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Original Research

Role and Results of Constrained Insert in Computer-Assisted Primary Total Knee Arthroplasty: A Propensity-Matched Study

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ABSTRACT

Purpose: Mild ligament imbalance is often encountered in the mediolateral plane during complex primary total knee arthroplasty. A constrained (CP) polyethylene insert compatible with the primary femur is useful to manage these cases without the need to fall back on revision implants. The aim of the study was to define the correct indications of the use of a CP insert based on objective data from computer assisted surgery and to compare the early results of a CP insert with a standard posterior stabilized (PS) insert through one-to-one propensity score matching.

Methods: This is a retrospective case study from a prospectively collected database. One-to-one matching without replacement was used with a caliper width of 0.2 to match the scores between CP (N = 64) and PS groups (N = 1624), resulting in equal covariate matching of PS (N = 64) and CP (N = 64) cohorts. Patients were assessed radiographically and functionally at a minimum follow-up of 3 years.

Result: Average coronal and sagittal plane deformities were similar in both the group CP (varus 13.1 ± 5.2 valgus 13 ± 7.9) and the group PS (varus 13.4 ± 4.6 valgus 10.9 ± 8.6). The average residual medial lateral gap difference was significantly higher in group CP (3.8 ± 1.8) in comparison to group PS (1.3 ± 1) ($P < .05$). A CP insert was chosen where mild ligament imbalance of 3-5 mm persisted after medial soft tissue releases in a varus knee and in cases with residual medial collateral ligament laxity in valgus knees.

Conclusions: Constrained insert used with the primary femoral component is a valuable option to handle mild ligamentous instability in complex primary total knee arthroplasty after mechanical alignment is achieved with computer navigation.

Level of Evidence: III.

Introduction

The ascending levels of constraint used in knee arthroplasty are cruciate retaining, anterior stabilized, posterior stabilized (PS), constrained (CP), and hinge. Cruciate retaining, anterior stabilized, and PS are mostly used in primary total knee arthroplasty (TKA), CP in revision TKA, and hinge is reserved for revisions with instability [1]. However, the knee arthroplasty surgeon is often faced with mild ligament imbalance in complex primary TKA. These knees are difficult to balance with PS TKA, and shifting to revision TKA requires revision instruments and implants [2].

It is also difficult to convert the bone preparation of primary TKA to revision cuts, as it requires revision jigs to be used on intramedullary trial rods. This may make the procedure complicated and lengthy [3]. A CP PS insert compatible with the primary femur is useful to manage these cases without the additional support of a stem or a revision femur implant [4,5].

Most studies on constraint insert with primary nonstemmed femurs report higher failure rates in the mid- to long-term. Retrieval analysis demonstrates increased wear on the anterior aspect of cam and polyethylene insert. All these studies have been done with conventional instruments where components and overall alignment could be suboptimal, leading to insert wear and early failure. It may be possible that our study using computer navigation leading to accurate alignment and objective guidance to soft tissue balance could lead to improved long-term survival of CP

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Table 1
Unmatched covariates constrained with PS group.

Categories	Case (constrained) (N = 64)	Control (PS) (N = 1624)	*P* value
Age (y)	67 ± 8.2 (45-81)	64.82 ± 8.1 (27-88)	**.03**
Gender			**-**
Male	18 (28%)	518 (32%)	
Female	46 (72%)	1106 (68%)	
Height (cm)	154 ± 10 (135-179)	156.9 ± 8.3 (133-186)	**.05**
Weight (kg)	73 ± 13 (42.5-103.8)	73.2 ± 12 (34.4-119)	.8
Body mass index (kg/m^2)	31 ± 4.7 (20.5-44.5)	29.8 ± 4.9 (15.5-49.7)	.08
CCI scores	2.6 ± 1 (0-5)	2.4 ± 1.1 (0-7)	.1
Varus (degree)	13.1 ± 5.2 (1-25)	9.7 ± 4.3 (0-40)	**.001**
Valgus (degree)	13 ± 7.9 (2-25)	7.2 ± 5.8 (0-30)	**.01**
Fixed flexion deformity (FFD) (degree)	12.7 ± 11.8 (0-50)	8.9 ± 7.7 (0-52)	**.0004**
Recurvatum (degree)	−7.9 ± 6.7 (−18 to [−1])	−3.7 ± 3.4 (−18.5 to [−0.5])	**.002**

CCI, Charlson comorbidity index.
Bold values indicate statistical significance (*P* < .05).

insert [3-6]. The aim of the study was to [1] define the correct indications of the use of a CP insert based on objective data from navigated TKA and [2] compare early results of CP insert with standard PS insert through propensity matching.

Material and methods

This is a retrospective case study from a prospectively collected database that records patients' demographic details, preoperative and postoperative radiological measurements, functional outcomes, navigation findings, and soft tissue releases. This study was approved by the institutional review board of our institution.

Eligibility criteria included all patients with knee osteoarthritis (Kellgren grade of 3 or 4) who underwent computer-assisted primary TKA. Patients with inflammatory arthritis, post-traumatic deformity, revision TKAs, and cases with higher constraint were excluded.

A total of 2940 cases underwent TKA from 2016 to 2019. Of these, 1624 cases with PS insert met the inclusion criteria, including 1329 cases with varus/fixed flexion deformity (FFD), 232 cases with varus/recurvatum, 38 cases with valgus/FFD, and 25 cases with valgus/recurvatum. The other group included 64 cases of CP insert with 54 cases of varus/FFD, 2 cases of varus/recurvatum, 3 cases of valgus/FFD, and 5 cases with valgus/recurvatum (Table 1) (Fig. 1).

To match baseline covariates between the CP (N = 64) and PS groups (N = 1624), propensity score matching was used with logistic regression model for each patient in both groups. The covariates used for generating the propensity score included age, gender, height, weight, body mass index, Charlson comorbidity index, and preoperative deformity (Table 1). One-to-one matching (without replacement) was used with a caliper width of 0.2 to match the scores between CP (N = 64) and PS groups (N = 1624), resulting in equal numbers being matched for both groups PS (N = 64) and CP (N = 64) (Tables 2 and 3) (Fig. 2).

All operations were performed using image-free Ci navigation system (Brain Lab, Munich, Germany). A cemented, posterior cruciate substituting TKA (Legion, Smith and Nephew, USA) with patellar resurfacing was utilized for all cases. All cases were balanced with either a PS or CP insert (Legion, Smith and Nephew, USA) depending on mediolateral (M-L) balance and laxity. Constrained insert has a broader cam as compared to a PS insert and provides additional rotational stability and jump height (Fig. 3) [5].

