Research Square

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Under-correction is not advisable in valgus knee and lateral approach is more feasible than medial approach to achieve this: A 5-year follow-up study

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Research Article

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Abstract

Background: It is commonly recommended to restore the mechanical axis to within –0° ± 3° in valgus knee. However, the situation is quite different when the alignment is –3° or 3° in the presence of a compromised MCL in Ranawat type II valgus knee. This study compared the results of over-correction and under-correction of valgus knee.

Methods: A retrospective cohort study was conducted on TKA for valgus knee with a minimum follow-up of 5 years. Knees of the patients were classified as Ranawat II and 109 knees in 104 patients were enrolled. Patients in Group A underwent a TKA through a medial approach, while group B through a lateral approach by a different surgeon. The patients in Group B were matched 1:1 to patients in Group A. The KS knee score, KS function score and range of motion (ROM), HKA angle, distal femoral angle (DFA), proximal tibial angle (PTA), surgical time were recorded, Mediolateral stability were recorded. Complications were also recorded.

Result:

A significant difference in soft tissue release was observed between the two groups. There was significant difference in terms of HKA alignment immediately after surgery (180.6±1.5 vs 179.7±1.2; *P*□0.05) between the two groups. Significant differences were observed between Group A and Group B in rate of outlier, under-correction, 180°-correction and over-correction (P□0.05). when HKA alignment was under-corrected or valgus outlier, the medial stability at final follow up was worsen compared with that of immediately after surgery, but the lateral stability at final follow-up remained the same as immediately after surgery.

Conclusion□In order to protect the already compromised MCL, the Ranawat type II valgus knee should not be under-corrected, and a lateral approach is more feasible than a medial approach for achieving this goal.

Introduction

To restore a neutral overall mechanical axis in total knee arthroplasty (TKA) is supported by numerous studies.[1–3] Recent studies have shown that mild under-correction deformity within 3° had similar or superior clinical outcomes on the prerequisite of intact of medial collateral ligament (MCL) in varus knee.[4–6]

Among all TKA cases, approximately 10% of patients have a valgus deformity, which differs from varus. Particular tailored considerations are required during TKA in valgus knees, including femoral condyle hypoplasia, lax medial structures, lateral soft-tissue contracture, bone loss, and patellar mal-tracking. However, it is quite a different situation when the alignment is -3° or 3° in the presence of a compromised MCL in a type II valgus knee. Some studies demonstrated that over-correction may be preferable to counter the tendency to shift back to valgus by protect MCL, however, it was technique challenging, especially through a standard medial parapatellar approach.[7–10] Due to the difficult technique in valgus knee to release the contracted lateral soft tissue structures, under-correction is an acceptable postoperative alignment,[11,12] however, carry the risk of stressing the already compromised MCL, which might result in recurrence of valgus knee.[9] Few studies have compared the mid-term outcomes of under-correction and over-correction.

The aim of this study is to compare a minimum 5 years of follow-up clinical outcomes of under-correction and over-correction in valgus knees. The primary hypothesis was that over-correction provides better medial stability than under-correction. The secondary hypothesis was that the lateral approach is more effective than the medial approach in achieving soft tissue balance.

Methords

The medical records and radiological data were retrospectively collected from our institutional arthroplasty database of TKAs performed from January 2010 to January 2017. This study was approved by the Ethics Committee of Luoyang Orthopedic Hospital of Henan Province and conducted in accordance with the Declaration of Helsinki (NO. 2019-008-02). Informed consent was obtained from all individual participants included in the study.

Valgus knees have been classified into three types by Ranawat et al.[9] Type I knees (intact MCL) can usually be successfully treated with bone cut only and non-constrained implants, and type III knees usually require a high constrained implant. During the present study period, there were 180 patients with type I, 118 with type II, and 23 with type III. The inclusion criteria were type II valgus knee. The exclusion criteria were patients with extra-articular deformity, infectious arthritis or any other additional associated surgical procedure (such as femoral epicondyle upsliding or quadriceps snip). Of the 118 patients with type II valgus deformity, 2 were excluded due to not all X-rays were available, 4 died during the follow-up and 3 were lost, leaving 109 knees in 104 patients were enrolled in present study. The minimum follow-up period was 5 years.

