% answered yes. So about 9% of surgeons changed opinion on the appropriate treatment for any typical patient compared to them.

A survey was furthermore performed on their opinions about coronal alignment with "I do" and "I don't" as well as abstention answers. The results are given in Table I. When asked about a fixed anatomical-mechanical angle (AMA-angle) of the femur ; 27% replied it was always 5°, 28% answered it was 6° and 11% answered it was 7°. Twenty-eight percent replied the angle is patient specific and should be measured on each case and 6% had no opinion.

DISCUSSION

The most important finding of this survey study was that the opinions on coronal alignment are still divided in the orthopaedic community. The principles of residual postoperative varus alignment after TKA are well known, but not generally accepted by everyone. The concept of a joint line parallel to the floor seems more accepted. Surgeons overall prefer neutral mechanical alignment but abstain of strict radiological postoperative evaluations.

Another interesting finding of this survey was that surgeons seem to prefer a unicompartmental arthroplasty for themselves when confronted with isolated bone on bone anteromedial osteoarthritis of

Table I. — Survey questions and answers about coronal alignment

Survey questions and answer options	I do	I do not	No opinion
Do you perform preoperative full leg radiographs prior to TKA ?	49%	13%	38% in special cases
Do you perform postoperative full leg radiographs after TKA ?	19%	54%	27%
I believe short film radiographs give enough information for adequate preoperative planning prior to TKA ?	32%	68%	0%
I believe short film radiographs give enough information for adequate postoperative evaluation after TKA ?	54%	46%	0%
I always measure the preoperative HKA-angle before TKA ?	49%	51%	0%
I always measure the postoperative HKA-angle after TKA ?	26%	71%	3%
I believe a varus knee should remain in varus postoperatively ?	40%	58%	2%
I can see preoperatively who had constitutional varus and needs remaining varus after surgery ?	46%	50%	4%
To keep a TKA in varus, I perform a varus cut on the tibia ?	16%	78%	6%
To keep a TKA in varus, I perform a varus cut on the femur ?	36%	58%	6%
I believe a 180° +/- 3° HKA-angle is important for good functional results ?	50%	40%	10%
I believe more than 3° of an alignment outlier is acceptable in TKA ?	50%	50%	0%
I believe a valgus knee should remain in valgus ?	54%	43%	3%
I believe valgus should remain on the femoral side in the valgus knee ?	14%	83%	3%
I believe valgus should remain on the tibial side in the valgus knee ?	15%	80%	5%
I believe the femur should be cut in more varus in the valgus knee ?	60%	36%	4%
I believe the primary goal in TKA alignment is to have a joint line parallel to the floor ?	72%	22%	6%
I believe it is more important to have a central load bearing axis than a 180° HKA-angle after TKA ?	63%	19%	18%
I believe mechanical alignment of the lower limb is more important than anatomical alignment after TKA ?	77%	20%	3%
I believe the anatomical alignment after TKA should be 6° of valgus from a vertical axis ?	57%	33%	10%

the knee. However about 9% of surgeons would treat their patient with a TKA.

Alghamdi *et al* proved the importance of preoperative full leg radiographs showing that many patients, especially with valgus deformity present with extra-articular deformities that are difficult to predict or evaluate on short film radiographs (*2*). This survey showed that surgeons performed in about 50% of cases preoperative full leg radiographs but only 20% used that technique to evaluate their postoperative radiological alignment and 26% would measure their result as an HKA-angle. This finding clearly shows that the importance of evaluating alignment with full leg standing radiographs should be further analyzed. It should also be proven that alignment is related to clinical outcome and wear so that the cost of the radiographic analysis can have some consequences in the prevention of wear or in obtaining better outcomes (*12,26*).

Recent literature on alignment reconfirmed the findings of Hsu *et al* (*15*) and Moreland *et al* (*21*) that the overall coronal alignment of the population is not neutral but rather varus. Bellemans *et al* introduced the principle of constitutional varus (*4*). A majority of the surveyed surgeons believed a neutral mechanical axis should be the aim in the varus knee (58%) and only 46% thought they were able to identify which patient has or had constitutional varus before the disease process took place. In the survey group only a slight minority (16%) was ready to cut

the tibia in varus and aim for anatomical or kinematical alignment (*5,14,16*). The principles of anatomical and kinematic alignment are of growing interest nowadays. The majority (58%) would keep the femur in varus if that were their ambition for postoperative alignment. A femoral component in varus is however in contrast to the concept of anatomical alignment, where the distal femur should be in relative valgus (*5,14*).

Parratte *et al* showed that for one particular surgeon (Dr. Rand from the Mayo Clinic, Rochester, US) neutral mechanical axis whas not determining for longevity of the implants he used (Kinematic Condylar II, PFC and Genesis) (*23*). And several authors showed that the functional outcome was better with remaining varus after correction of preoperative varus alignment with TKA (*17,19,30*). A straight mechanical axis of 180° seemed important for good functional results for 50% of surveyed surgeons and the same amount thought outliers of more than 3° are unacceptable after TKA. Several authors showed however that the anatomy of the varus patient often leads already to undercorrection and that therefore a neutral mechanical axis should be the initial objective for a TKA (*3,6,10,18,26*).

Fifty-four percent of surgeons thought a valgus knee might remain in some valgus (< 184°) after TKA (*12*). The majority corrects the femoral valgus however with an adapted varus cut on the femur, aiming at a correction of the Anatomical-Mechanical femoral angle lower than measured on the full leg radiographs.

A strong majority (72%) estimated that a joint line parallel to the floor was an important objective after TKA as well as having a central load-bearing axis running through the center of the knee prosthesis (63%). The joint line has been proven to be parallel to the floor in normal knees and knees with constitutional varus (*7,31*).

Finally 77% of surveyed surgeons estimated that mechanical alignment was more important than anatomical or kinematical alignment (*16,32*). Howell *et al* showing good clinical results for patients have extensively studied the concept of kinematical alignment, but according to this survey study this concept is not yet popular in the orthopaedic community (*5,14*).

The treatment of bone on bone medial compartment osteoarthritis remains a controversial topic. When surgeons were offered the choice of UKA versus TKA they preferred UKA much more for themselves than for their patients. This confirms how the option of UKA still remains uncertain for surgeons (*24*). The question whether patients will prefer survival over function is not solved yet (*29*).

A weakness of this study is the intrinsic problems of a survey study. Not all surgeons attending the meeting were surveyed. There is therefore a selection bias by the surgeons who preferred to use the audience response system. Furthermore there is always a suggestion in the question and the response time doesn't always allow sufficient reflexion about the question. Questions can be knowledge based or attitude based as in this survey. Often answers are impulsive and straightforward. The advantage of the weaknesses is that the answers are straight and reflect well the opinions of the surveyed surgeons. The authors also tried to balance the questions by separating "threatening" questions like (e.g. how many TKA did you perform last year ?) from the actual survey with a break. The scientific presentations were used to create a time period between both sections of questions. Despite that most questions were closed-ended a "no opinion" option was offered as a further category of closed-response. Since this was an "opinion" survey the questions were well designed using the "I do/ I do not" format and making them "non-elliptical". General questions preceded specific questions and the number of questions was limited to avoid lower response rates (*13*).

CONCLUSION

Mechanical alignment of the knee is estimated as highly important by surveyed surgeons. Their primary ambitions are a joint line parallel to the floor and a centrally running load bearing axis. Despite of these strong opinions about alignment only a minority of surgeons evaluates his surgical result with postoperative full leg radiographs and HKA-angle measurements.

Surgeons with medial bone on bone arthritis prefer unicompartmental arthroplasty more for themselves than for their patients.

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