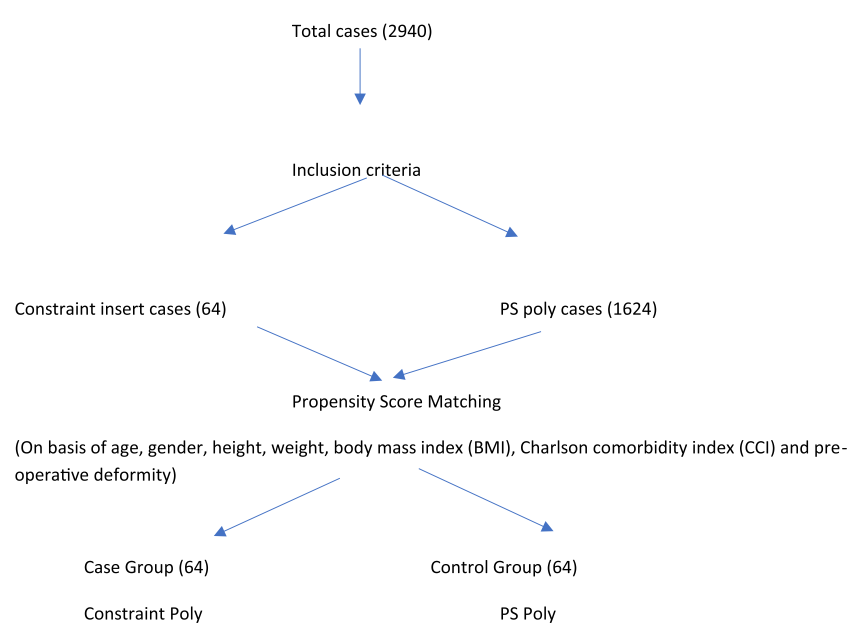

Figure 1. Flowchart showing study design.

Table 2
Matched covariates constrained with PS group.

Categories	Case (constrained) (N = 64)	Control (PS) (N = 64)	*P* value
Age (y)	67 ± 8.2 (45-81)	66.4 ± 7.9 (48-48)	.3
Gender			-
Male	18 (28%)	17 (27%)	
Female	46 (72%)	47 (73%)	
Height (cm)	154 ± 10 (135-179)	155 ± 8.5 (135-178)	.2
Weight (kg)	73 ± 13 (42.5-103.8)	72 ± 9.6 (50-92)	.38
Body mass index (kg/m^2)	31 ± 4.7 (20.5-44.5)	30.3 ± 4.9 (19.8-44.5)	.2
CCI *scores*	2.6 ± 1 (0-5)	2.5 ± 1 (0-5)	.25
Varus (degree)	13.1 ± 5.2 (1-25)	13.4 ± 4.6 (1-25)	.36
Valgus (degree)	13 ± 7.9 (2-25)	10.9 ± 8.6 (1-25)	.3
Fixed flexion deformity (FFD) (degree)	12.7 ± 11.8 (0-50)	12.1 ± 11.7 (0-50)	.38
Recurvatum (degree)	−7.9 ± 6.7 (−18 to [−1])	−6 ± 5.9 (−18 to [−2])	.29

CCI, Charlson comorbidity index.

All knees were exposed with standard medial parapatellar arthrotomy under combined spinal epidural anesthesia. Two unicortical femoral and tibial pins for navigation were inserted within the anterior longitudinal incision. Following registration, coronal and sagittal plane deformities along with kinematic pattern of the arthritic knee were recorded.

The femur was prepared first with a distal femur cut taken with the help of navigation control. The initial distal femur cut was conservative in cases with severe coronal deformity or associated recurvatum. Femur sizing was done with an antero-posterior sizer. Rotation was kept parallel to interepicondylar axis and perpendicular to the Whiteside line, and it was checked with navigation. After femur preparation, gaps were checked, and a tibial cut was taken to create a gap for minimal insert thickness. Soft tissues were released according to the residual deformity to achieve a mechanical axis of ±3° of varus/valgus and 1-3 degrees of flexion.

PS insert was chosen if M-L gap difference was less than 2 mm on clinical examination and on navigation kinematic analysis. If the M-L gap difference was more than 3 mm on navigation kinematic

Table 3
Case distribution in both groups.

Cases	Case	Control	*P* value
Unilateral cases	48	58	-
Bilateral cases	8	3	-
Insert thickness (mm)	10.7 ± 2.1 (9-18)	10.4 ± 1.6 (8-15)	.36

analysis and could not be balanced with PS insert, then a trial with CP insert was taken. If M-L instability was found to be greater than 5 mm, then hinged implants were used and excluded from this study (3 patients). Intraoperative stability with the CP insert was assessed in extension, mid-flexion, and 90-degree flexion with varus and valgus stress and confirmed with navigation values. The aim was to achieve M-L stability within 2 mm after trial with the CP insert (Figs. 4-8) [7]. If trial appeared satisfactory, final components were cemented in place. In 12 knees with associated tibial bone defects, a tibial stem was used for load sharing [8]. In 3 knees, epicondylar osteotomies were performed to achieve optimal limb alignment, and CP insert was used to address the residual ligament imbalance of 3-5 mm mediolaterally [9]. No knees in the PS group had adjuvant stem fixation, and none underwent epicondylar osteotomies. Wounds were closed without a drain, and mobilization started on the same evening of surgery.

Radiological and clinical evaluation was done at 6 weeks, 3 months, 1 year, and at the end of a minimum of 3 years postoperatively by the first and second authors using Knee Society guidelines [10]. In radiological assessment, hip-knee-ankle axis was calculated from full-length standing lower limb radiographs (hip to ankle) preoperatively and postoperatively. Coronal femoral and tibial angle along with joint line was calculated from antero-posterior radiographs of the knee. Preoperative and postoperative posterior femoral offsets were measured from lateral radiographs. Special emphasis was given to search for any evidence of lysis or loosening.