Patients in Group A with type II valgus knee from this patient pool, who underwent a TKA through a medial approach by senior A, while group B from this patient pool through a lateral approach by senior B. To mitigate the baseline differences between the two groups, patients in Group B were matched 1:1 to patients in Group A using propensity score matching based on the following covariates: age, gender, body mass index (BMI), and preoperative mechanical alignment. Details of the groups are shown in Table 1. No difference was found between the two groups in terms of demographic characteristics.

Table 1
Characteristics of the study population before and after matching.

	Before propensity score matching			**After propensity score matching**		
	Group A(SD)	**Group B(SD)**	**p-value**	**Group A**	**Group B**	**p-value**
Number of patients	53	56		50	50	
Mean age, y (SD)	65.4(6.2)	67.2(7.1)	n.s.	64.9(5.8)	66.5(6.9)	n.s.
Gender (Female), n (%)	46(63.9)	41(56.2)	n.s.	45(64.2)	41(58.5)	n.s.
BMI, kg/m^2 (SD)	29.4(5.2)	30.1(4.7)	n.s.	29.7(5.1)	29.9(3.9)	n.s.
Preoperative HKA alignment (°)	195.4(6.6)	194.6(5.9)	n.s.	196.2(6.2)	194.6(5.6)	n.s.

SD=standard deviation; BMI=body mass index, HKA = hip knee ankle, p values with non-statistical significance are marked with n.s.

Surgical procedure

The target for the postoperative alignment was natural (0° ± 3°) for both groups. A medial parapatellar approach was used for group A and a lateral parapatellar approach was applied for group B. The medial soft tissue was undisturbed as far as possible in both groups. In group A, the lateral retinaculum was released to stabilize the patellofemoral joint. In group B, the lateral retinaculum–capsule complex was released using a coronal Z-plasty to facilitate soft tissue closure after alignment correction. An intramedullary guide was used to perform the distal femoral cut in 3° or 4° of valgus in both groups. Extramedullary guide was used for the primary tibial cut at 90°, and posterior tibial slope was set according to the manufacturer's recommendation. Proximal tibial resection was minimized, with reference to the medial tibial condyle. To achieve rectangular extension and flexion gap, soft-tissue release was performed and recorded as described in the previous studies.[7,9,13,14] First, Attention should be directed to the extension gap. The iliotibial band was released first, and then the posterolateral corner, lateral ligament was gradually released if necessary. The popliteus tendon was preserved whenever possible. The rotational alignment of the femoral component was determined using proximal tibial cut surface, Whiteside line and epicondylar axis. A cemented posterior stabilized knee was used in all cases.

Clinical and Radiographic evaluation

Clinical evaluation including KS knee score and KS function score and Range of motion (ROM) were evaluated pre-operatively and at the final follow-up. Pre- and post-operative hip-knee-ankle (HKA) alignment immediately after surgery using weight-bearing long-leg anteroposterior radiographs. Based on postoperative HKA angle, knees were categorized as follows: HKA

angle < 177° =varus outlier; 177° ≤ HKA angle ≤ 180° = over correction; HKA angle = 180° = neutral alignment; 180° ≤ HKA angle ≤ 183° = under correction; HKA angle > 183° = valgus outliers. To assess component positioning in the coronal and sagittal planes, distal femoral angle (DFA) and proximal tibial angle (PTA) were measured on postoperative long leg radiographs, as described by Volkan[15]. The DFA was defined as the medial angle between a line drawn parallel with the femoral component condyles on the AP X-ray and the anatomical axis of the femur, PTA was defined as the medial angle between a line across the base of the tibial tray on the AP X-ray and the anatomical axis of the tibia.

