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Original Article

Remodeling Pattern of the Medial Tibial Metaphysis after a Cementless Unicondylar Knee Replacement; a Radiological Study

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ABSTRACT

Objective: Unicondylar knee arthroplasty (UKA) is a surgical procedure primarily used for the resurfacing of the medial compartment and many studies have previously analyzed the changes taking place on the surrounding osseous tissues after the procedure. The purpose of this study is to investigate the effects of bone strain in the medial tibial metaphysis after a cementless unicondylar replacement.

Methods: Patients treated with a cementless UKA between March 2015 and March 2019 was selected for this study. Inclusion criteria were a minimum of 1 and a maximum of 2 years follow-up and presence of standard radiographs of the operated knee at yearly intervals. A total of 109 patients were included in the study. Two lines at a distance of 5 and 7 cm from the lateral tibial eminence were horizontally drawn and the medial cortical thickness and the total cortical distance were measured. A cortex-to-metaphysis (CTM) ratio was established. The increase of density in the metaphysis was analyzed though the "reactive triangle" phenomenon. We initially hypothesized that some degree of increase in sclerosis would be detected in the medial tibial metaphysis and that the increase would be greater in patients with an implant underhanging, since more cancellous bone would come under strain.

Results: The CTM ratio showed a decreasing pattern during the 1st post-operative year for all measured levels. An increase in density at the metaphyseal area just below the keel was observed in 58% of patients during the 1st post-operative year and in 80% during the 2nd year. The increase in the density was correlated with the absence of coronal overhanging. Patients with coronal overhanging of the tibial implant showed an increase in CTM ratio.

Conclusion: Increased strain after a unicondylar procedure leads to cortical and cancellous bone changes in the proximal tibial metaphysis. These changes depend on the presence or absence of coronal overhanging.

INTRODUCTION

Unicondylar knee arthroplasty (UKA) is a surgical procedure whose popularity has grown these last years after good-to-excellent long-term results have been constantly reported.[1–4] It is favored to total knee arthroplasty because of its lesser invasive nature, quick recovery, and more anatomic post-operative kinematic results.[5–7] Despite lateral compartment applications having gained popularity recently, UKA is still primarily performed on the medial side.[3] Furthermore, many studies have previously analyzed the radiological changes taking place on the adjacent bone structures after the procedure.[8–10]

Increased bone strain is observed on the medial tibial metaphysis after a unicondylar arthroplasty.[8–12] The medial tibial metaphysis has been shown to get overloaded due to the loss of subchondral bone and remodeling is expected to follow to accommodate the new metallic structures.[9,10] However many of these studies, were either finite-element analyses or cadaveric studies, and radiological studies in real patients are still lacking.

The purpose of this study is to radiologically investigate the effects of the remodeling process in the medial tibial metaphysis after a unicondylar replacement, by measuring the cortical thickness of the proximal tibial metaphysis and establishing a new ratio parameter. Although not yet radiographically proven, it has frequently been stipulated that overloading of the new subchondral bone should lead to some degree of remodeling which itself may present as change in the cortical thickness or the increase in sclerosis of the cancellous bone of the proximal tibial metaphysis. We initially hypothesized that some degree of increase in sclerosis would be detected in the medial tibial metaphysis and that this increase would be greater in patients with an implant underhanging, since more cancellous bone would come under strain.

MATERIALS AND METHODS

Patient selection

All patients with a diagnosis of antero-medial osteoarthritis or focal femoral osteonecrosis of the medial condyle, who underwent a unicondylar replacement with the cementless Oxford implant (Biomet Orthopedics, Inc, Warsaw, Ind) between March 2015 and March 2019 were selected for this retrospective study. A total of 209 patients were identified. Informed consent was taken from all patients and the Local Ethics Committee approved the study design.

Inclusion criteria were a minimum of 1 and a maximum of 2 years follow-up, and the presence of standard standing radiographs of the knee taken at yearly intervals (±2 months from the operated date). This interval was decided based on the concept that at least a year would be required for certain radiological change to appear on a direct radiograph. Patients who underwent a revision procedure before the 1st post-operative year, patients whose radiological data were not present or whose radiographs were taken in rotational positions, and therefore making measurements inappropriate, were excluded from the study. An American Society of Anesthesiologists score of >3 and age >85 was also among our exclusion criteria.

Demographic data were collected from the hospital records. The surgeries were performed in a standard fashion by two surgeons with at least 15 years of experience in orthopedic surgery.

Surgical method

Patients with severe pain, a bone-on-bone lesion of the medial compartment of the knee, and a healthy lateral compartment were indicated for surgery. A high body mass index (BMI) was not considered a contraindication. All patients were clinically evaluated before surgery for contractures and an intact anterior cruciate ligament (ACL) was required before the procedure.

Surgeries were performed on a custom leg-holder allowing for at least 110 degrees of flexion. After antibiotic prophylaxis, a medial parapatellar mini approach was used to access the medial compartment of the knee joint. After assessing the state of the ACL, an Oxford Phase III mobile-bearing implant was implanted in all procedures.

