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Reconstructive REVIEW

OFFICIAL JOURNAL OF THE

Joint Implant Surgery and Research Foundation

Strategic Alliance with

ICJR | International Congress for Joint Reconstruction

ASIA PACIFIC ARTHROPLASTY SOCIETY

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JISRF

Joint Implant Surgery and Research Foundation

Strategic Alliance with

An Announcement From:

Dr Rami M Sorial FRACS FAOrthA

President, Asia Pacific Arthroplasty Society & Associate Editor-in-Chief, Pacific Rim, Reconstructive Review

&

Timothy McTighe, Dr. H.S. (hc)

Executive Director, JISRF,

& Editor-in-Chief, Reconstructive Review

We are pleased to announce that JISRF's journal Reconstructive Review will become the official journal for APAS. We welcome its Members to open free access to all publications and encourage its Members to submit manuscripts for publication in one of four quarterly issues.

We also welcome interested Members to become reviewers for the Reconstructive Review.

Reconstructive Review Editor-in-Chiefs Role has been Expanded Providing Global Outreach

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Dr. Evert Smith, UK

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JISRF, founded in 1971, has had significant experience with continuing medical education, product development, and clinical surgical evaluation of total joint implant devices.

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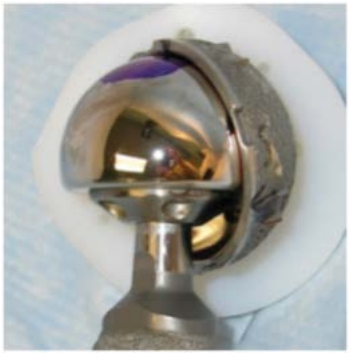
Ian Clarke, PhD & Thomas K. Donaldson, MD



Metal on metal retrieval

A Special APAS Issue of the Reconstructive Review

Our fourth and final edition for 2014 is a special issue in conjunction with the Asia Pacific Arthroplasty Society. JISRF and Reconstructive Review are proud to present a sampling of peer reviewed and award winning articles submitted from the 15th annual APAS meeting held in Chengdu, China in June 2014.

In his welcome message for that meeting the President of APAS, Dr. Rami Sorial said *"Our vision will be to deliver a meeting that will introduce debate and reflect on current issues in joint replacement that we meet every day in our current practice but also share with you topics that you may need to broaden your scope of practice into the future. Our aim is to give you the tools technically, scientifically and academically to allow you to deliver better outcomes for your patients. This will include central themes to joint replacement but also recent advances and controversy as well as region specific topics as we all appreciate that our practice is influenced by the geopolitics and cultures of each country and region."*

We welcome the contribution APAS makes to improving and expanding the content of Reconstructive Review!

Timothy McTighe, Dr. HS (hc)
Executive Director, JISRF
& Editor-in-Chief
Reconstructive Review

JISRF Mission Statement

The specific and primary endeavors are to operate for scientific purposes by conducting medical research of potential improvements in medical surgical methods and materials for preserving and restoring the functions of the human body joints and associated structures which are threatened or impaired by defects, lesions or diseases.

This Journal as all activities conducted by JISRF are available to all interested surgeons, scientists and educators. Our focus is on new cutting edge technologies, science – all with the intent to raise the level of discussion and discovery. Please become a part of this endeavor, we look forward to your interest and participation.

A Message from the President of APAS

A small group of twenty orthopaedic arthroplasty surgeons from the Asia-Pacific region met on the Gold Coast of Queensland, in Australia, in 1997 to discuss the need for a scientific body to foster and represent the academic and professional needs of the region. The Asia Pacific Arthroplasty Society – APAS - was born out of that meeting with Wui K Chung the founding chairman. Ray Randle was elected the 1st President of the society and Chit Ranawat honoured the society by accepting to be the Patron of the society.

