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Effect of preoperative flexion contracture in the knee joint on the accuracy of digital templating before knee replacement surgery

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ABSTRACT

Introduction: Flexion contracture in the knee joint before knee replacement surgery has been implicated as one of the factors that could affect the accuracy of digital templating.
Aim: The aim of the study was to detect the accuracy of digital templating in predicting the size of knee implants and to detect the effect of preoperative flexion contracture in the knee joint on the accuracy of digital templating.
Material and methods: The flexion contracture of the knee joint was measured in every patient prior to knee replacement surgery and digital templating of the knee joint was made in mediolateral (ML), anteroposterior (AP) and AP long leg views. The sizes of prosthetic components predicted by templating were compared to the sizes of prosthetic components implanted during the surgery. The effect of flexion contracture on the accuracy of digital templating was analyzed using χ^2 test and Mann–Whitney *U* test.
Results and discussion: The size of the prosthetic component predicted by templating matched the size of the implanted component in 45.2%–62.9% of the cases, in 91.9%–98.4% of the cases it was within the range of one size. Statistically significant effect of the flexion contracture in the knee joint on the accuracy of digital templating was observed in the femoral component, AP view if the flexion contracture exceeded 10°.
Conclusions: Digital templating is very accurate method in predicting the size of knee implants. Flexion contracture in the knee joint that exceeds 10° diminishes the accuracy of digital templating of the femoral component in AP view.

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1. Introduction

Preoperative planning is an important aspect of knee arthroplasty. It allows the surgeon to detect the size of the implant and to assess the joint alignment.[1] Malalignment is inversely correlated with implant survival.[2] Accurate planning leads to precise prosthetic component placement, correct size of the implant, shorter surgical time and fewer complications.[1,3,4] Therefore it can reduce the overall costs of joint arthroplasty.

Historically templating has been done on analog radiographs but recently digital templating has taken its place providing better options of picture archiving and data processing.[1] The accuracy of analog and digital templating has been compared and none of them has been found clearly superior to the other.[5]

According to data in literature, digital templating of the knee joint allows to precisely predict the size of the femoral implant in 48%–70% of cases; in 92%–100% of cases it allows to predict the femoral implant within one size. Digital templating allows to precisely predict the size of the tibial implant in 48%–67% of cases; in 94%–100% of cases it allows to predict the tibial implant within one size.[1,5–10]

Several factors that could affect the accuracy of digital templating of the knee joint have been implicated: quality of radiographs, rotation of radiographs, surgical technique and patient's preoperative deformity such as flexion contracture or rotational deformity.[11] Larger degree of knee flexion contracture leads to greater distance between the knee and the X-ray plate, thereby changing the degree of magnification on the radiographs.[12] The effect of flexion contracture in the knee joint on the accuracy of digital templating has not been extensively studied, therefore the exact degrees that make the measurements significantly less accurate are still not known.

2. Aim

The aim of the study was to detect the accuracy of digital templating in predicting the size of knee implants and to detect the effect of preoperative flexion contracture of the knee joint on the accuracy of digital templating.

3. Material and methods

Prospective study was made including all patients who underwent primary knee arthroplasty from September 2013 to December 2013 in Hospital of Traumatology and Orthopaedics, Riga, Latvia. An agreement of Bioethical Commission of Riga Stradins University and an agreement of Hospital of Traumatology and Orthopaedics were obtained. There were 63 patients who met the inclusion criteria. Data were obtained from 62 of them; 1 patient refused to participate in the study.

The flexion contracture of the knee joint was measured with a goniometer in every patient one day before the surgery. The digital templating on the radiographs of the knee joints in mediolateral (ML), anteroposterior (AP) and AP long leg views was made using AGFA Orthopaedic Tools software. The sizes of prosthetic components predicted by templating were then compared to the sizes of prosthetic components implanted during surgery.

To detect the effect of flexion contracture in the knee joint on the accuracy of digital templating the measurements were divided into several groups according to the observed degree of flexion contracture. The statistical significance of differences in accuracy of templating between those groups was detected using χ^2 test and Mann–Whitney U test. Differences were considered statistically significant at $P < 0.05$.

Data analysis was performed using IBM SPSS Statistics 20.0 software.

4. Results

The study consists of 62 patients (12 males, 50 females). Age of the patients on the day of surgery varied from 48.4 to 85.9 years, mean age was 69.7 years, SD 8.7 years. The age histogram is presented in Fig. 1.

The observed flexion contractures in the knee joint varied from 0° to 22°. Median value was 9°. The histogram of measured flexion contractures is presented in Fig. 2.