In clinical assessment, all patients were evaluated preoperatively and postoperatively using Knee Society Score, Knee Society Functional Score, Oxford Knee Score, Western Ontario and McMaster Universities Osteoarthritis Index knee score and high flexion knee score. Patients were carefully evaluated for any M-L

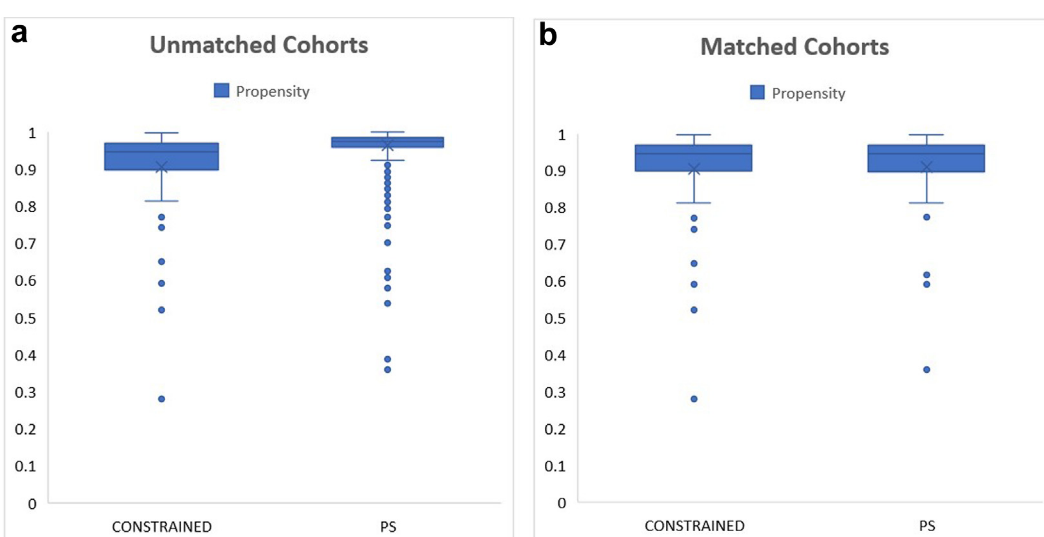

Figure 2. (a) Boxplot showing distribution of unmatched groups. (b) Boxplot showing distribution of matched groups.

Figure 3. PS (yellow) and constrained (green) insert trials.

instability in the entire range of movement during all follow-up visits.

Statistical analysis

To check and compare the balance of covariates, statistical test (T test) (Table 1), as well as the distribution BOXPLOT was used for both unmatched cohorts (Fig. 2a) and match cohorts (Fig. 2b). The T-test was used as a statistical test. All the statistical calculations were done using statistical analysis software SAS 9.4 (SAS Institute, Cary, NC). Continuous variables were presented as mean and standard deviation, whereas categorical variables were presented as numbers and percentages. The level of significance was set at $P <$ .05.

Results

The propensity score between the 2 groups is shown in the boxplot (Fig. 2). This suggests that there were no significant differences in the propensity scores and covariates between the CP and PS groups.

The average follow-up in group CP was 44 ± 9.9 months (range 37-61) and in group PS was 42.7 ± 5.5 months (range 36-43) ($P =$ .06). The average insert thickness in the CP group was 10.7 ± 2.1 mm [3,9-17], while in PS group it was 10.4 ± 1.6 mm [3,8-14] (range 9-15) ($P =$ .36) (Table 3).

Both groups were similar with respect to magnitude of deformity in coronal and sagittal plane (Table 1). There was no statistical significance between distal femur and tibia cuts in both groups (Table 4).

Soft tissue releases were compared in both the groups and found to be statistically non-significant ($P =$ .6) (Fig. 9). A CP insert was chosen where mild ligament imbalance persisted after reduction osteotomy, downsizing, postero-medial release, and medial collateral ligament (MCL) pie crusting in varus knee and in cases with residual MCL laxity in valgus knees [11]. The average residual medial lateral gap difference was significantly higher in group CP 3.8 ± 1.8 [3-5] in comparison to group PS 1.3 ± 1 (0.5-2) ($P =$ .001) (Table 4). Out of 64 cases of constraint insert, 28 had mild ligament instability in flexion, 20 in extension only, and 16 had mild instability throughout the range of motion.

There was significant correction of coronal and sagittal deformity in both groups immediately postoperatively and at the end of a minimum of 3 years of follow-up (Table 5). The preoperative and postoperative radiological parameters of both groups are summarized in Table 4. There was significant correction of hip-knee-ankle axis postoperatively ($P <$ .05) in both groups. There was also significant correction of coronal femoral and tibial angles postoperatively in comparison to preoperative values ($P <$ .05). The posterior femoral offset was restored in both groups ($P >$ .05) (Tables 6 and 7).

The functional parameters of knees in groups CP and PS are summarized in Tables 8 and 9. At the end of the final follow-up of

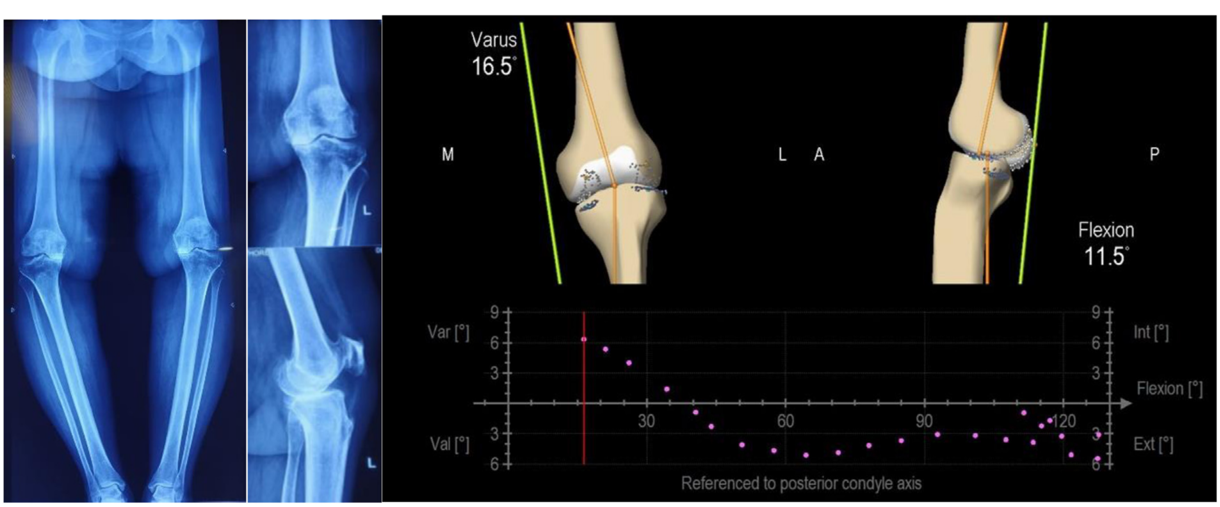

Figure 4. Varus flexion deformity of the left knee with 16.5° varus and 11.5° flexion.

