COMPUTER ASSISTED REVISION OF FAILED UNICOMPARTIMENTAL KNEE ARTHROPLASTY

Abstract:

The Authors performed a matched-paired study comparing 22 CAS-UKR revisions to a similar group performed conventionally. Aim of the study was to assess differences in implants used in the revision, surgical time, limb alignment, joint line restoration and procedure's costs.

In the conventional-group there were both an higher percentage of PS/CCK implants and augmentations/stems/offsets. There were no statistical significant differences in the post-operative mechanical axis, in surgical time and hospital staying. There was a lower number of outliers and better joint line restoration in the CAS-group. Both the percentage of blood transfusions and economical costs for each procedure were higher in the conventional-group

Introduction

Revision of failed knee arthroplasty still represents a challenging procedure cause of simultaneous associated problems such as bone loss, soft tissue balancing and restoring the normal joint line. Regarding revision of unicompartimental knee replacement (UKR) to total knee replacement (TKR) , in literature contrastant opinions have been reported. According to some authors even this procedure can be considered high demanding with technical difficulties associated to worse results than primary total knee replacement. Likewise some authors report conversion of failed UKR to TKR with similar results to primary TKR at a short follow-up with no particular intraoperative difficulties . However almost all the authors report the necessity of using of allografts, wedges stems and in selected cases even constrained or semicontrained implants during UKR revision. As the matter of fact despite more conservative modern UKR designs Springer et al in 2006 reported 23% of metal wedge augmentation with 2 long stems in his series of 22 UKR revision. More recently Sargaglia et al in his series of 33 UKR revisions reported metal wedge augmentation in more than 60% of his patients.

Computer assisted surgery (CAS) has been developed to help surgeon in reconstructive procedure in improving implants alignment and performances and in literature different studies have demonstrated its efficacy in primary knee replacement surgery despite different systems available. Furthermore more accurate implant alignments and more precise bone cuts can easily lead to a new concepts of tissue sparing surgery.

Nevertheless very few studies have analyzed using CAS in revision procedures. Perlick et al in 2005 reported that even in revision cases CAS can achieve similar improved implant alignment compared to traditional techniques. In 2008 Massin et al reported a more reliable joint line restoration using navigation in revision of failed TKR. However no study in literature has reported the results of navigated revision of failed UKR.

The Authors performed a matched-paired study comparing 22 CAS-UKR revisions to a similar group performed conventionally. Aim of the study was to assess differences in implants used in the revision, surgical time, limb alignment, joint line restoration and procedure’s costs.

Materials and methods

Among 878 computer assisted knee replacements performed since 1999 22 consecutive navigated UKR revision were included in the study (group A). In all the cases the diagnosis was aseptic loose or painfull medial implants. No cases of evident or suspect sepsis was included in the study. Navigation was used to assist the surgeon in assessing limb alignment, bone cuts and ligament balancing. At a minimum follow-up of 12 months all the patients were successfully matched to patients who had undergone a UKR revision in our hospital using traditional alignment guides (group B). Every single patient was matched in terms of sex, age, pre-operative diagnosis and intraoperative bone loss according to Anderson Orthopaedic Research Institute Bone Defect Classification. Patients were matched with a maximum difference in age of 3 years. In group A the revision procedure was performed using a CT-free computer assisted alignment system (Orthopilot version 4.1, 4.2 and 4.3, Aesculap, Tuttelingen, Germany). In group A all procedures were performed by two of the Authors (N.C. and A.M.), while in group B by different surgeons working in our hospital. .

Twelve months after surgery each patient had long-leg standing anterior-posterior radiographs and lateral radiographs of the knee using the same standard protocol. We have painstakingly educated and communicated with our radiographers in obtaining consistent films before embarking on this trial. The radiographs were repeated if malrotation was detected.

The radiographs were assessed by an independent radiologist blinded to the original procedure to determine the mechanical axis of the limb (hip-knee-ankle angle: HKA) as primary radiological outcome measure. The desired prosthesis alignment was considered as an HKA angle of 180°. The number and percentage of outliers (prostheses with any alignment parameter beyond 3° of the desired value for HKA angle) was determined. Joint line restoration was performed according to Feggie's indications assessing the differences with the opposite untreated side on the lateral radiographs and considering 0 mm as the ideal values.

According to hospital charts, surgical time, implants adopted for the revisions, hospital staying and percentage of blood transfusions for each patient were considered in the final assessment We estimated mean costs for the procedure by implant adopted and hospital charges. Mean Implant costs were extimated considering a fixed price for every implants component (including wedges, offsets and stems) and considering a mean of prices given by the 2 main companies supplying our hospital. Mean hospital charges were extimated considering both mean hospital staying and mean blood transfusions costs for boths groups. Furthermore we considered a mean fixed extra cost about 336 euros more for procedure in the navigated group typical of innovative surgical procedures like computer-assisted surgery as suggested in 2006 by Dong et al.