ligamentous stability

Postoperative coronal ligamentous stability was assessed using stress radiographs obtained at approximately 15° of knee flexion, as described previously by Tadashi.[16] On the stress radiographs, the angle was measured between a line tangent to the distal contours of the femoral component condyles and the proximal tibial joint line. This angle was defined as the varus or valgus angle according to the description by Yagishita et al.[17] These angles indicated the values of medial ligamentous laxity or lateral ligamentous laxity, respectively. All the measurements were performed in the operating room immediately after surgery and repeated at the final follow-up.

Statistical Analysis

Univariate analysis was performed using the Chi-square test. Continuous variables were compared using the t-test. Pearson's rank correlation was calculated to evaluate the correlation between postoperative HKA immediately after surgery and coronal ligamentous stability at final follow-up. Statistical tests were conducted using Graphpad Prism 10.1, with significance defined as $P < 0.05$.

Result

For both groups, there was a significant improvement in clinical outcomes compared with preoperatively status. No statistically significant difference concerning clinical outcomes were shown between the two groups. There was no significant difference in terms of surgical time, DFA and PTA between the two groups (Table 1).

A significant difference in soft tissue release was observed between the two groups. In the medial approach group, 50 (100%) cases required iliotibial band (ITB) release at Gerdy's tubercle, 50 (100%) required posterolateral corner release, 46 (92%)required ITB release at distal of patella, 10 (20%) required lateral collateral ligament (LCL) release and 3 (6%) required popliteus tendon (PT) release. In the lateral approach group, 50 (100%) required posterolateral corner release, 36 (72%) required ITB release at distal of patella, 20 (40%) required LCL release and 2 (4%) required PT release. (Table 2).

Table 2. Comparisons of variables in medial approach group and lateral approach

	Group A(medial)	Group B(lateral)	p-value
Surgical time (min)	54.6	50.6	n.s.
DFA	95.4±1.1	95.2±1.2	n.s.
PTA	90.2±2.5	89.4±1.9	n.s.
Constrained prosthesis (n)	4	0	*P*0.05*
Number of soft-tissue release procedures			*P*0.05*
ITB release at Gerdy's tubercle (n)	50	0	
Posterolateral corner (n)	50	50	
ITB at distal of patella (n)	46	36	
LCL (n)	10	20	
PT (n)	3	2	
HKA alignment immediately after surgery(°)	180.6±1.5	179.7±1.2	*P*0.05*
Distribution of HKA alignment immediately after surgery			*P*0.05*
Valgus outlier (n)			
Under correction (n)	3	0	
180°Aligned (n)	18	8	
Over correction (n)	12	11	
Varus outlier (n)	12	26	
	0	0	

DFA= distal femoral angle, PTA =proximal tibial angle, HKA=hip knee ankle, ITB= iliotibial band, LCL= lateral collateral ligament, PT= popliteus tendon, p values with statistical significance are marked with *, p values with non-statistical significance are marked with n.s.

There was a significant difference in HKA alignment immediately after surgery between the two groups (180.6 ± 1.5 vs 179.7 ± 1.2; $P<0.05$) (Table 2). Significant differences were observed between Group A and Group B in the rates of outlier, under-correction, 0°-correction, and over-correction ($P<0.05$) (Table 2). The KS knee score, KS function score and ROM were improved postoperatively in both groups compared with preoperative status and there was not significantly different among the two groups (Table 3). In both groups, when HKA alignment was overcorrected or neutral, medial and lateral stability remained unchanged at final follow-up compared with immediately after surgery (Fig. 1, Fig. 2). However, when HKA alignment was under-corrected or in valgus outlier, medial stability at final follow-up was worse than that immediately after surgery, but lateral stability at final follow-up remained the same as immediately after surgery (Fig. 1, Fig. 2). Pearson's rank correlation showed that postoperative HKA angle was correlated with medial ligamentous stability at the final follow-up ($P < 0.05$) (Fig. 3).