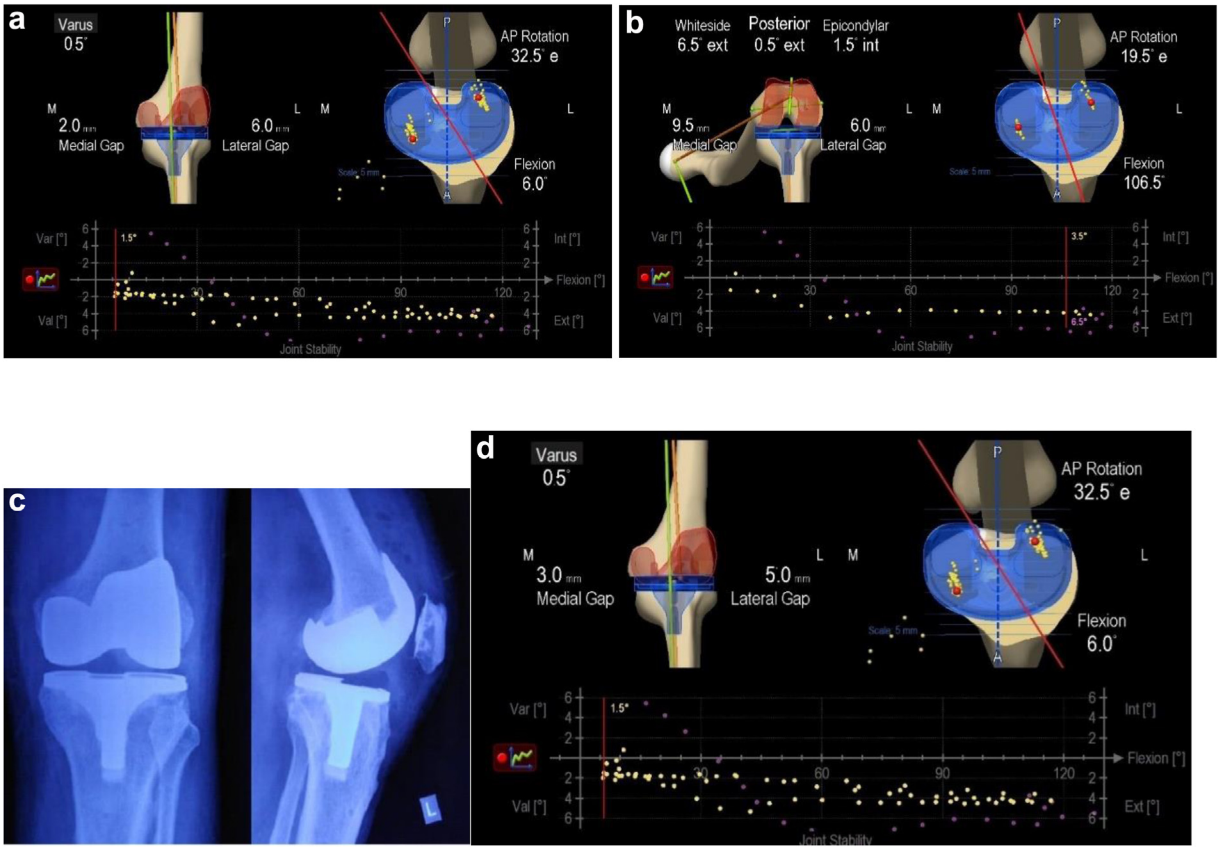

Figure 5. (a and b) Postoperative kinematics in extension and flexion showing paradoxical laxity with mediolateral gap imbalance. (c and d) Postoperative radiograph and corrected medio-lateral gap with constrained insert in extension.

a minimum of 3 years, there was significant improvement in Knee Society Score, Knee Society Functional Score, Oxford Knee Score, high flexion knee score, and Western Ontario and McMaster Universities Osteoarthritis Index knee score in comparison of preoperative scores ($P < .05$). Soft tissue releases for deformity correction were similar in both groups ($P = .6$) (Fig. 9). The incidence of lateral release for patella was significantly higher in the control group ($P = .03$).

There were no cases of M-L instability at the 3-year follow-up, and there were no revisions for instability in either of the

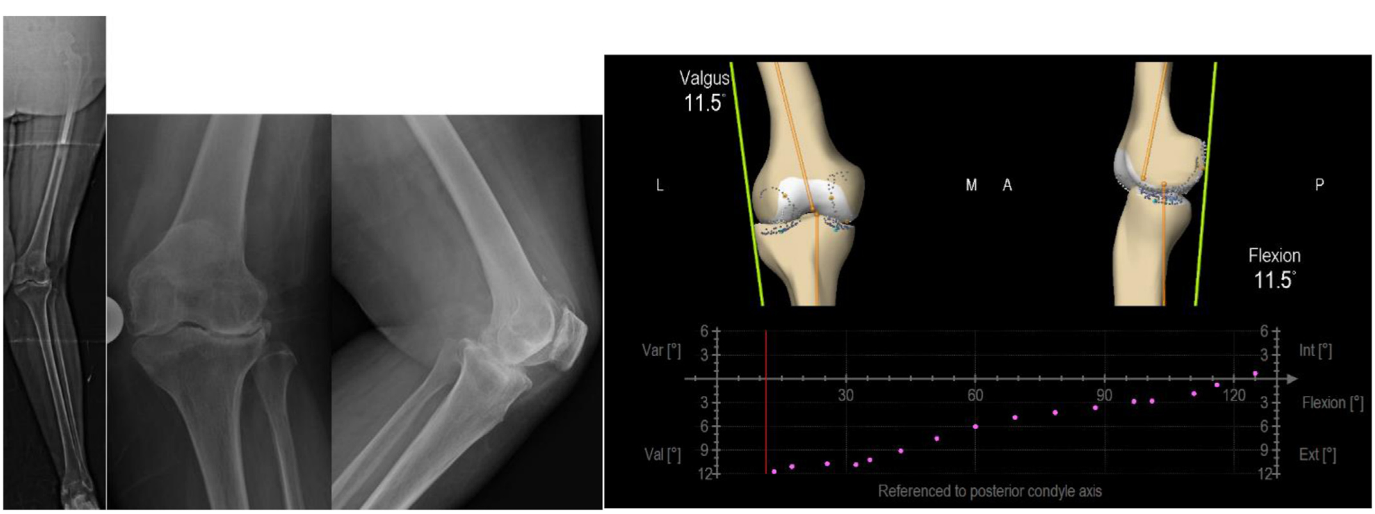

Figure 6. Valgus-flexion deformity of left knee with 11.5° valgus and an equivalent fixed flexion deformity.