The sizes of prosthetic components predicted by templating were compared to the sizes of prosthetic components implanted during the surgery. Differences between those sizes are shown in Table 1.

The size of the femoral component predicted by templating matched the size of the femoral component implanted during the surgery in 45.2%–58.1% of cases, in 96.8%–98.4% of cases it was within the range of one size. The size of the tibial component predicted by templating matched the size of the tibial component implanted during the surgery in 46.8%–62.9% of cases, in 91.9%–98.4% of cases it was within the range of one size.

There was very strong correlation between the size of prosthetic component predicted by templating and the size of the component implanted during surgery for both femoral and

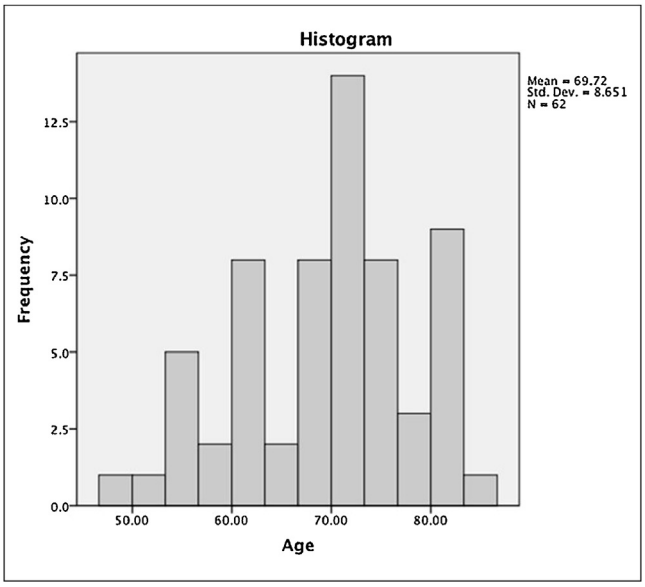

Fig. 1 – Age histogram of patients included in the study.

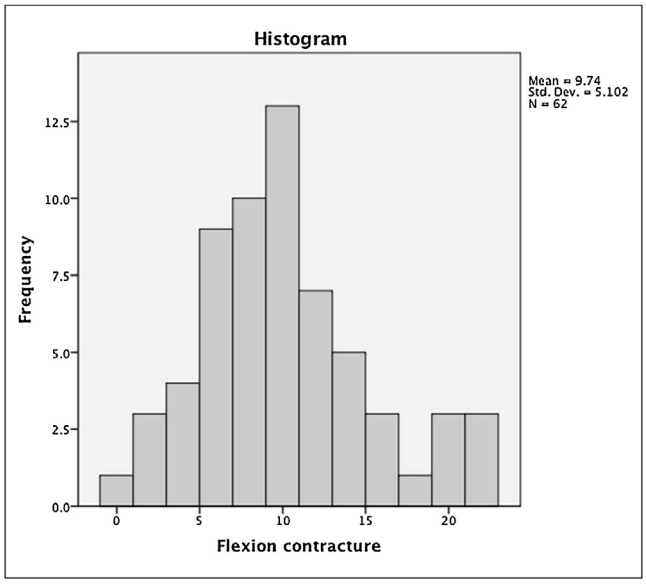

Fig. 2 – Histogram of measured flexion contractures.

tibial components in all views. Spearman's rank correlation coefficients were: $r = 0.881$ for femoral component in ML view, $r = 0.839$ for femoral component in AP view, $r = 0.860$ for femoral component in AP long leg view, $r = 0.873$ for tibial component in ML view, $r = 0.893$ for tibial component in AP view, $r = 0.895$ for tibial component in AP long leg view.

To detect the effect of knee flexion contracture on the accuracy of digital templating the obtained data about accuracy for each component in all of the views were divided into groups according to flexion contracture. Then the statistical analysis was made using χ^2 test to detect if there were statistically significant difference in accuracy of templating between patients who had larger degree of knee flexion contracture and patients who had smaller degree of knee flexion contracture. No statistical significance was found ($P < 0.05$ for both femoral and tibial components in all views).

Data were also analyzed using Mann–Whitney *U* test. The measurements were divided in groups according to the degree of knee flexion contracture: in one group were included patients with knee flexion contracture in the range of 0° to *n*, in the other group were included patients with knee flexion contracture more than *n*. Analysis was made with different *n* values; the chosen *n* values were from 5° to 15° (87.1% of measured knee flexion contractures were within this range). Statistical significance in differences of the accuracy of templating between these groups at different *n* values is presented in Table 2. Statistically significant difference was observed when measuring femoral component in ML view at $n = 7°$ and when measuring femoral component in AP view at $n = 6°$, $n = 7°$, $n = 8°$, $n = 10°$.