After implantation, local anesthetics and prednisolone were infiltrated throughout the soft tissue of the joint and the periosteum. The patients were postoperatively mobilized with immediate full weight bearing and crutches and were started on active knee range of motion exercises.

Radiological evaluation

Radiological data were gathered through the picture archive and communication system of our medical center. All patients had undergone a routine standing knee radiograph on the first day after surgery. The radiograph was aligned so that a clear and standard antero-posterior (AP) and lateral view of the implant could be seen, as also described by the manufacturer.[13,14] An "implant AP and lateral" view, rather than a "knee AP and lateral," was used in all measurements for standardization purposes. On the early post-operative X-rays tibial and femoral component coronal and sagittal alignment was measured. On the coronal plane and for both implants, negative values were used to denote valgus angles while positive values were used to denote varus angles. On the sagittal plane and for the tibial implant, a low and inverted slope (compared to the horizontal plane) was denoted with negative values while a high slope was denoted with positive values. The sagittal alignment of the femoral component was measured according to the manufacture's description using a mid-intramedullary line and a line passing through the middle of the major peg of the implant.[13,15] Positive values were used to denote flexion and negative values were used to denote extension (Fig. 1). Overhanging, whether on the coronal or sagittal plane, was defined as an implant protrusion of more than 2 mm from the bone.

The previous studies have shown that strain increase takes place on the medial metaphysis of the tibia but can also reach close to the posterior cortex, especially with an extended vertical cut.[16] Therefore, the medial and posterior proximal tibial cortexes were measured at distances of 5 and 7 cm below the joint line, since this is approximately the region that has been defined to come under strain.[8,9] As a reference starting point and for standardization purposes, a line passing through the middle of the shaft distally and through the highest point of the lateral tibial eminentia proximally was used in all cases to determine the right height. Starting from the lateral eminentia, 5 and 7 cm distally, a line perpendicular

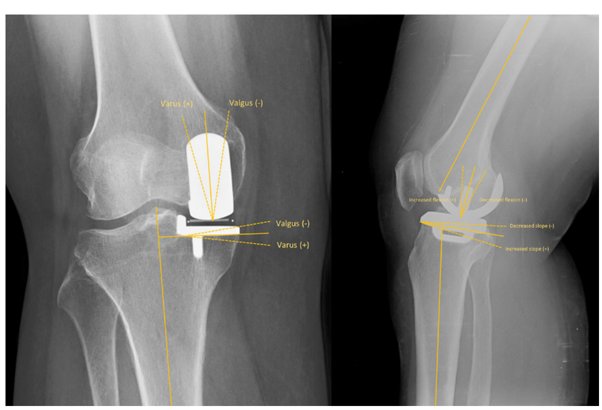

Figure 1. Alignment measurements for both unicondylar implants on antero-posterior and lateral view.

to the first ones was drawn. A horizontal measurement of the cortex thickness was performed at the defined distances, both on the coronal and sagittal planes (Fig. 2a-c). At the same level, a measurement of the whole tibial metaphysis was also performed (cortex-to-cortex) and a cortex-to-metaphysis (CTM) ratio was then obtained (measured as X/Y ratio) (Fig. 2d). On the lateral view, the most upper and anterior tip of the implant were used as a reference point for standardization purposes. A line passing through the middle of the shaft distally and the most upper point of the implant proximally was used during measurement. 5 mm and 7 mm distal and perpendicular to the reference line (Fig. 3a-c), the metaphysis and cortical thickness were measured and again a CTM ratio was obtained (measured as X/Y) (Fig. 3d). This ratio was used for comparison in between yearly intervals. The early post-operative radiograph was denoted as zero (0) and the X-rays taken on the definite intervals were denoted according to their taken time (1 and 2). Change was assessed comparing the ratios of CTM 0–1 year and 0–2 years.

Even though the X-rays taken at our center are calibrated, the height of the tibial implant from the tip of the horizontal baseplate to the tip of the keel was used as reference measurement. This height is 10 mm, as reported by the manufacturer itself.[17] All measurements were calibrated according to this measurement.