Statistical Analysis was carried out using SPSS for Windows Release 11.0 (SPSS Inc, Chicago, Ill, USA). Differences between the two groups were measured with an independent Student's T test or Mann-Whitney non-parametric test depending on the data distribution of the continuous variables. Differences in the percentage of outliners for each parameter were tested using a Fisher exact test. A p value of less than 0.05 was considered statistically significant for all analyses.

Results

All the pre-operative values were presented in table 1 while the postoperative values in table 2. In group A the mean patients age at the time of revision was 71.8 years (range: 62-83) with a mean of 7.5 years (range: 2-15) from the original UKR surgery. In group B the mean patients age at the time of revision was 73.6 (range: 66-81) with a mean of 8.2 years (range: 3-16) from the original UKR surgery. There were 14 female and 8 male for each group. The mean pre-operative Hip-Knee-Ankle angle (HKA) was 174.1 degrees (range: 172-179) and 175.1 degrees (range: 173-178) for the navigated group and the manual group respectively. Pre-operatively the mean Knee Society score was 42.9 (range: 39-48) in the group UKR and 41.4 (range: 37-50) in the TKR group. The pre-operative Functional score was 46.9 (range: 42-53) for group A and 45.3 (range: 41-50) for group B.

No intra and post-operative complication related to surgical technique was registered. The mean surgical time was longer in the computer assisted group: 104.3 minutes (range:85-132) and 98.8 minutes (range: 80-122) respectively in group A and B buth without any statistical significant differencebetween the 2 groups.

Intra operatively According to Anderson Orthopaedic Research Institute Bone Defect Classification there were 10 cases of grade I and 12 cases of grade II for each group.

In group A the revision procedure was performed using in 2 case again a Uni, a Bi-uni in 1 case, a CR TKR in 7 cases and a PS TKR in 12 knees. In group B the revision procedure was performed using a CR TKR in 5 cases a PS TKR in 14 cases, a CCK TKR was used 3 cases in the group B. A 4mm metal wedges augmentations were used in 3 case of group A. Five 4mm metal wedges augmentations and 1 8mm metal wedges augmentations were used in group B. Bone allografts were used in 2 cases only in group B. Two 80mm uncemented tibial stems were used in group A, 2 80mm, 3 120mm uncemented tibial stems were used in group B.

At the latest follow-up the mean Knee Society Score was 80.04 (range: 74-88) and 77.9 (range: 73-87) for group A and B respectively. No statistically significant difference was seen for the Knee Society score between the 2 groups. The mean Functional score was 82.3 (range: 70-100) for group A and 77-9 (range: 69-90) for group B. No statistically significant difference was seen for the Functional score with between the 2 groups.

In the navigated group the patients remained in the hospital for a mean of 7.1 days (range: 4-10) and in traditional group 8 days (range: 4-13). In addition, patients in group B required post-operative a mean 1.4 (range: 0-2) blood transfusions each compared to 0.7 (range: 0-3) in group A.

At latest follow-up the mean HKA angle was 179.4 ° (range: 177°-181°) in the navigated group and 178.1° (range: 175°-182°) for the traditional group with no statistical differences. All the navigated revision implants were positioned within 3° of an ideal hip-knee-ankle angle of 180° compared to 5 cases of outliers in group B. Joint line restoration was calculated in 20 patients in group A and in 19 patients in group B, 2 case and 3 case in group A and B respectively were excluded because a TKR was already present in the opposite side. At the latest follow-up joint line was statistically better restored in group A with a mean value statistically closer to 0 mm (table 2).

Analysing the mean cost for procedure considering mean implant cost, hospital costs and despite a fixed extra cost for the navigated group we extimated a mean of 131.4 euros less for each procedure in the navigated group.

Discussion:

Up to now UKR revision has been considered either a challenging procedure or a routinary primary replacement according to different authors experiences. Springer et al in 2006 considered conversion of failed UKR to TKR as a technically demanding procedure and advocated a careful pre-operative planning. Likewise Levine et in 1996 and Chatain et al in 2004 indicated that results of revision of failed UKRs are superior to those of failed TKRs and failed high tibial osteotomy and similar to their results of primary TKRs. Furthermore Johnson reported similar clinical results between revised UKR and primary TKR at a 10 years follow-up.

One of main difficulty during this surgical procedure is to address bone loss which is a more complicated in revision following first generations of UKRs compared to more conservative modern designs. Padgett et al. have reported technical difficulties in revision and failure following the use of cement to treat large bony defects suggesting bone augmentations, metal wedges, stems and even constrained implants.

Theoretically computer assisted surgery can offer different advantages in these complicated case. In 2007 Thielemann et al has already pointed out how navigation can help surgeons in achieving a neutral mechanical alignment of the limb and a restored joint line even in in TKR revision. Furthermore the surgeons is always aware about the amount of bone cuts even according to the limb alignment a soft tissues balancing potentially reducing the necessity of augmentations and bone graft. In our experience of more than 800 implants CAS has create a new concept of tissue sparing surgery based not on shorter surgical approaches but upon less invasive implants.