The aims of the society are to:

- foster social and scientific exchange
- provide a platform for surgeons from the Asia Pacific region to present their surgical experience
- encourage exchange scholarship

The 1st Annual Scientific Meeting was held in New Delhi in 1998. Not less than 600 delegates attended that meeting. Since then there have been 14 hugely successful Annual Meetings held in cities including Shanghai, Beijing, Xian, New Delhi, Mumbai, Seoul, Kota Kinabalu, Kuala Lumpur, Bangkok and Chengdu.

Our past Presidents include Ray Randle, Ashok Rajgopal, Jim Sullivan, Yoo Myung-chui, Wang Yan and Arun Mullaji.

As the current President it is my great pleasure to foster the needs of the society and I look forward to the challenge of another year ahead. I hope to continue to drive the mission of this society that was originally founded by our senior colleagues over 16 years ago. The central tenant of APAS has always been education in both the art and science of hip and knee joint replacement with an emphasis on optimising surgical techniques throughout the Asia Pacific area.

There is no denying that the role of joint replacement has undergone enormous evolution in this region, particularly in the last decade and this work has continued to increase not only in substantial quantity but also in the quality of technique, outcomes and the collaboration between orthopaedic surgeons and industry to improve our patient's quality of life. APAS has been an integral part of this process over the years with high quality annual meetings targeting broad areas of our craft that are topical and reflect the interest and desire to broaden their members knowledge in that field.

To that end I am delighted to report that we enjoyed a successful 2014 meeting this year in China. Chengdu was a great host city in the centre of China with a thriving metropolis and exquisite spicy food. The faculty was on fire delivering an excellent program with many local and international contributions from 10 different countries. With my co-convenor Prof. Fuxing Pei the invited faculty of 27 surgeons and an additional 14 colleagues delivered over 100 papers. In addition there was 1 masterclass session and 3 industry led presentation sessions. All who attended enjoyed the content of the meeting as well as the fellowship of being part of the society. In conjunction with Joint Implant Surgery & Research Foundation APAS is privileged to be given the opportunity to present some of the work presented at our Chengdu meeting in this special edition of Reconstructive Review.

ASIA PACIFIC ARTHROPLASTY SOCIETY

This showcase of material is a small sample of the rich tapestry of scientific content delivered at our 15th annual meeting.

APAS is now working with a new organising and scientific committee to engineer our next meeting in India. The next APAS meeting which will be the 16th annual scientific meeting of APAS and will be held in Delhi, one of the major metropolitan centres in India. This meeting is planned for the 11th to 13th September 2015. The centre of a rich and diverse heritage, Delhi will be a great host city for us to meet and share knowledge, science and recent advances in a warm and collegiate atmosphere that has always been at the heart of APAS.

I invite all who share an interest in hip and knee arthroplasty to join us in Delhi next September. The APAS website at http://apasonline.org will keep you informed and becoming a member will allow access to the clinical forum. As member's you can gain password access to the member's clinical forum where monthly cases are posted and now a library of cases are present for your review including technique videos. As a member you are also welcome to publish case reports on this site and join the online community.

Please bookmark our website for your future reference and mark your calendars with the dates of the next APAS meeting for 2015 (September 11-13) and I look forward to meeting many of you there.

Dr Rami Sorial
FRACS, FAOrthA
President, APAS

Kind Regards,
Rami Sorial

Reconstructive REVIEW

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Now with its own website to facilitate a more user friendly platform for viewing and searching all past and current articles. The website is based on open source software called Open Journal Systems (OJS) created by the Public Knowledge Project.

OJS was designed for the management and online presentation of open access, peer-reviewed academic journals. The software has a 'plugin' architecture allowing easy integration of key features including tools to facilitate indexing in online directories such as Google Scholar and PubMed Central.

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Reconstructive Review

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JISRF Founder

Charles Bechtol, MD

was internationally known in the fields of biomechanics and orthopedic surgery. His engineering and biomechanical research resulted in the development of numerous joint replacement implants and internal fracture fixation devices – instruments that are familiar to orthopedic surgeons the world over. His innovations included shoulder and knee prostheses, the Bechtol Total Hip system, the Bechtol "fluted" bone screw, and the Bechtol "continuous strength" bone plate.