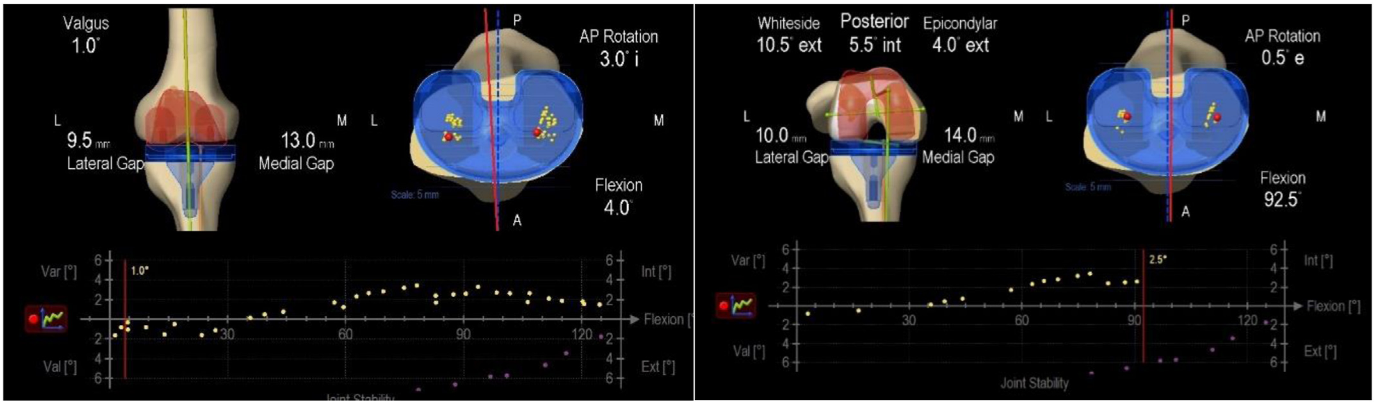

Figure 7. Postoperative kinematics in extension and flexion showing medial laxity despite correction of valgus deformity.

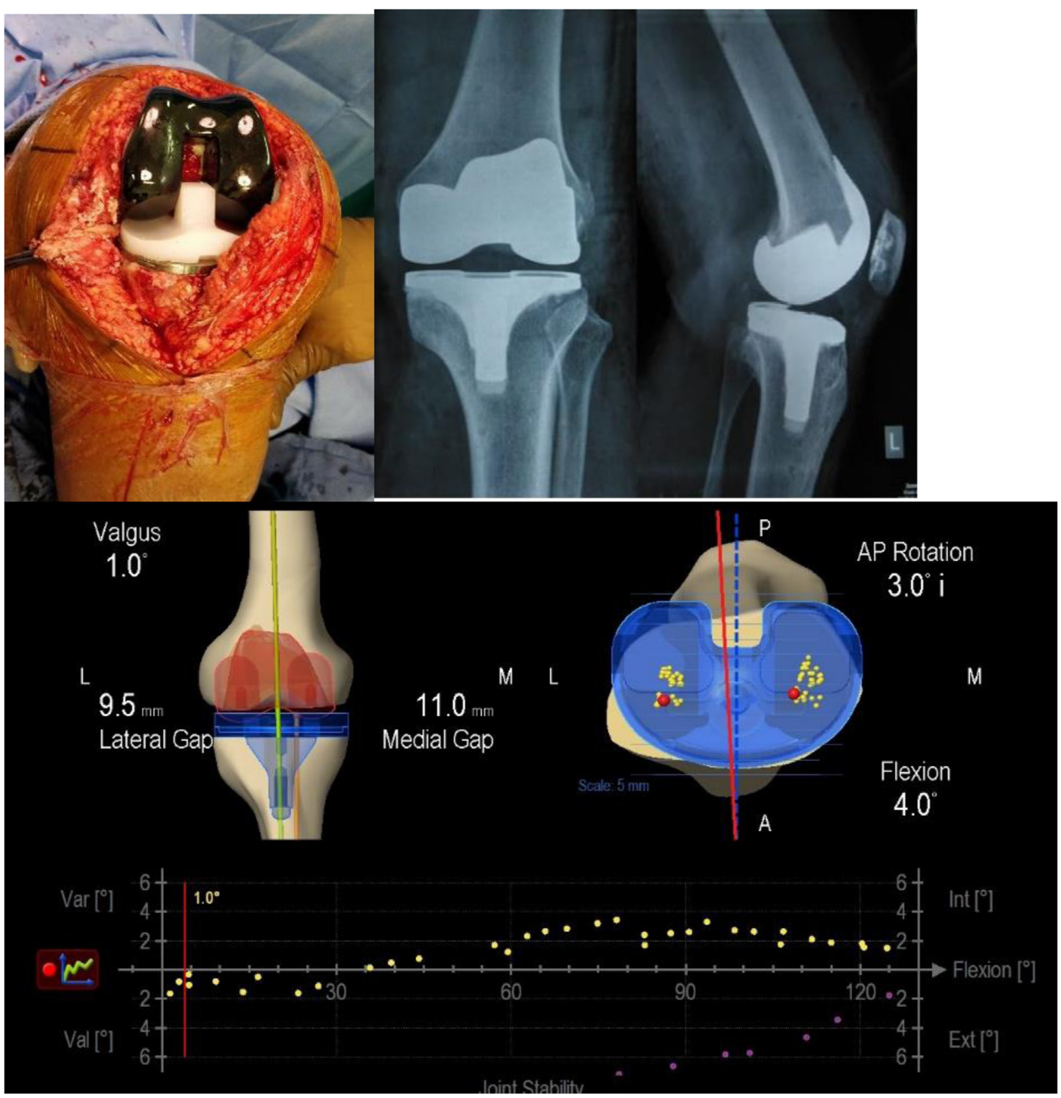

Figure 8. Postoperative kinematics showing correction of mediolateral gap imbalance with constrained liner. Intraoperative image and postoperative radiograph showing balanced knee.