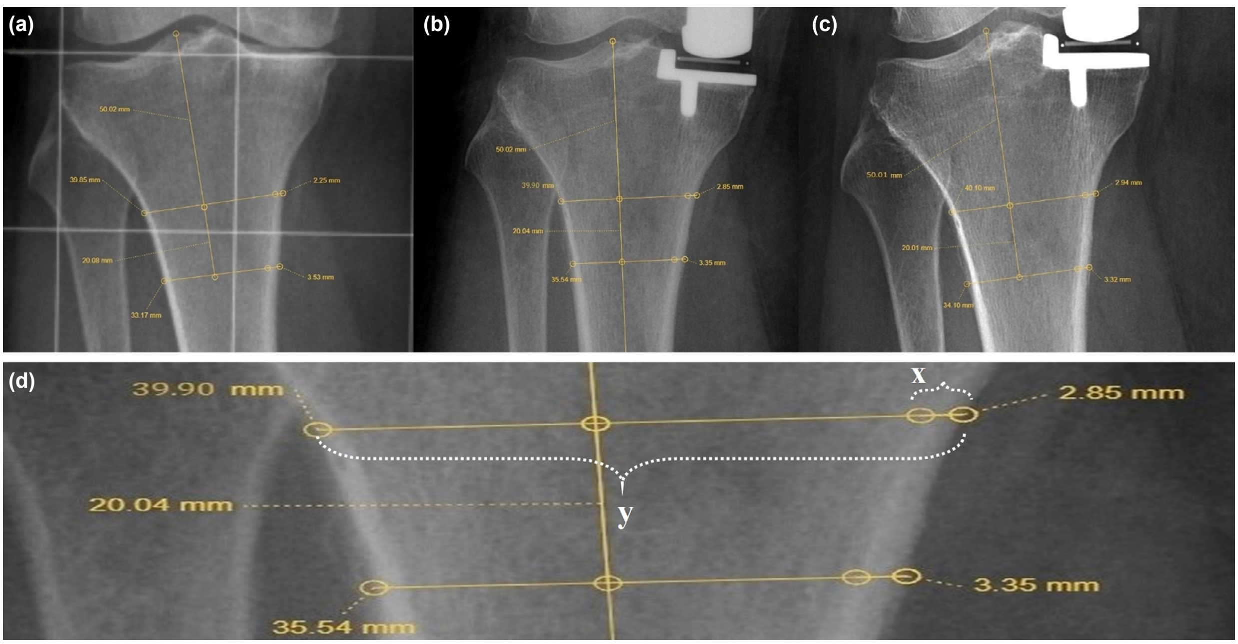

Figure 2. Measurement of the cortical thickness and metaphyseal width on the antero-posterior radiograph immediately after the operation **(a)**, at the end of first year **(b)**, and at the end of the second year **(c)**. The ratio was defined as XY **(d)**.

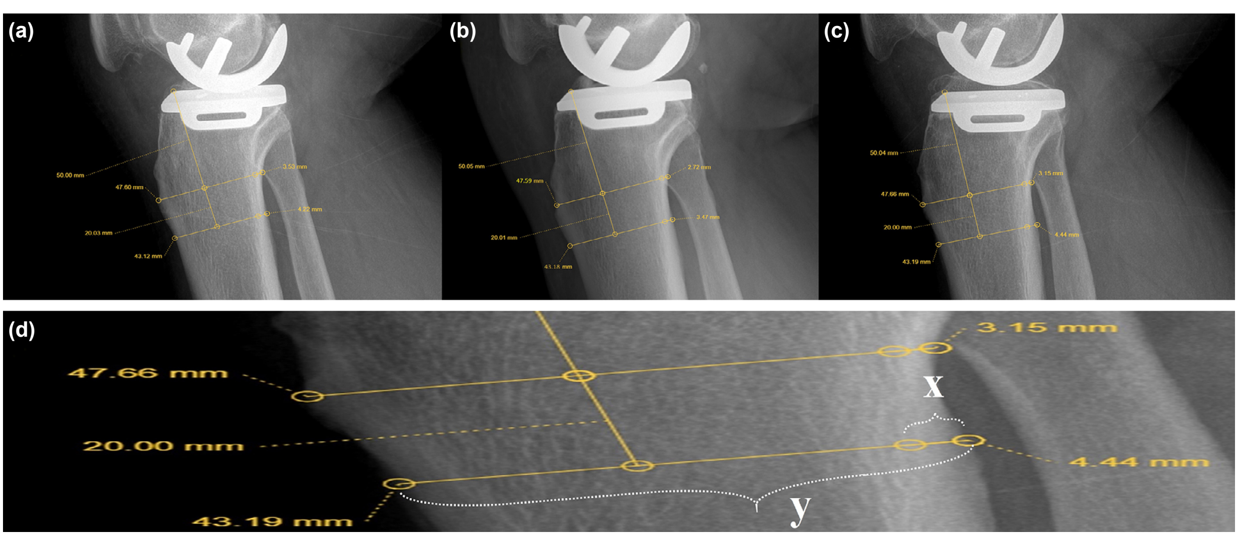

Figure 3. Measurement of the CTM ratio on the lateral radiograph immediately after the operation **(a)**, at the end of first year **(b)**, and at the end of the second year **(c)**. The ratio was defined as XY **(d)**.