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Direct any questions regarding the submission process, or requests for reprints to David Faroo, Director of Communications, JISRF, 46 Chagrin Plaza #117, Chagrin Falls, Ohio 44023, dfaroo@jisrf.org.

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- Basic Science
- Case Reports
- Clinical/Surgical
- Commentary
- Controversial Issues (i.e. modularity, tapers, MoM)
- Historical Reviews
- Letters to the Editor
- Surveys

The emphasis for these subjects is to address real life orthopaedics in a timely fashion and to encourage the participation from a broad range of professionals in the orthopaedic health care field.

We will strive to be responsible and reactive to the needs expressed to our editors and all members of JISRF. We anticipate our format will evolve as we move forward and gain more experience with this activity. Your opinion is a critical step to our motivation and overall success, please do not hesitate to communicate with us.

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- Trim Size: 8.5" x 11"
- Live Area: 7.25" x 9.25"
- No Bleeds

Ad Specification

- Full color or black and white - available sizes:
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ORIGINAL ARTICLE

Influence of Posterior Condylar Offset on Maximal Flexion and Outcome Scales Following TKA in Asian Patients

Sae Kwang Kwon, MD[1]; Nimesh Prakash Jain, MS (Ortho)[2]; Jong Yeal Kang, MD[2]; Yeon Gwi Kang, MS[2]; Tae Kyun Kim, MD, PhD[2]

Abstract

Background: Infection complicates traditional joint reconstruction prostheses in up to 7% of cases, witBackground: Alteration in femoral posterior condylar offset (PCO) after total knee arthroplasty (TKA) has been reported to influence maximal flexion angle after TKA. However, there are contradictory reports about its influence on clinical outcome, and the effects of PCO alterations may vary with implant type.

Question / purposes: The purpose of this study was to determine whether PCO alterations affect maximal flexion after TKA and other functional outcomes, and whether the effects of PCO alterations differ by implant type.

Patients and Methods: Fifty consecutive cases of TKAs in each of four implant types, namely, fixed bearing (FB) cruciate retaining (CR) or posterior stabilized (PS), mobile bearing (MB) CR or PS were included in the study. Patients were evaluated for maximal flexion and clinical outcome scales. The PCO alteration was measured using pre- and postoperative true lateral knee radiographs. Correlations between PCO alterations and functional outcomes including maximal flexion were compared among the four implant types.

Results: No significant correlation was found between PCO alterations and maximal flexion achieved in any of the four implant groups (Correlation Coefficient [CC]=-0.03, 0.14, -0.14, 0.04; p> 0.05). The mean maximal postoperative flexion was greater in PS implants than in CR implants (p <0.05). In MB-CR implanted knees, a greater PCO alteration was correlated with worse anterior knee pain score as measured by the PF scoring system (CC=-0.44, p=0.003) and worse WOMAC pain score (CC=-0.41, p=0.007).

Conclusions: Our findings indicate that PCO alterations have no effect on maximal postoperative flexion after TKA regardless of the implant type. Whether the implant is of PS or CR type is a better predictor of the final flexion achieved. However, increased PCO is correlated with worse pain score in MB-CR implants.

***Level of Evidence**: Level III, Retrospective comparative study*

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Introduction

Pain relief and functional restoration are the fundamental goals of total knee arthroplasty (TKA). Various factors, including maximal postoperative flexion, are thought to influence the functional outcomes of TKA [15,28]. After Bellemans et al. [5] reported that alterations in posterior condylar offset (PCO) influences the maximal flexion achieved after TKA, numerous studies have evaluated the effect of these alterations [1,3,11,14,17,20,23,24,29]. However, these studies reported contradictory results regarding the effect of PCO on maximal postoperative flexion. Therefore, the role that PCO alterations play in functional outcomes including maximal flexion remains uncertain.