This is the first study in literature reporting the results of a series of computer assisted UKR revisions comparing the results to a similar traditional group.

At a first follow-up we could not detect any difference in the clinical outcome but this was not the main objective of the study.

Neverless we demonstrated no differences in surgical time and rate of complications even using navigation. Similarly to previous reports in literature for primary TKRs we could demonstrated an improved mechanical axis with a significant lower number of outliers compared to the traditional group. Furthermore joint line was restored more anatomically in the navigated group.

Finally we demonstrated in the navigated group a less frequent use of more invasive implants. Likewise despite similar bone loss classification in the navigated group we could use even again a Uni or a Bi-uni to revised a failed one with no CCK implant.

In literature already in 2007 Saldanha et al., using traditional alignment systems, advocated augmentations and wedges only in very selected cases and 83% of his cases did not require any form of reconstruction for bone loss. Furthermore he reported a mean thickness of the tibial component including the polyethylene insert slightly thicker than a primary TKR. Similarly in our study we tried to reduce wedges and augmentations in both the groups, and according to our results using navigation this was possible more frequently.

Furthermore no intramedullary alignments systems, less invasive surgeries, cheaper implants, lower necessity of bone transfusions could reduce procedure cost despite we considered a fixed higher cost for the adoption of navigation. In our study we demonstrated a mean of 121.4 euros off using navigation in revisions of failed UKR.

In conclusion following computer suggestions for a minimal bone cut and for an ideal joint line improved by the modern softwares, we could recreate a more anatomical revision in term of implant alignment and joint line restoration using less invasive implants. The Authors believe that computer assisted surgery advantages can be easier demonstrated in more complicated cases such as UKR revision to prumove an its wider use. The surgeon can more easily appreciate the possibility to restore limb alignment and joint line using tissue sparing procedure even with economical savings in this more demanding procedure than in primary implants where immediate and significant advantages of CAS are still far to be share by all the orthopaedic community.

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	Group A *(22 Knees)* **(Cas UKR revision)**	**Group B** *(22 Knees)* **(Traditional UKR revision)**
Age *(years)*	71.8 (range:63-83) SD:6.5	73.6 (range:66-81) SD:4.4 ***p: 0.2***
Time from UKR Implant *(years)*	7.5 (range:2-15) SD:3.6	8.2 (range:3-16) SD:3.3 ***p: 0.5***
Follow-up *(months)*	42.7 (range:13-66) SD:16.7	48.4 (range:14-65) SD:13.9 ***p: 0.06***
Pre-operative Deformity *(HKA angle)*	174.1° (range:172-179) SD:1.8	175.1° (range:173-178) SD:1.6 ***p: 0.06***
Pre-operative KS score	42.9 (range:38-48) SD:2.7	41.4 (range:37-50) SD:2.9 ***p: 0.07***
Pre-operative Functional score	46.9 (range:42-53) SD:2.9	45.3 (range:41-50) SD:2.8 ***p: 0.06***
Bone loss classification	Grade I: 9cases Grade II: 13cases	Grade I: 9cases Grade II: 13cases

Table I: Demographic and pre-operative data. (SD: standard deviation)

	Group A *(22 Knees)* **(Cas UKR revision)**	**Group B** *(22 Knees)* **(Traditional UKR revision)**
Surgical time *(minutes)*	142.3 (range:85-132) SD:13.7	98.8 (range:80-122) SD:11.8 ***p: 0.2***
Type of implant for revision	2 Unis, 1 bi-Unis, 7 CR TKR, 12 PS TKR	5 CR TKR, 13 PS TKR 3 CCK
Type and number of augmentations	3 4mm wedges	5 4mm wedges, 1 8mm wedge, 2 allogragfts
Post operative HKA angle *(# of outliers)*	178.1° (range:175-182) SD:2.0 (0 outliers)	179.4 (range:177-181) SD:1.1 ***p: 0.06*** (5 outliers)
Jont Line Restoration *(differ. in mm with the opposite side)*	1.6 (range:0-4) SD:1.2	2.5 (range:0-6) SD:1.5 ***p: 0.6***
Post-operative KS score	80.04 (range:74-88) SD:5.2	77-9 (range:73-87) SD:4.5 ***p: 0.1***
Post-operative Functional score	82.3 (range:70-100) SD:8.9	77.8 (range:69-90) SD:8.2 ***p: 0.08***
Blood transfusion	0.7 (range:0-2) SD:0.7	1.4 (range:0-3) SD:0.7 ***p: 0.006***
Hospital staying:	7.1 (range:4-10) SD:1.7	8 (range:4-13) SD:2.1 ***p: 0.1***

Table 2: Post-operative results (SD: standard deviation)