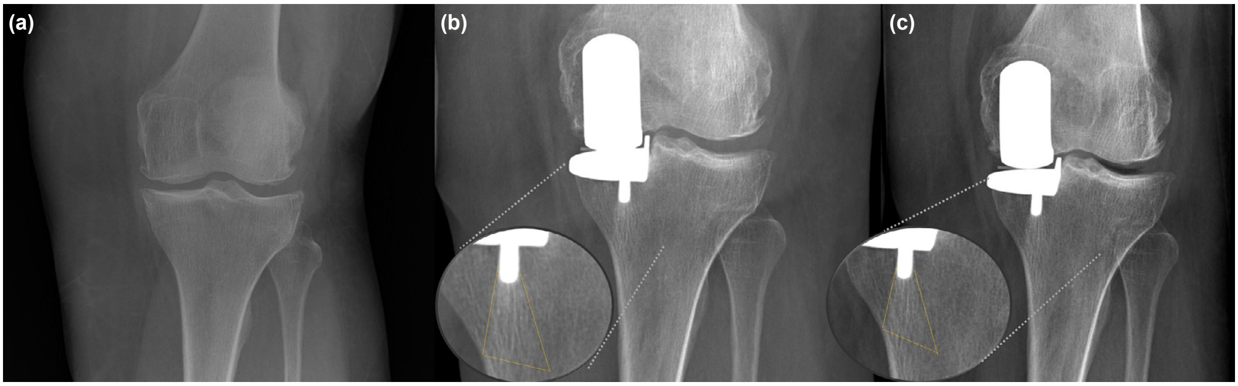

Figure 4. The ‘reactive triangle’ phenomenon. A normal metaphysis on the preoperative x-ray **(a)**, while on the first **(b)** and the second **(c)** postoperative year an increase in the density of the metaphysis, especially under the keel, creates a reactive zone, resemblin.

We also analyzed the cancellous bone of the proximal metaphysis. During the years, we have noted increases in the density of the metaphysis just below the tibial implant’s keel. These newly formed sclerotic regions are not present on preoperative X-rays but become prominent after most UKA procedures (Fig. 4). We call them “reactive triangles” since their shape resembles a triangle with an apex to the keel. Post-operative radiographs were analyzed for density increases below the keel. All obtained radiographical data were analyzed for correlation with the other variables of the study to look for factors leading to this change. All measurements were performed by two of the authors. They were aware of the purpose of the study but were blinded from each other’s measurement results. Disputed cases were analyzed by a third author and a majority decision was taken.

Statistical Analysis

Statistical analysis was carried out using SPSS 22.0 (Chicago, IL, USA). Categorical variables are stated as number (n) and percentage (%), and continuous variables as mean±standard deviation (SD) and median (minimum-maximum) values. Inter-observer reliability was analyzed and an intraclass correlation coefficient (ICC) was calculated.

The Shapiro–Wilk test was used to assess for distribution normality. Pearson correlation was used for normally distributed values while a Spearman correlation test was used for values which were not normally distributed. The Wilcoxon Signed-Rank test was applied in the comparison between data sets and $p<0.05$ was considered statistically significant.

RESULTS

Out of the identified initial 209 patients, 67 patients had been completely followed up at other centers, 19 patients had radiological views taken at random dates and could not be standardized, 13 patients had yearly radiographs, but they were taken with the knee in rotation (knee AP/L rather than implant AP/L) and they were inadequate for measurements and one patient underwent a revision procedure due to an early infection. The study was conducted in the remaining 109 patients.

Mean age was 57.7 years (46–77) and 88.1% of the patients were female (n=96). All relative demographic and descriptive data are shown in Table 1.

Coronal and sagittal alignment of the implant was measured on their early post-operative X-rays. The tibial implants had been implanted with an average varus angle of 1.8 degrees while the femoral component had been averagely implanted with an average valgus angle of 2.6 degrees. Overhanging was a relatively rare phenomenon with only 13 patients having a coronal plane overhanging of their tibial components and only six patients having sagittal plane overhanging. All data regarding alignment angles are presented in Table 2.

Reliability was analyzed and an ICC of 0.902 was obtained, showing good intra-observer reliability.

On the AP view, 5 cm from the joint line, the cortex thickness was on average 2.7 mm while the metaphysis was measured as 43.1 mm. The CTM ratio at this level was 0.0634. After the 1st year the ratio changed to 0.0615 and then on the 2nd year it was measured as 0.0625. All the relative measurements and the respective ratios are shown in Table 3. Figure 5 shows the graphical depiction of the change in ratio over the years and for all heights.

Table 1. Demographic and descriptive data

	Total n=109
Age, (years)	
Mean±SD	57.77±6.467
Median (min-max)	56 (46–77)
Sex, n (%)	
Male	13 (11.9%)
Female	96 (88.1%)
Side, n (%)	
Right	56 (51.4%)
Left	53 (48.6%)
BMI, (kg/m^2)	
Mean±SD	32.87±4.518
Median (min-max)	32 (24-48)

BMI: Body mass index; SD: Standard deviation.