The effect of PCO alteration on functional outcomes may differ by the characteristics of the implant, specifically the type of bearing mobility (fixed bearing [FB] versus mobile bearing [MB]) [30] and whether the implant sacrifices PCL or not (cruciate retaining [CR] versus posteriorly stabilized [PS]) [1]. Several studies reported a definite correlation between PCO alteration and maximal flexion in CR knees [1,5,23,24], whereas two recently published studies did not find this association in MB-CR knees [17,29]. This association was not found in several studies involving PS prosthesis [1,3,14,17]. In addition, other studies reported that flexion kinematics and thus the ultimate flexion achieved differ between CR and PS TKAs [2,8,13,31]. These varied findings in studies conducted with different prostheses by various authors suggest the need for studies using different representative cohorts using relevant prostheses to determine whether the effect of PCO alteration varies by implant type. Moreover, little information is currently available for the influence of PCO alteration on outcome scales, such as American Knee Society (AKS) scores, Patellofemoral scores and the Western Ontario and McMaster Universities Arthritis (WOMAC) Index scores. On the other hand, it is well established that Asian patients have greater preoperative and postoperative maximum flexion than Western patients do [8,9,21,22,27,31]. Therefore, it is conceivable that the effects of PCO alteration on maximal flexion and other functional outcomes may be different between Asians and Westerners. However, few studies have been performed to investigate the effects of PCO alteration on functional outcomes of TKA in Asian patients.

Therefore, the present study aimed to determine whether PCO alterations that follow TKA influence functional outcomes including maximal postoperative flexion in an Asian population. We were particularly interested in determining whether the effects of PCO alterations vary by the following implant types: (1) FB-CR, (2) FB-PS, (3) MB-CR and (4) MB-PS. We hypothesized that alteration in PCO influences maximal postoperative flexion angle and other functional outcomes, and that the effects differ by implant type.

Patients and Methods

This study was approved by the Institutional Review Board of our institution, and informed consent was obtained from all patients. To determine sample size, power analysis was performed a priori using the two-sided hypothesis test at an alpha level of 0.05. The test indicated that the sample size of 50 in each of 4 groups would provide power of 80% or higher with an alpha level of 0.05 to detect a difference of 5% in the radiographic measurements and functional scores, and a correlation coefficient greater than 0.3. To select 50 cases consecutively in each implant group, we retrospectively reviewed the records of 1,300 consecutive TKAs performed using four implant types (FB-CR, FB-PS, MB-CR and MB-PS) between October 2003 and January 2007. Inclusion criteria were the following: a diagnosis of primary osteoarthritis, no postoperative complications affecting postoperative outcomes, no systemic comorbidities that interfered with the benefits of the replaced knee, and an available record of clinical outcomes evaluated 12 months after surgery. Fifty cases were selected for each of the four implant types. The four groups did not differ in demographic characteristics or preoperative functional status including maximal flexion angle (Table 1).

All surgical procedures were performed by a single surgeon (one of the authors) via the medial parapatellar approach, and similar rehabilitation protocols were given. The patella was routinely resurfaced. All implants were fixed with cement (Palacos; Heraeus Kulzer GmbH, Hanau, Germany). The four prosthesis types were (1) FB-CR, Genesis II (Smith & Nephew, Memphis, U.S.A.), (2) FB-PS, Genesis II, (3) MB-CR, e.motion-FP (B.Braun-Aesculap, Tuttlingen, Germany), and (4) MB-PS, e.motion-PS (B.Braun-Aesculap). All of the devices mentioned above were approved by the United States Food and Drug Administration for use. After surgery, a compressive dressing was applied with immobilization for the first 24 hours. Knees were then placed in a continuous passive-motion machine. On the second postoperative day, all patients began walking with crutches or a walker, and started active and passive range-of-motion (ROM) exercises. Knee ROM exercises and weight bearing were gradually increased.