Table 3
Comparisons of clinical functions in medial approach group and lateral approach

	Group A		Group B		Inter		Intra	
	Pre	Post	Pre	Post	Pre	Post	Group A	Group B
KS knee score	61.5(13.9)	90.5(11.2)	62.7(12.4)	91.4(10.8)	P<0.05*	P<0.05*	n.s.	n.s.
KS function score	60.4(18.7)	80.5(18.3)	59.6(19.2)	81.6(17.2)	P<0.05*	P<0.05*	n.s.	n.s.
ROM	87.9(19.1)	113.2(16.8)	87.9(19.1)	110.2(14.4)	P<0.05*	P<0.05*	n.s.	n.s.
Pre=preoperative, Post=Postoperative, ROM=range of motion, Intra=intra-group comparisons, Inter= inter-group comparisons.								
p values with statistical significance are marked with *, p values with non-statistical significance are marked with n.s.								

One case of temporary nerve palsy occurred in a patient in Group B who had 25° of valgus alignment preoperatively; the nerve had fully recovered by 10 months postoperatively. No deep venous thrombosis or infections were observed at the final follow-up.

Discussion

This study consisted of a retrospective review assessing evaluate postoperative knee alignment on medial instability of valgus knee. The most important finding of the present study was that over correction of a valgus knee by lateral approach was more stability than under correction by lateral approach after a mean follow-up of 5 years. Multiple studies demonstrated various technique to deal with the valgus knee, however, there still had debate on under-correction (180°>HKA>177°) or over-correction(180°<HKA<183°) of valgus deformity.

It was widely accepted that a deviation of the mechanical axis more than 3° from 0° was associated with prosthetic failure due to increased contact stresses.[19–21] Various studies demonstrated that the outlier population had a higher complication rate than aligned group, however, these studies did not discriminate between valgus and varus knees pre-operatively.[18,21] To date there was no published evidence to define what the targeted alignment should be about valgus knee nor the risk factors about valgus recurrence in long fellow up.[12] Krackow et al.[22] demonstrated that under-correction of valgus deformity should be avoided, which will stress the already compromised MCL. Mark et al.[23] reported a retrospective study of 10 years of followed-up with valgus deformity with medial approach. In this study, in order to protect over-correction of the underlying deformity, distal femoral resection is performed in 3° of valgus in relation to the anatomical axis. The mean anatomic valgus angle was over-corrected from 15° preoperatively to 5° postoperatively. The stability of the knee at one year follow-up was the same as that of ten years follow-up. Friedrich et al.[24] reported a 2-year follow-up results of patients with valgus osteoarthritis by medial approach, 14% of medial opening more than 3° and one outlier required revision 4 years for medial instability. Kenji et al.[8] reported the 10–20 years of followed-up when the valgus the alignment was over corrected in varus with none of late-onset instability, however, who advocate under corrected of valgus without long terms followed-up. This is highlighted in a recent study by Merrül et al.[25] This study consisted of a retrospective review assessing evaluate postoperative knee alignment on prosthesis survival of valgus knee. In this study, postoperatively valgus alignment more likely to fail because of lateral instability than those that were in varus preoperatively but neutral postoperatively. In present study, the medial ligamentous stability was not changed at final fellow up when valgus knee was over corrected.