Table 2. Alignment data of the tibial and femoral implants on their early post-operative radiographs

	Total n=109
Coronal alignment of the tibial component, (degrees)	
Mean±SD	1.8±4.0143
Median (min-max)	2.1 (−6.3–10)
Sagittal alignment of the tibial component; slope angle (degrees)	
Mean±SD	9.8±2.6152
Median (min-max)	9.8 (3.4–16.2)
Coronal alignment of the femoral component, (degrees)	
Mean±SD	-2.6°±4.1107
Median (min-max)	-2.7° (-13.8°–8.2°)
Sagittal alignment of the femoral component, flexion angle (degrees)	
Mean±SD	6.7±4.0391
Median (min-max)	6.7 (−2.7–16)
Coronal overhanging	
Yes	13 (11.9%)
No	96 (88.1)
Sagittal Overhanging	
Yes	6 (5.5%)
No	103 (94.5%)

SD: Standard deviation.

Interestingly, the ratio seems to decrease after the 1st year and then again slightly increase after the second. Change of the cortical thickness in millimeters and change in ratio was compared in-between the years and no statistically significant difference was found between them ($p>0.05$). All data are shown in Table 4. Because the changes were not significant, no correlation analysis could be performed.

The "reactive triangle" effect below the tibial keel, while not being present on any of the pre-operative views, was present on 57.8% of the views of the 1st (n=63) and on the 79.8% of the views of the 2nd year (n=87). Twenty-four patients, by consensus of the two authors making the measurements, had no increase in the density of the metaphysis on the 1st year but progressed on the second. A correlation analysis was performed to understand if this phenomenon was related to other variables in this study (BMI, postoperative lower limb anatomical axis, overhanging presence, component coronal/sagittal alignment, etc.). The presence of the triangle was correlated only with the absence of overhanging in the tibial component on the coronal plane. All data are shown in Table 5.

We then performed a subanalysis of the cases with a tibial implant overhang, to see if their cortical thicknesses and CTM ratios would behave differently during the years. Thirteen patients were identified with coronal overhang. Their change pattern was different from that of the other patients, showing a considerable increase in thickness and in CTM ratio over the 1st year (Fig. 6).

DISCUSSION

This study shows that radiological change occurs at the medial tibial plateau after a unicondylar knee replacement. Our initial hypothesis that some degree of increase in sclerosis was confirmed. The change is not reflected as an increase of cortical thickness, as we had expected, but mainly as an increase in the density of the proximal metaphysis, especially below the keel. This phenomenon is correlated with the absence of a tibial component overhang, just as we had also hypothesized. The CTM ratio seems to decrease in the 1st post-operative year.

Several studies have shown an increase in bone strain at the medial tibial plateau and its adjacent cortex after a unicondylar procedure. Simpson et al.[18] were among the first to use a finite element study to show the increase of bone strain at the medial tibial plateau. They also showed that an overhanging of more than 3 mm and a varus malalignment were also a cause for overloading. Other studies have found a valgus malalignment of >4 degrees to be a cause for increased strain.[10] This phenomenon is common and similar in unicompartmental procedures independently of fixation method, whether cemented or cementless.[12] An increase in bone strain has also been shown to lead to periprosthetic tibial fractures in unicompartmental knee arthroplasty.[16] In this study, we document the changes this strain creates on the metaphysis. The increase in density is likely to be the result of remodeling taking place on

Table 3. Average values of the cortexes and metaphyseal thicknesses and the calculated CTM

X-ray view and distance from the joint line									
Year	Modality	AP-5 cm		AP-7 cm		Lateral-5 cm		Lateral-7 cm	
0	mm	2.7	43.1	3.5	34.6	2.9	41.3	4.0	36.8
	CTM ratio	0.0634		0.1023		0.0704		0.1097	
1	mm	2.6	43.1	3.4	34.6	2.8	41.3	3.8	36.8
	CTM ratio	0.0615		0.0996		0.0690		0.1045	
2	mm	2.7	43.1	3.5	34.6	2.9	41.3	3.9	36.8
	CTM ratio	0.0625		0.1003		0.0713		0.1057	

CTM: Cortex-to-metaphysis ratio; AP: Antero-posterior.