All clinical information was prospectively collected using pre-designed datasheets and maintained in our database

*Table 1. Comparison of preoperative demographic characteristics and functional status among the four groups divided by types of implants**

Parameter	FB-CR (n=50)	FB-PS (n=50)	MB-CR (n=50)	MB-PS (n=50)	p-value (ANOVA)
Age (years)	68.4 (5.9)	68.0 (6.6)	67.7 (6.1)	68.0 (4.8)	0.959
Men / Women	1 / 49	1 / 49	3 / 47	4 / 46	0.383
BMI (kg/m2)	26.1 (3.6)	26.9 (4.1)	26.4 (3.8)	25.9 (3.6)	0.612
Maximal flexion (°)	141.4 (12.2)	135.8 (14.2)	139.7 (12.8)	141.1 (13.6)	0.136
PF score					
Anterior knee pain	11.4 (5.0)	11.4 (5.1)	10.7 (5.6)	11.5 (4.2)	0.851
AKS					
Knee score	49.2 (11.0)	44.9 (7.8)	47.7 (9.5)	44.7 (10.8)	0.070
Function score	53.8 (9.7)	53.5 (12.0)	53.5 (8.5)	57.7 (14.2)	0.191
WOMAC					
Pain	10.8 (3.8)	11.6 (3.7)	10.7 (4.5)	11.3 (4.5)	0.683
Stiffness	4.7 (1.8)	5.1 (2.1)	4.4 (2.1)	4.8 (2.1)	0.424
Function	39.2 (10.6)	42.9 (12.0)	38.7 (11.3)	40.3 (14.2)	0.326

** Data are presented as means with standard deviations in parentheses.*
Abbreviation: FB, fixed bearing; MB, mobile bearing; CR, posterior cruciate ligament retaining; PS, posterior cruciate ligament sacrificing; ANOVA, Analysis of variance; PF, patellofemoral; BMI, body mass index; AKS, American knee society score; WOMAC, Western Ontario McMaster Universities Osteoarthritis index

by an independent investigator (one of authors). Our clinics have a regular follow-up schedule (2 weeks, 6 weeks, 3 months, 6 months, 12 months after surgery, and yearly thereafter), and we evaluated the outcomes at 12 months after surgery for postoperative functional outcomes. Relevant preoperative and postoperative outcomes collected were knee range of motion (ROM), the patellofemoral score [10] , the AKS score [16] and the WOMAC index score [4]. The knee ROM was calculated by subtracting the angle of flexion contracture from the angle of maximal flexion. An independent investigator (one of authors) measured the flexion contracture and maximal flexion angles to the nearest 5° by using a standard (38 cm) clinical goniometer, with the patients in supine position. The lateral femoral condyle was used as the landmark to center the goniometer with the proximal limb directed towards the greater trochanter and the distal limb towards the lateral malleolus.

An independent investigator (one of authors) performed the radiographic measurements of PCO, joint line elevation, and postoperative posterior tibial slope. The PCO was measured pre- and postoperatively on true lateral knee radiographs by determining the shortest distance between the line tangent to posterior femoral cortex and the most posterior point of the femoral condyle (preoperatively) or femur prosthesis (postoperatively) respectively (Figure 1). After correcting for radiographic magnification using a reference measurement of the tibial shaft diameter at the level of tibial tubercle, PCO alteration was calculated from the respective measurements. PCO alteration was defined as the value obtained by subtracting the amount of preoperative PCO from the amount of postoperative PCO. Joint line distance from tibial tuberosity was also measured preoperatively and postoperatively (Figure 2). Preoperatively, it was defined as the perpendicular distance from the most anteriorly prominent point of tibial tuberosity to a