Table 2 – *P* values in differences of the accuracy of templating.

n, degrees	*p*					
	Femor, ML view	Femor, AP view	Femor, AP long leg view	Tibia, ML view	Tibia, AP view	Tibia, AP long leg view
5	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
6	>0.05	0.011	>0.05	>0.05	>0.05	>0.05
7	0.047	0.003	>0.05	>0.05	>0.05	>0.05
8	>0.05	0.045	>0.05	>0.05	>0.05	>0.05
9	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
10	>0.05	0.004	>0.05	>0.05	>0.05	>0.05
11	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
12	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
13	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
14	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
15	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05

Further the measurements were divided in two groups: one group consisted of patients with knee flexion contracture within the range from 5° to 10° (32 patients), the other group consisted of patients with knee flexion contracture larger than 10° (22 patients). The difference in accuracy of digital templating between both groups was analyzed using Mann–Whitney *U* test. Statistically significant difference was found for femoral component in AP ($P = 0.006$) and AP long leg ($P = 0.044$) views. In the group that consisted of patients with knee flexion contracture within the range from 5° to 10° the size of femoral component predicted by templating and the size of femoral component implanted during surgery was within the range of one size in all of the cases, whereas in the group that consisted of patients with knee flexion contracture larger than 10° there was one case where the femoral component predicted by templating was two sizes smaller than the one implanted during surgery.

5. Discussion

The purpose of this study was to assess the accuracy of digital templating in predicting the size of knee implants and to

Table 1 – Difference between the sizes of the implants.

Difference between the size of the prosthetic component predicted by templating and the size of the prosthetic component implanted during surgery	Femur, ML view	Femur, AP view	Femur, AP long leg view	Tibia, ML view	Tibia, AP view	Tibia, AP long leg view
−2	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.6%)	1 (1.6%)	1 (1.6%)
−1	9 (14.5%)	14 (22.6%)	13 (21.0%)	26 (41.9%)	18 (29.0%)	9 (14.5%)
0	36 (58.1%)	28 (45.2%)	33 (53.2%)	29 (46.8%)	39 (62.9%)	31 (50.0%)
1	16 (25.8%)	19 (30.6%)	14 (22.6%)	6 (9.7%)	4 (6.5%)	17 (27.4%)
2	1 (1.6%)	1 (1.6%)	2 (3.2%)	0 (0.0%)	0 (0.0%)	4 (6.5%)

detect the effect of preoperative flexion contracture in the knee joint on the accuracy of digital templating. The accuracy of digital templating observed in this study is similar to the accuracy of digital templating observed in studies done before.[1,5–10] Our results demonstrate that digital templating is very accurate method in preoperative prediction of the size of knee implants. Sizes of the implants predicted by templating correlated very strongly with the sizes implanted during surgery. Size of the prosthetic component predicted by templating matched the size of the prosthetic component implanted during surgery in up to 70% of cases, in almost all of the cases these sizes were within the range of one size.

Considering the benefits that templating gives, it is clear that templating is crucial in preoperative planning of knee arthroplasty. It provides the surgeon with information about the range of implant sizes needed in the operating room and reduces the risk of malalignment. This decreases surgical time and leads to fewer complications, therefore it is also a cost-effective instrument.

The benefits of templating are limited by accuracy. The factors that affect the accuracy have not been widely studied, however some of them have been identified.[11] It has been reported that deformity of the patient's knee can affect the accuracy of templating since it changes the position of the knee relative to the X-ray plate.[12] While small degrees of flexion contracture in the knee joint do not lead to significant inaccuracy in templating, greater degrees of knee flexion contracture can make the templating inaccurate. Results of this study demonstrate that flexion contracture in the knee joint that exceeds 10° leads to statistically significant decrease in accuracy when templating is made for femoral component in AP view.

Assessment of knee deformity prior to the templating is always advisable. The surgeon should take in consideration that major flexion contracture in the knee joint can significantly affect the accuracy of templating.

To make more convincing conclusions about the effect of knee flexion contracture on accuracy of templating further research should be done, including larger number of patients.

6. Conclusions

1. Digital templating is very accurate method of preoperative prediction of size of the knee implants.
2. Flexion contracture in the knee joint that exceeds 10° diminishes the accuracy of digital templating of the femoral component in AP view.
3. Statistically significant effect of flexion contracture in the knee joint on the accuracy of digital templating of the femoral component in ML view and tibial component was not proven.

Conflict of interest

No conflict of interest to declare.

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