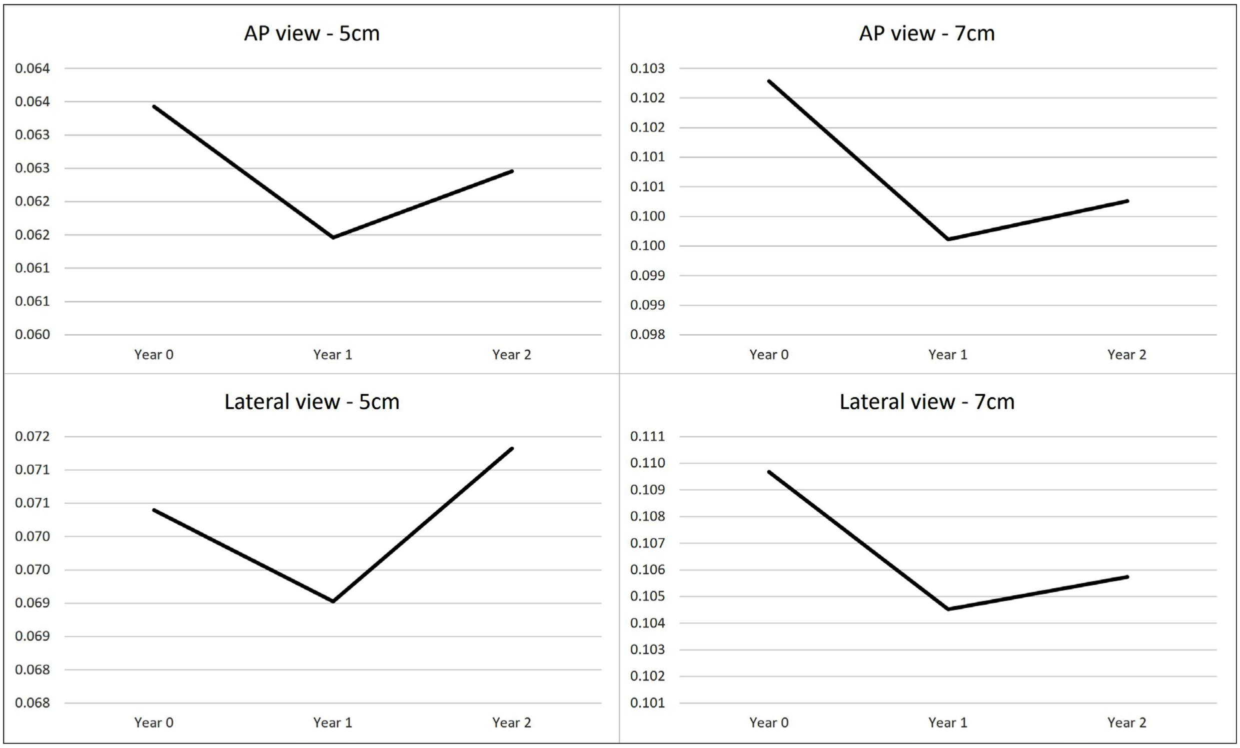

Figure 5. Average change in CTM ratio over the years and for all heights. Interestingly, the ratio seems to decrease after the first year and then again slightly increase after the second.

Table 4. The mean values of cortical thickness for the different levels below the joint line and change in these values and in the CTM ratio in between the years

	Post-operative X-ray (0)		1st year X-ray (1)		2nd year X-ray (2)		Change between 0 and 1 years (p)[a]		Change between 0 and 2 years (p)[a]	
	Cortical thickness	CTM ratio	Cortical thickness	CTM ratio	Cortical thickness	CTM ratio	Cortical thickness	CTM ratio	Cortical thickness	CTM ratio
AP view – 5 cm										
Mean±SD	2.7±0.896	0.0634	2.6±0.821	0.0615	2.7±0.860	0.0625	<0.179	<0.156	<0.509	<0.474
Median (min-max)	2.7 (1.1–5.3)		2.5 (1.1–5.6)		2.5 (1.1–5.3)					
AP view – 7 cm										
Mean±SD	3.5±0.855	0.1023	3.4±0.923	0.0996	3.5±0.964	0.1003	<0.103	<0.089	<0.557	<0.702
Median (min-max)	3.4 (1.9–5.9)		3.2 (1.8–6.6)		3.4 (1.7–6.6)					
Lateral view – 5 cm										
Mean±SD	2.9±1.342	0.0704	2.8±0.600	0.0690	2.9±0.779	0.0713	<0.716	<0.738	<0.490	<0.466
Median (min-max)	2.6 (1.6–5-1)		2.8 (1.6–4.3)		2.9 (1.6–5.3)					
Lateral view – 7 cm										
Mean±SD	4.0±0.821	0.1097	3.8±0.910	0.1045	3.9±1.134	0.1057	<0.425	<0.484	<0.269	<0.284
Median (min-max)	2.5 (1.1–5.6)		3.7 (1.8–6.9)		3.6 (2.0–7.2)					

CTM: Cortex-to-metaphysis ratio; average value of ratios; AP: Antero-posterior; [a]Wilcoxon singed-rank test.

the newly surfaced cancellous bone created by the horizontal cut during the procedure. A new layer of "subchondral" bone, absorbing the bodyweight is created below the implant though compression and therefore remodeling. In patients without a tibial implant overhang, the process seems to be accompanied with an increase in the density of the metaphysis. This density commonly takes the shape of a triangle, with an apex to the implant's keel. For patients with a tibial overhang on the other hand, load is distributed more on the cortexes than on the subchondral bone. Especially during the 1st year, these patients show an increase in cortical thickness, and therefore an increase in the CTM ratio.