When performing surgery for valgus knees, the surgeon should always be prepared with constrained prostheses for unexpected situations. Bertrand et al.[21] reported a multi-center retrospective study of 8 years of followed-up when the alignment of fixed severe valgus knee was corrected into aligned-corrected, outlier (under- and over-corrected) groups. In this

study, over-corrected groups were defined as HKA angle > 4°, and under-corrected was defined as HKA angle <-4°. The complication rate of over-corrected group and under-corrected was 26% and 4%, respectively. Even there was no statistically significant difference was found between outlier group and aligned knee group, the study did not test the medial stability, and 16% patients were implanted with high constrained implant. Alexander et al.[13] reported that lateral approach without tibial tubercle osteotomy allowed better correction of valgus deformity than medial approach (10.8° vs 7.3°), the rate of constrained implants in lateral approach group and medial approach was, 9% and 16%, respectively. In present study, 5% of patients were implanted with constrained prostheses in group A while 0% in Group B. Possible reasons include: the lateral approach provides direct visualization, allowing for easier intraoperative assessment of soft tissue stability and balancing.

Even in the hands of experienced surgeons, manual instrumentation resulted in overall coronal malalignment (> 3° from neutral) in approximately 28% of patients.[1] So how to achieve well-aligned or over-corrected in valgus is difficult thing for surgeons, still needing definite answers regarding surgical approaches. Several studies have stated that lateral approach offered benefits over the medial approach, such as direct release of lateral structures by virtue of the lateral approach itself, allows better visualization of the lateral side of the knee, making knee balancing easier, lateral release of the patella is less, and the medial is not disturbed.[13,26] In the present study, 75% of cases achieved over-correction without requiring a constrained implant in group B. Although not statistically significant, the lateral approach required the release of fewer lateral structures (2.8 vs. 3.5) compared to the medial approach. This indicates that the lateral approach may facilitate over-correction more readily than the medial approach. This is highlighted in recent studies.[25,27]

Limitation

This study has several limitations. First, it is a retrospective study rather than a randomized controlled trial, which inherently carried limitations and potential biases. In particular, the comparison between medial and lateral approaches is heavily confounded because the operations were performed by different senior surgeons, however, the target alignment was 180 ± 3°. Second, the duration of follow-up was short, longer follow-up is required. Third, the present study divides patients into narrow HKA-based categories, yet postoperative alignment within 0 ± 3°degrees of varus or valgus is generally regarded as acceptable in clinical practice. However, it is quite a different situation when the alignment is -3° or 3° in the presence of a compromised MCL in a type II valgus knee. Fourth, to simplify the issues of over- and under-correction for valgus knee, only coronal alignment was studied. There is a risk of transverse or sagittal malposition, which may also affect overall limb alignment and kinematics. There was no difference in clinical outcomes between the two groups at final follow-up. However, because postoperative coronal ligamentous stability was assessed with the knee at 15° of flexion in the present study, the stability of the posterior capsule was ignored; therefore, longer follow-up is warranted. sixth, this is a single-center study, multi-centers studies are needed to validate these findings before the technique can be widely adopted.

Conclusion

Overcorrecting a Ranawat type II valgus deformity results in better medial stability at 15° of flexion compared with under-correction. When HKA alignment was over-corrected or neutral, medial and lateral stability remained unchanged at the final follow up compared with immediately after surgery. However, when HKA alignment was under-corrected or in valgus outlier, medial stability at the final follow up was worse than that immediately after surgery, while lateral stability remained unchanged. Postoperative HKA angle was correlated with medial ligamentous stability at the final follow-up. Compared with the medial approach, the lateral approach offers the advantages of being easier to avoid under-correction, requiring less lateral soft tissue release, and having a lower rate of constrained prosthesis use.

Declarations

Conflict of interest:

All authors declared that they had no conflict of interest.

Ethics approval and consent to participate

The study was approved by the Ethical Committee of Luoyang Orthopedic Hospital of Henan Province (NO. 2019-008-02).

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Author Contribution

Shuailei Li, Writing – original draft. Hao Chai, Weidong Bao and Quanbo Ji, Collecting data. Yongqiang Sun, Resources, Writing – review & editing. Jiankang Pan, Project administration, Conceptualization, Supervision.All authors have read and approved the final submitted manuscript.