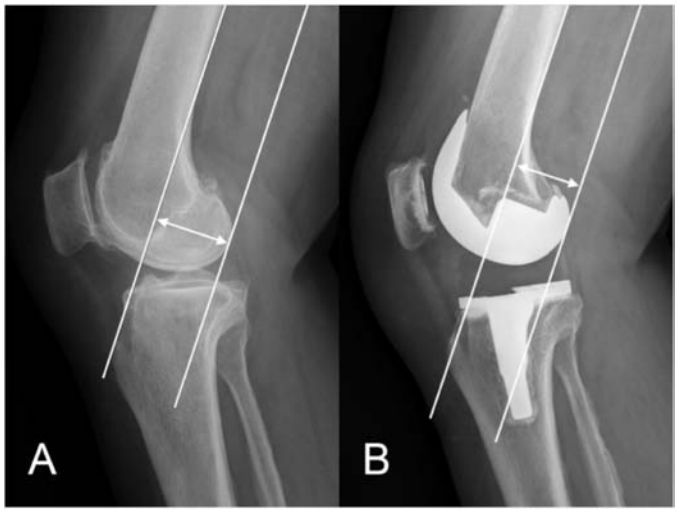

Figure 1. Radiographs showing the method for measuring the posterior condylar offset (PCO) on a true lateral radiograph, pre-operatively (A) and post-operatively (B). PCO alteration was calculated by subtracting preoperative value from postoperative value.

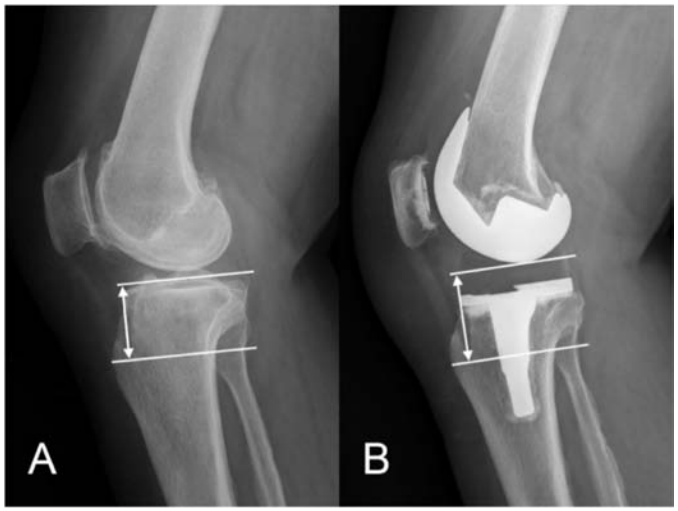

Figure 2. Radiographs showing the method for measuring the joint line distance from tibial tuberosity on a true lateral radiograph, pre-operatively (A) and post-operatively (B). Joint line elevation was calculated by subtracting preoperative value from postoperative value.

line parallel to the weight-bearing surface of the tibial plateau, which was defined as the line passing the midpoint between the medial femoral condyle and the medial tibial plateau. Postoperatively, it was defined as the perpendicular distance from the same point of tibial tuberosity to a line parallel to the weight-bearing surface of the polyethylene insert, which is tangent to the most distal point of the femoral component. After adjusting for magnification, joint line elevation was calculated by subtracting preoperative joint line distance from postoperative joint line distance. Posterior tibial slope was measured in postoperative images. It was defined as the angle between the line parallel with the upper surface of the tibial tray and the line perpendicular to the anatomical axis of the proximal tibia, which was defined as the line connecting the midpoints of the two lines 5 cm and 15 cm distal and parallel to the joint line, respectively (Figure 3). In order to assess the reliability of the measurements using the methods described above, two orthopedic surgeons (two of the authors) and one clinical investigator (one of the author) performed the measurements twice within an interval of one week in 30 knees randomly selected from the 200 knees. The degree of measurement reliabilities was assessed using the intraclass correlation coefficient (ICC). The ICCs for intra- and inter-rater agreement were greater than 0.85 for all radiographic measurements. As no significant differences were found among the measurements by the three examiners, the measurements performed by a single investigator were used in the following analyses.