Pain after a unicondylar knee replacement, similar to total knees, is one of the main reasons of postoperative patient dissatisfaction and is known to lead to early unnecessary revisions. Mohammad et al. found pain to be the second most common cause for revision surgery, independently of

Table 5. Correlation of the study variables with the presence of the "reactive triangle"

	Presence of the "Reactive triangle" on year 1		Presence of the 'Reactive triangle' on year 2	
	Correlation Coefficient R*	Significance p	Correlation Coefficient R*	Significance p
Body mass index	0.042	0.666	−0.013	0.892
Coronal alignment-Tibia	0.054	0.579	0.087	0.369
Sagittal alignment-Tibia	0.087	0.369	0.025	0.769
Coronal alignment - Femur	0.109	0.258	−0.088	0.363
Sagittal alignment - Femur	0.148	0.125	0.057	0.558
Coronal overhang-Tibia	−0.259	0.007	−0.379	0.000
Sagittal overhang - Tibia	−0.038	0.694	0.121	0.209
Final post-operative limb axis	0.075	0.440	0.114	0.239
Total change of the axis (pre-post-op)	−0.084	0.384	0.021	0.825

*Spearman's rho.

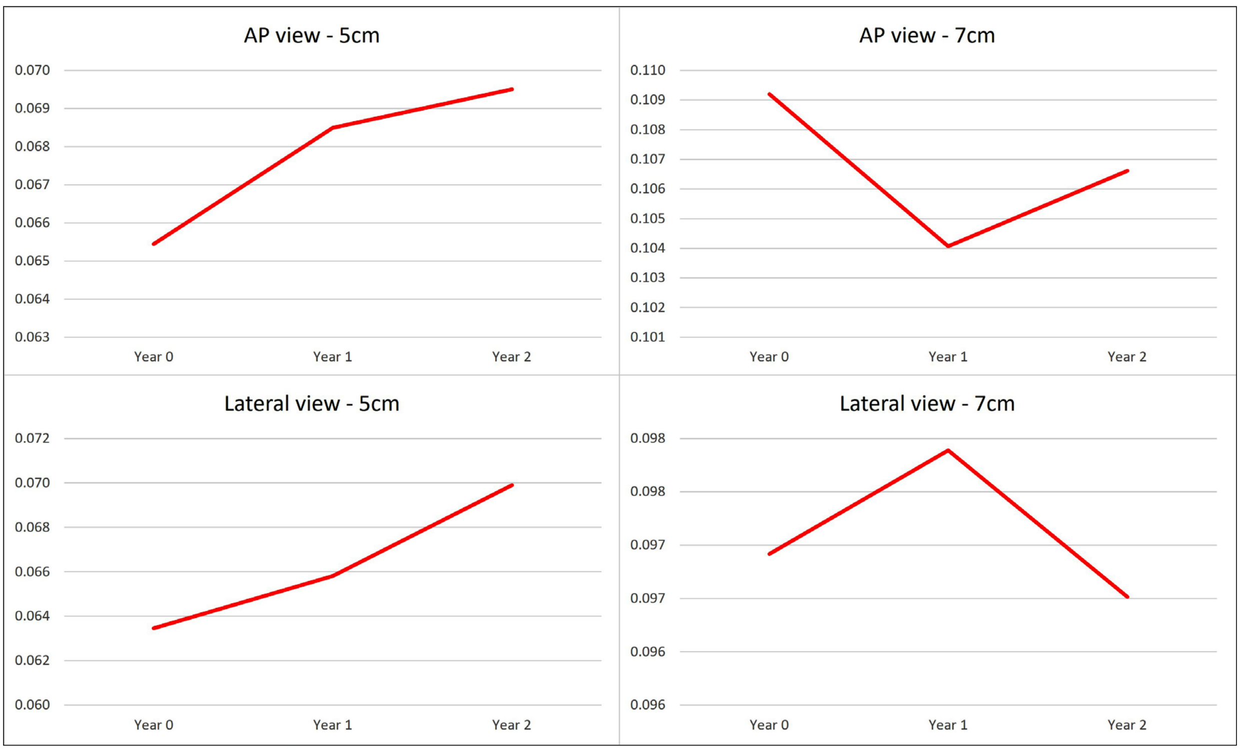

Figure 6. Change of the CTM ratio in patients with a tibial overhang. These patients were characterized with an absence of the 'reactive triangle' and therefore we suspected that the overloading and the strain would reflect more on the cortexes.

fixation method.[19] Because the reasons of antero-medial tibial pain in unicondylar knees are still poorly understood, the procedure has a lower revision threshold compared to a total knee replacement.[20] Increased osteoblastic activity has also been shown to be a cause of pain in the subchondral bone and has also been linked with pain after unicondylar knee replacements.[21–24] Considering that unicondylar implants tend to subside after surgery, the new subchondral bone that appears after the removal of the original one, tends to remodel itself in light of Wolff's law.[25–27] The radiological changes documented by this research might be linked to this remodeling process.

SPECT/CT scans of chronically painful knees have shown increased uptake at the proximal medial tibial metaphysis, especially in cases with aseptic loosening and with misaligned implants.[24] In time this osteoblastic activity is supposed to decrease and then end completely, hence the disappearance of pain in the medial tibia after 8–12 months after surgery. It is not clear why in some cases the pain is persistent and sometimes leads to revisions, but studies suggest it could be linked to continuous remodeling.[3,23] More research is still needed on this topic.