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Figures

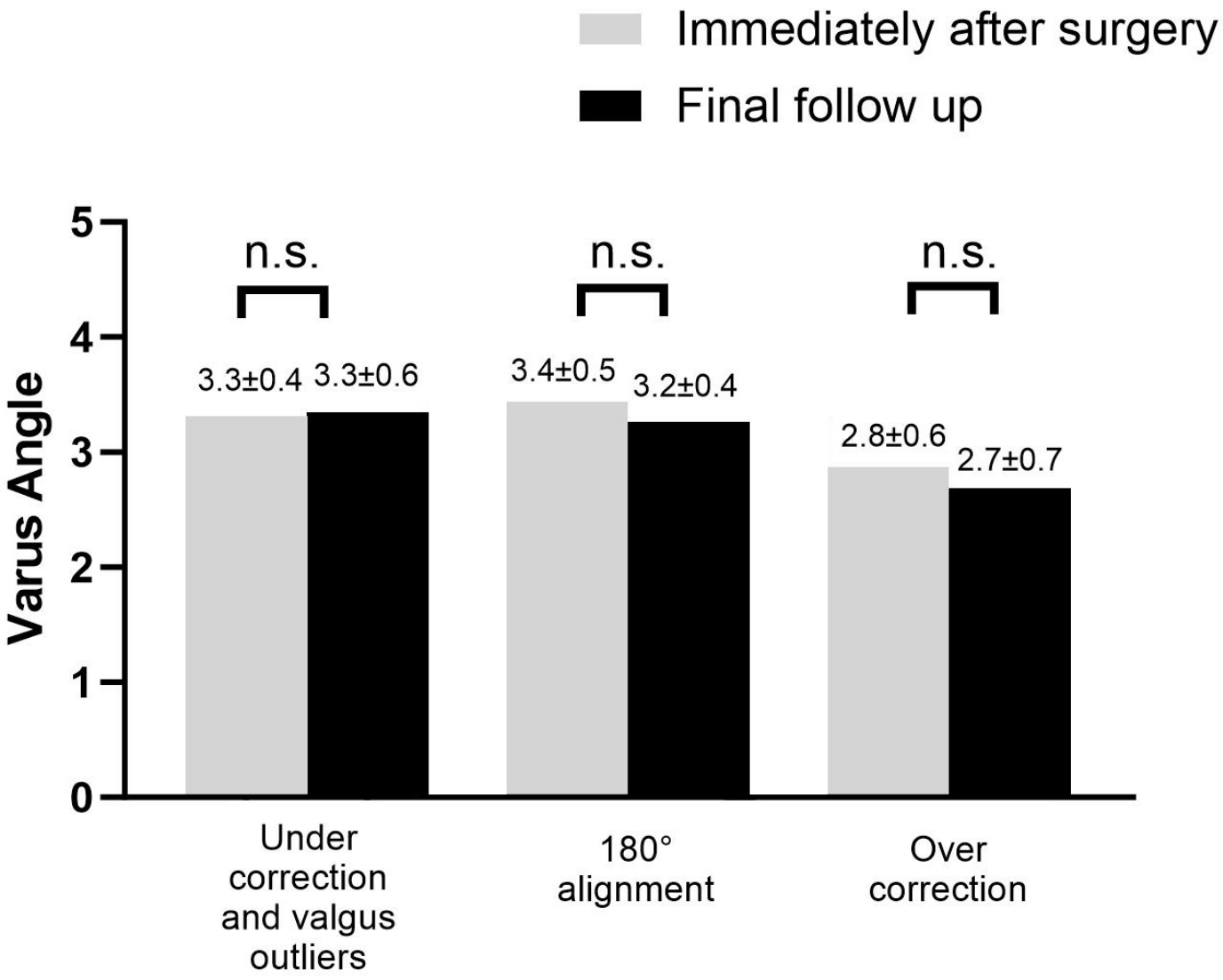


Figure 1

Mean values are shown for varus angles immediately after surgery and at final follow-up. We found that lateral stability remained unchanged at final follow-up compared with immediately after surgery, regardless of HKA alignment.