Table 4
Average bone cuts in both PS and CP groups.

Bone cut	Case	Control	*P* value
Distal femur cut (mm)	10.2 ± 5.3 (8-12)	10.1 ± 2.1 (7-12)	.8
Tibial cut (mm)	8.6 ± 2.1 (6-11)	8.9 ± 1.1 (7-11)	.3
Medio-lateral gap difference (mm)	3.8 ± 1.8 (3-5)	1.3 ± 1 (0.5-2)	.0001

groups. There were no patellar or implant-related complications like avascular necrosis, fracture, or loosening seen at the end of at least 3 years of follow-up in any knee. There were no pin-related complications like periprosthetic fractures. No patients were reviewed for any complications during the follow-up period.

Discussion

The main finding of our study is that a CP insert with a primary femur is a valuable option for handling mild ligament imbalance in cases where M-L gap difference is more than 3 mm but less than 5 mm in spite of achieving mechanical alignment [3]. The aim of knee arthroplasty is to keep the M-L gap difference less than 2 mm for long-term success and stability [12].

Our main indications of its use were in “paradoxical laxity” found in severe subluxed varus knees, wherein patients walk with lateral thrust for many years [12]. These knees are difficult to balance in extension in spite of reduction osteotomy and soft tissue releases. This is because of chronic stretching and plastic deformation of lateral stabilizers [3,12]. Paradoxically, the knee opens up in flexion medially because of extensive soft tissue release. Thus, these knees have “paradoxical laxity” where lateral gap is more in extension and medial space opens up in flexion. These knees can be balanced and stabilized effectively by CP insert [13]. A CP insert is not a substitute to proper and meticulous soft tissue balancing but an added measure to prevent instability and dislocation (Figs. 4 and 5) [5,14].

Table 5
Postoperative coronal correction in both PS and CP groups.

Immediate postoperative correction	Case	Control	*P* value
Varus (degree)	2.6° ± 1.7 (0-4)	1.9° ± 1.2 (0-4)	.008
Valgus (degree)	0.6° ± 1.1 (0-2)	0.5° ± 0.3 (0-1)	.5

A CP insert with primary femoral component is also effectively used in valgus knees where medial laxity persists in extension and flexion after valgus deformity is corrected to ±2 degree with the help of computer assisted surgery (CAS) [15]. Similar to varus knees, CP insert is not a substitute for inadequate soft tissue balancing in a valgus knee but only an adjunct to achieve more stability and maintain M-L gap difference between ≤2 mm throughout the arc of motion (Figs. 6-8) [16,17].

We have used CP insert along with epicondylar osteotomies, which were performed for severe uncorrectable deformities (3 cases) where mechanical correction could not be achieved with all plausible soft tissue releases [18]. We perform these osteotomies in recalcitrant cases to bring the alignment to neutral. A CP PS insert helps handle these complex cases with efficacy without resorting to revision sets, instruments, and implants.

It may be argued that CP insert should be used along with revision femur in complex cases, but that leads to the opening up of revision sets, instruments, potential recutting of bone for revision implant, and additional costs. A CP insert helps as a quick solution without increasing inventory, maintaining simplicity, and continuing primary procedure [15].

Few authors have reported the use of a CP insert with primary femoral component in complex primary cases. They have reported higher early failure and revision rates [3,4,13]. Retrieval studies also showed wear on anterior aspect of cam in CP insert cases [4,19]. It may be noted that these cases were operated by

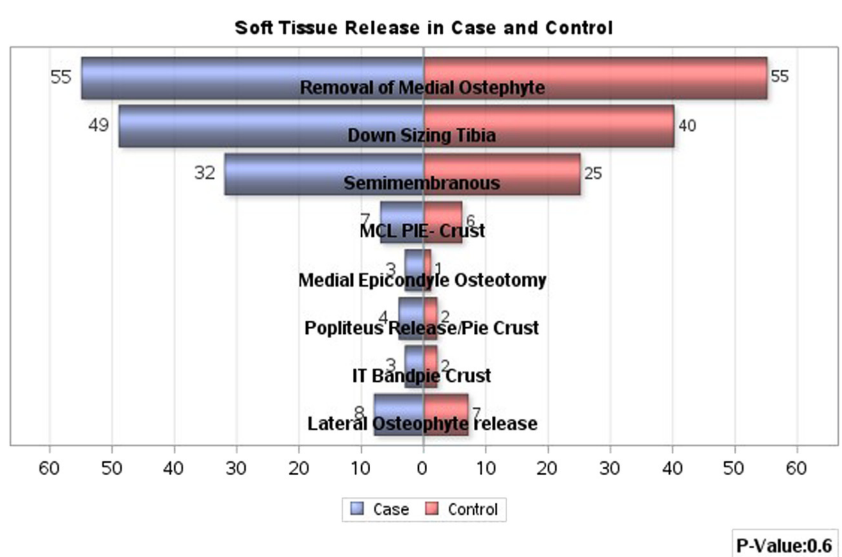

Figure 9. Comparison of soft tissue releases in both groups PS and CP.

Table 6
Radiological summary preoperative vs postoperative in groups PS and CP.

Categories	Case		*P* value	Control		*P* value
	Preoperative	Postoperative		Preoperative	Postoperative	
HKA (degree)	165.5 ± 2.7 (161-174)	178 ± 0.8 (177.5-180)	.001	164.4 ± 3 (153-171)	177.8 ± 1.5 (174-179.8)	.001
Posterior femoral offset (mm)	22.1 ± 0.1 (20-23.8)	22.2 ± 0.1 (20.1-23.7)	.001	21.8 ± 1 (19.5-23.5)	22 ± 1 (19.2-23.2)	.4
Joint line (mm)	14.2 ± 0.6 (12.9-15.2)	14 ± 0.6 (13-15.1)	.1	13.8 ± 0.6 (12.8-15.4)	13.9 ± 0.5 (13.2-15)	.3
Coronal femoral angle (degree)	87.2 ± 4.4 (81-97)	89.3 ± 1 (88-91)	.02	85.1 ± 4.2 (81-94)	89 ± 1.1 (87-91)	.001
Coronal tibial angle (degree)	86.1 ± 4 (81-94)	89.3 ± 1 (87-91)	.001	84.3 ± 4.1 (80-93)	88.3 ± 1.4 (87-93)	.001

HKA, hip-knee-ankle.