The results of this study should also be interpreted in light of its limitations. Nearly half of the identified initial patients were ineligible for the study, shrinking our sample and lowering the power of the study. A second limitation of this study is that it was conducted on plain radiographs and measurements performed on radiographs are prone to errors.[28] Even though the change of the CTM seems to follow a similar pattern on most views and levels, the change is minimal and measured in millimeters. We tried to minimize errors by standardizing the radiographs and excluding the ones with oblique views. Despite its drawbacks, this study is the first to report radiological change of the tibial cortex and medial metaphysis in real patients. Studies with a greater number of patients and conducted with CT or SPECT/CT scans are needed to further understand the remodeling phenomenon taking place on the medial proximal tibia after arthroplastic procedures and whether this phenomenon is linked to early postoperative pain.

CONCLUSION

Radiological change occurs at the medial tibial plateau after a cementless unicondylar knee replacement. The change is not reflected as an increase of cortical thickness, but mainly as an increase in the density of the proximal metaphysis, especially below the keel. This phenomenon is correlated with the absence a tibial component overhang.

Ethics Committee Approval

This study approved by the Ankara City Hospital Clinical Research Ethics Committee (Date: 03.03.2021, Decision No: E1-21-1577).

Informed Consent

Retrospective study.

Peer-review

Externally peer-reviewed.

Authorship Contributions

Concept: E.V., A.F.; Design: E.V., A.F., İ.Ö.S.; Supervision: A.Ş., H.A., K.K.; Fundings: E.V., A.F., İ.Ö.S.; Materials: A.Ş., H.A., K.K.; Data: E.V., A.F., İ.Ö.S.; Analysis: A.Ş., H.A., K.K.; Literature search: E.V., A.F., İ.Ö.S.; Writing: A.Ş., H.A., K.K.; Critical revision: E.V., A.F., İ.Ö.S.

Conflict of Interest

None declared.

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Çimentosuz Unikondiler Diz Artroplastisi Sonrası Proksimal Tibial Korteksin Kalınlaşma Paterni; Radyolojik Bir Çalışma

Amaç: Unikondiler diz artroplastisi (UDA) öncelikle medial kompartmanın yüzey değişimi için kullanılır ve orta-uzun vadeli sonuçlar umut vericidir. Daha önce birçok çalışmada tibial komponentin etrafındaki kemik dokularda meydana gelen değişiklikler analiz edilmiştir ve bu değişikliklerin, bölgesel olarak artan strese bağlı olduğu bildirilmiştir. Bu çalışmanın amacı, çimentosuz UDA sonrası tibia metafizinin medialinde kemiğin yeniden şekillenme paternini araştırmaktır.

Gereç ve Yöntem: Bu geriye dönük çalışma Mart 2015 ile Mart 2019 arasında çimentosuz UDA ile tedavi edilen hastalarımız ile yürütüldü. Dahil edilme kriterleri, en az bir olmak üzere, en fazla iki yıl takipli ve yıllık standart ayakta çekilen direkt radyografilerinin mevcut olmasıydı. Toplam 109 hasta dahil edildi. Lateral tibial eminentia'nın 5 ve 7cm aşağısında iki adet horizontal seviye belirlendi. Bu seviyelerde total metafizier kalınlık ve medial korteks kalınlıkları ölçüldü. Korteks-metafiz oranı (KM) belirlendi ve ölçüm için seri radyografiler kullanıldı. Metafizdeki fokal sklerotik odakların varlığı 'reaktif üçgen' fenomeni olarak değerlendirildi. Hipotezimiz, tüm hastalarda belirli bir düzeye kadar sklerotik değişikliklerin meydana geleceği ve bu değişikliklerin küçük boyuttaki tibial komponentlerde daha fazla olacağı yönündeydi.

Bulgular: KM oranı, ölçülen tüm seviyeler için ameliyat sonrası ilk yıl boyunca azalan bir patern gösterdi. Ameliyat sonrası birinci yılda hastaların %58'inde, ikinci yılda ise %80'inde tibial komponentin (keel) hemen altındaki metafiz alanında yoğunluk artışı gözlemlendi. Bu yoğunluk artışı grafiye fokal sklerotik bir alan olarak yansıdı ve koronal planda implant taşmaması ile ilişkilendirildi. Tibial komponentin görece büyük olduğu hastalarda KM oranında artış görüldü.

Sonuç: Unikondiler diz artroplastisi prosedüründen sonra artan kemikteki gerilim stresi, proksimal tibial metafizde kortikal ve kansellöz kemik değişikliklerine yol açar. Bu değişiklikler koronal planda tibial komponentin taşmamasıyla ilişkilidir.

Anahtar Sözcükler: Çimentosuz unikondiler diz artroplastisi; diz cerrahisi; kemik gerilim stresi.