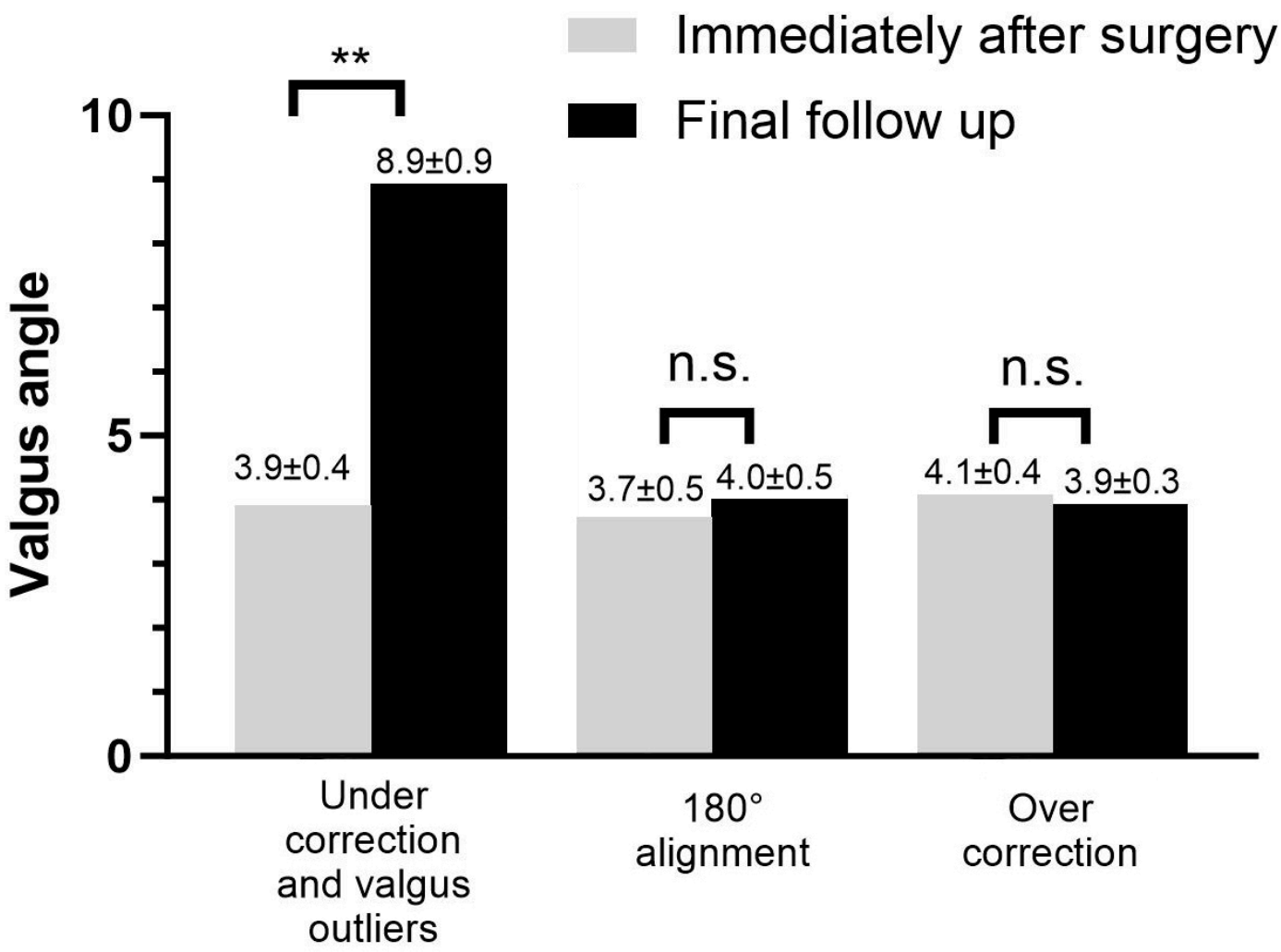


Figure 2

Mean values are shown for valgus angles immediately after surgery and at final follow-up. We found that when HKA alignment was under-corrected or was a valgus outlier, medial stability at final follow-up was worse than that immediately after surgery, whereas lateral stability remained unchanged.