Table 7
Radiological summary: group CP-PS preoperative vs group CP-PS postoperative.

Categories	Preoperative		*P* value	Postoperative		*P* value
	Case	Control		Case	Control	
HKA (degree)	165.5 ± 2.7 (161-174)	164.4 ± 3 (153-171)	.01	178 ± 0.8 (177.5-180)	177.8 ± 1.5 (174-179.8)	.3
Posterior femoral offset (mm)	22.1 ± 0.1 (20-23.8)	21.8 ± 1 (19.5-23.5)	.02	22.2 ± 0.1 (20.1-23.7)	22 ± 1 (19.2-23.2)	.1
Joint line (mm)	14.2 ± 0.6 (12.9-15.2)	13.8 ± 0.6 (12.8-15.4)	.001	14 ± 0.6 (13-15.1)	13.9 ± 0.5 (13.2-15)	.3
Coronal femoral angle (degree)	87.2 ± 4.4 (81-97)	85.1 ± 4.2 (81-94)	.007	89.3 ± 1 (88-91)	89 ± 1.1 (87-91)	.1
Coronal tibial angle (degree)	86.1 ± 4 (81-94)	84.3 ± 4.1 (80-93)	.01	89.3 ± 1 (87-91)	88.3 ± 1.4 (87-93)	.001

HKA, hip-knee-ankle.

Table 8
Functional scores preoperatively vs postoperatively in groups PS and CP.

Categories	Case (CP group)		*P* value	Control (PS group)		*P* value
	Preoperative	Postoperative		Preoperative	Postoperative	
KSS	48.5 ± 7 (17-58)	95 ± 6.2 (89-100)	.001	46.6 ± 8.5 (17-57)	92 ± 5.7 (90-100)	.001
KSFS	26.7 ± 15 (10-30)	76.6 ± 11.4 (50-90)	.001	15.2 ± 5 (10-35)	75.2 ± 11 (50-90)	.001
HFKS	24.8 ± 4.2 (19-28)	42.7 ± 6.2 (38-44)	.001	24.2 ± 3.9 (18-28)	42.5 ± 5.8 (35-44)	.001
WOMAC	21.3 ± 9.6 (18-36.7)	92.3 ± 4 (82.9-98)	.001	19.9 ± 9 (10-36.7)	92 ± 4 (82 -98)	.001
OKS	19 ± 3 (19-23)	44.9 ± 3.2 (43-46)	.001	17.9 ± 3.6 (17-23)	43.8 ± 3 (42.7-46)	.001
Range of motion (ROM) (degrees)	104 ± 23.2 (50-130)	129.7 ± 6.2 (120-140)	.001	109 ± 15 (60-130)	127.7 ± 7.1 (120-140)	.001

KSS, knee society score; KSFS, knee society functional score; HFKS, high flexion knee score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index knee score; OKS, Oxford Knee Score.

conventional manual techniques where alignment and balance are subjective and prone to errors. This may be the reason for higher failure rates in these studies. However, we have not found any early failures in our CAS-based study, as the ±3 degree coronal alignment was achieved in all cases and constraint insert was used in very selective cases where M-L ligament imbalance was 3-5 mm [20].

There are a few limitations to this study. This is a single-surgeon, CAS-based study with a relatively small number of patients. It may be difficult for surgeons performing conventional surgery to objectively asses the instability pattern, which is otherwise well delineated with CAS [20]. Use of CP insert without achieving mechanical correction to within 3 degrees can lead to early failure. With the advantage of CAS, we restrict and advise the use of CP insert in very selective cases of mild M-L imbalance once mechanical alignment is achieved. This may be the cardinal reason for success in our cases, and no failures were reported at a minimum 3-year follow-up [21,22]. However, the finding of this study may help surgeons to find the right indications of a CP insert with a primary femur such as “paradoxical laxity” in varus knees and MCL laxity in type 2 and 3 valgus knees.

Secondly, constraint insert mating with primary femur is not available in all systems, which may be a limitation to its widespread use [7]. Third, the number of patients in both groups was small with a short-term follow-up of a minimum of 3 years. It could be possible that wear of the broader cam may present at 5-10 years. Long-term follow-up continues with this subset of patients to identify signs of wear and failure. It is also noteworthy that, in spite of propensity matching of all variables including preoperative deformity, in both PS and CP groups, the behavior of knee soft tissue releases was unpredictable, and some knees showed more instability than others, thus warranting the use of constraint insert [23,24].

In spite of the relatively small number of patients, this is the largest CAS-based study reporting CP insert use and its objective indications in comparison to PS insert.

Recent advances and current controversies

A CP insert mating with a primary femoral component and a non-stemmed tibia is a controversial yet practical solution to handle mild M-L soft tissue imbalance once component and overall alignment have been achieved in CAS.

Conclusions

Constrained insert used with the primary femur is a valuable option to handle mild ligamentous instability in complex primary knee arthroplasty after mechanical alignment is achieved. It helps in continuing with the primary procedure without restoring to revision set instruments and implants. Constraint does not seem to affect failure pattern in the short term once optimal implant and limb alignment are achieved with the help of CAS.

Acknowledgments

A comprehensive agreement for academic use of information such as functional scores, radiological measures, demographic data, or any other data as obtained from the patients by the hospital at the time of their hospitalization and that no identifiable information of the participants is included in the manuscript.

Conflicts of interest

The authors declare there are no conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2024.101423.

Table 9
Functional scores: group CP-PS preoperative vs group CP-PS postoperative.

Categories	Preoperative		*P* value	Postoperative		*P* value
	Case (CP group)	Control (PS group)		Case (CP group)	Control (PS group)	
KSS	48.5 ± 7 (17-58)	46.6 ± 8.5 (17-57)	.2	95 ± 6.2 (89-100)	92 ± 5.7 (90-100)	.005
KSFS	26.7 ± 15 (10-30)	15.2 ± 5 (10-35)	.001	76.6 ± 11.4 (50-90)	75.2 ± 11 (50-90)	.4
HFKS	24.8 ± 4.2 (19-28)	24.2 ± 3.9 (18-28)	.4	42.7 ± 6.2 (38-44)	42.5 ± 5.8 (35-44)	.8
WOMAC	21.3 ± 9.6 (18-36.7)	19.9 ± 9 (10-36.7)	.3	92.3 ± 4 (82.9-98)	92 ± 4 (82 -98)	.6
OKS	19 ± 3 (19-23)	17.9 ± 3.6 (17-23)	.06	44.9 ± 3.2 (43-46)	43.8 ± 3 (42.7-46)	.04
Range of motion (ROM) (degrees)	104 ± 23.2 (50-130)	109 ± 15 (60-130)	.1	129.7 ± 6.2 (120-140)	127.7 ± 7.1 (120-140)	.09

KSS, knee society score; KSFS, knee society functional score; HFKS, high flexion knee score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index knee score; OKS, Oxford Knee Score.

CRediT authorship contribution statement

Anoop Jhurani: Conceptualization. **Piyush Agarwal:** Formal analysis. **Hardik Sahni:** Methodology. **Gaurav Ardawatia:** Resources. **Mudit Srivastava:** Data Management and Statistical Analysis.

References

[1] Morgan H, Battista V, Leopold S. Constraint in primary total knee arthroplasty. J Am Acad Orthop Surg 2006;13:515–24.
[2] Stambough JB, Edwards PK, Mannen EM, Barnes CL, Mears SC. Flexion instability after total knee arthroplasty. J Am Acad Orthop Surg 2019;27:642–51.
[3] Limberg AK, Wyles CC, Taunton MJ, Hanssen AD, Pagnano MW, Abdel MP. Varus-valgus constrained insert with posterior-stabilized femoral components in complex primary total knee arthroplasties. Bone Jt Open 2021;2:921–5.
[4] Konopka J, Weitzler L, Westrich D, Wright TM, Westrich GH. The effect of constraint on post damage in total knee arthroplasty: posterior stabilized vs posterior stabilized constrained inserts. Arthroplast Today 2017;4:200–4.
[5] Thiengwittayaporn S, Hongku N, Uawisetwathana U, Sansawat P. When to use a condylar constrained insert in non-stemmed posterior-stabilized total knee arthroplasty. Clin Orthop Surg 2020;12:448–55.
[6] Crawford DA, Law JI, Lombardi AV, Berend KR. Midlevel constraint without stem extensions in primary total knee arthroplasty provides stability without compromising fixation. J Arthroplasty 2018;33:2800–3.
[7] Marya SKS, Singh C. Options and limitations of implant constraint. J Orthop 2020;23:18–24.
[8] Durig N, Pace T, Broome B, Osuji O, Harman MK. Clinical outcomes of tibial components with modular stems used in primary TKA. Adv Orthop 2014;2014:651279.
[9] Mullaji AB, Shetty GM. Surgical technique: computer-assisted sliding medial condylar osteotomy to achieve gap balance in varus knees during TKA. Clin Orthop Relat Res 2013;471:1484–91.
[10] Meneghini RM, Mont MA, Backstein DB, Bourne RB, Dennis DA, Scuderi GR. Development of a modern knee society radiographic evaluation system and methodology for total knee arthroplasty. J Arthroplasty 2015;30:2311–4.
[11] Thimmegowda VJ, Patel Dr. Sequential soft tissue release and unconstrained TKA implants in severe varus deformity- Prospective study in 75 knees. Int J Orthop Sci 2017;3:15–20.
[12] Matsuda S, Ito H. Ligament balancing in total knee arthroplasty-Medial stabilizing technique. Asia Pac J Sports Med Arthrosc Rehabil Technol 2015;2:108–13.
[13] Anderson JA, Baldini A, MacDonald JH, Tomek I, Pellicci PM, Sculco TP. Constrained condylar knee without stem extensions for difficult primary total knee arthroplasty. J Knee Surg 2007;20:195–8.
[14] Freisinger GM, Schmitt LC, Wanamaker AB, Siston RA, Chaudhari AMW. Tibiofemoral osteoarthritis and varus-valgus laxity. J Knee Surg 2017;30:440–51.
[15] Okamoto S, Okazaki K, Mitsuyasu H, Matsuda S, Iwamoto Y. Lateral soft tissue laxity increases but medial laxity does not contract with varus deformity in total knee arthroplasty. Clin Orthop Relat Res 2013;471:1334–42.
[16] Alesi D, Meena A, Fratini S, Rinaldi VG, Cammisa E, Lullini G, et al. Total knee arthroplasty in valgus knee deformity: is it still a challenge in 2021. Musculoskelet Surg 2022;106:1–8.
[17] Lee SS, Lee J, Alharthi H, Moon YW. Effect of mediolateral gap difference on postoperative outcomes in navigation-assisted total knee arthroplasty using an ultracongruent insert and the medial stabilising technique. Knee Surg Sports Traumatol Arthrosc 2023;31:3745–54.
[18] Mou P, Zeng Y, Pei F, Zhou Z, Shen B, Kang P, et al. Medial femoral epicondyle upsliding osteotomy with posterior stabilized arthroplasty provided good clinical outcomes such as constrained arthroplasty in primary total knee arthroplasty with severe valgus deformity. Knee Surg Sports Traumatol Arthrosc 2018;27:2266–75. https://doi.org/10.1007/s00167-018-5292-9.
[19] Stockwell KD, Gascoyne TC, Singh M, Turgeon TR. Survivorship of constrained polyethylene inserts in primary total knee replacements. Knee 2020;27:1343–8.
[20] Bae DK, Song SJ. Computer assisted navigation in knee arthroplasty. Clin Orthop Surg 2011;3:259–67.
[21] Confalonieri N, Biazzo A. Computer-assisted surgery in total knee replacement: advantages, surgical procedure and review of the literature. Acta Biomed 2019;90:16–23.
[22] Jhurani A, Agarwal P, Aswal M, Meena I, Srivastava M, Sheth NP. Do spacer blocks accurately estimate deformity correction and gap balance in total knee arthroplasty? A prospective study with computer navigation. Knee 2020;27:214–20.
[23] Kumar PJ, Dorr LD. Severe malalignment and soft-tissue imbalance in total knee arthroplasty. Am J Knee Surg 1997;10:36–41.
[24] Blakeney W, Beaulieu Y, Kiss MO, Rivière C, Vendittoli PA. Less gap imbalance with restricted kinematic alignment than with mechanically aligned total knee arthroplasty: simulations on 3-D bone models created from CT-scans. Acta Orthop 2019;90:602–9.