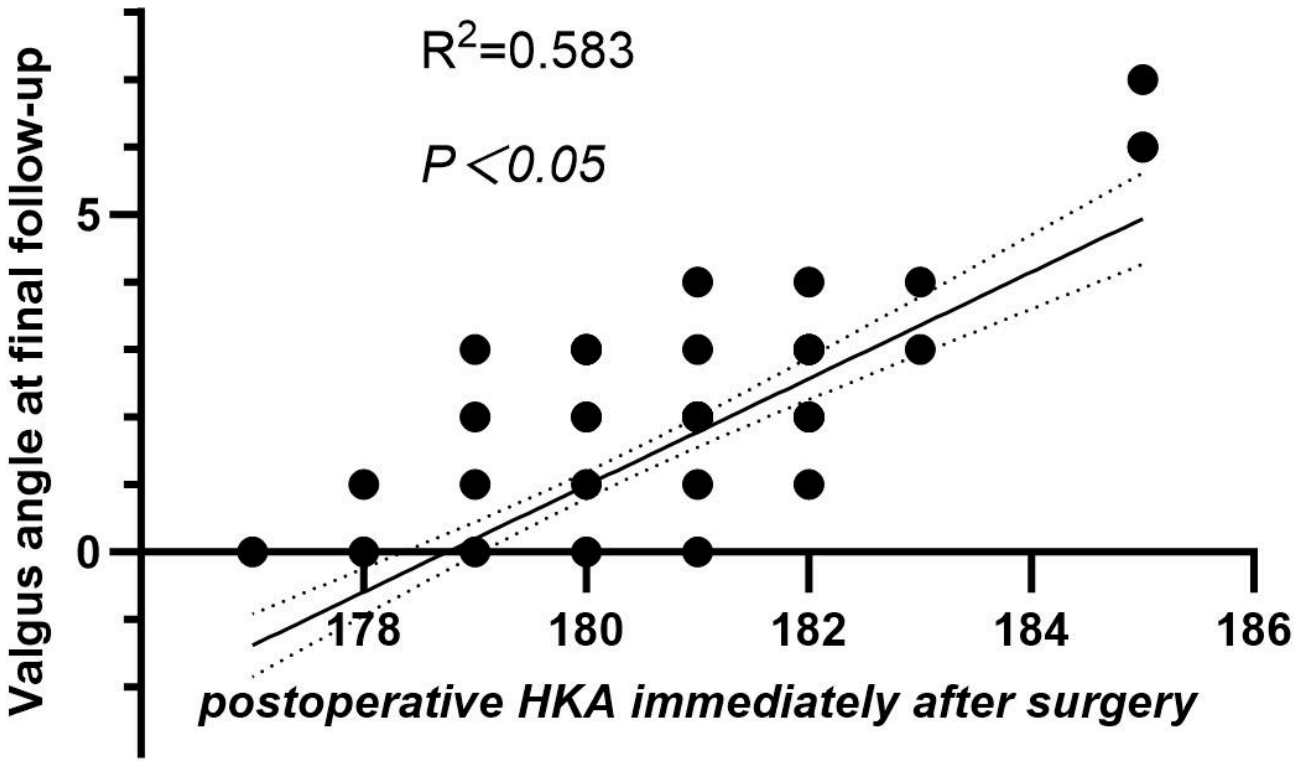


Figure 3

This graph shows a comparison of the postoperative HKA angle and Valgus angle at final follow-up on a standing radiograph. We found a correlation between postoperative HKA angle and medial ligamentous stability at the final follow-up.