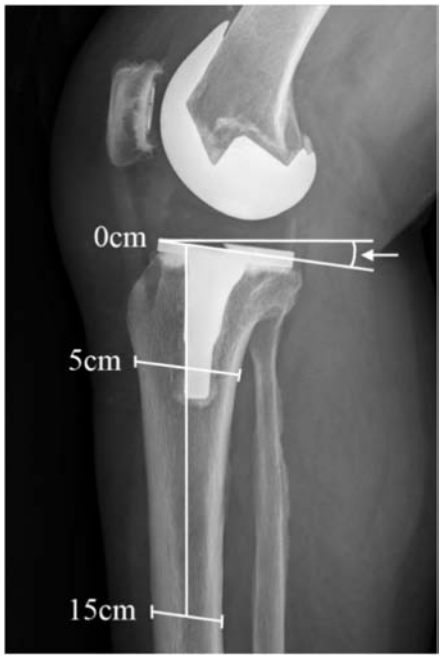

Figure 3. A radiograph showing the method for measuring the postoperative posterior tibial slope on a true lateral radiograph.

Statistical analyses were conducted using SPSS for Windows (version 15.0; SPSS, Chicago, Illinois), and p values of < 0.05 were considered significant. Kolmogorov-Smirnov test was used to evaluate whether the scores of the clinical outcome scale were normally distributed. As all variables showed normal distribution, parametric methods were used for all statistical analyses. Analysis of variance (ANOVA) was performed to make comparisons among the four implant groups to determine whether any difference exists among the groups regarding PCO alteration, joint line elevation and posterior tibial slope, maximal flexion, and other functional outcomes. If ANOVA showed significant differences among the 4 groups, post hoc test was conducted with Bonferroni method. Subsequently, we conducted correlation analyses in each of four groups to investigate the correlations between 1) PCO alteration and maximal flexion angle, and 2) PCO alteration and other functional outcomes. To control the effect of joint line elevation or posterior tibial slope, partial correlation analyses were performed with joint line elevation and posterior tibial slope set as covariates. Additionally, preoperative knee ROM was also set as a covariate in the analysis between PCO and maximal postoperative flexion. In the analysis of the correlation between PCO alteration and WOMAC subscale scores, WOMAC score was converted to a 100 point system where 0 indicates the worst score and 100 indicates the best score for consistency with other functional scores. Four implant groups were compared to determine whether the prosthesis type influenced how postoperative PCO alteration affected the functional outcomes including maximal flexion.

Results

No significant association was found between the degree of PCO alterations and the maximal flexion angle achieved in any of the four implant groups. The mean maximum flexion angle after TKA was greater after PS implants than after CR implants (FB-PS 137.0o vs. FB-CR 130.1o, $p = 0.008$ and MB-PS 136.4o vs. MB-CR 130.1o, $p = 0.020$) (Table 2). However, correlation analyses discovered no significant associations between PCO alterations and maximum flexion in any of the four groups ($p>0.05$).

The influence of PCO alterations on functional outcomes varied by the type of implant. In knees implanted with the MB-CR design, increased PCO was associated with a worse anterior knee pain score based on the PF scoring system (correlation coefficient [CC]=-0.44, p=0.003) and a worse WOMAC pain score (CC=-0.41, p=0.007) (Table 3). Increased PCO also tended to be associated with worse WOMAC function score (CC=-0.30, p=0.054). Likewise, in the FB-PS group, the increased PCO tended to be associated with a worse AKS knee score (CC=-0.34, p=0.063). In contrast, in both the FB-CR and MB-PS types, no significant associations were found between the PCO alteration and functional outcomes.

*Table 2. Comparison of PCO alteration, posterior tibial slope, joint line elevation and functional outcomes among the four groups divided by types of implants**

Parameter	FB-CR (n=50)	FB-PS (n=50)	MB-CR (n=50)	MB-PS (n=50)	p-value (ANOVA)
PCO alteration (mm)	0.2 (1.9)	0.7 (2.1)	0.3 (1.7)	1.3 (2.3)	0.066
Posterior tibial slope (°)	6.1 (2.9)	5.6 (2.4)	5.0 (2.2)	4.6 (3.7)	0.052
Joint line elevation (mm)	-0.3 (4.1)	1.3 (3.8)	-0.1 (3.9)	2.0 (3.8)	0.011+
Maximal flexion (°)	130.1 (10.0)	137.0 (9.6)	132.2 (9.0)	136.4 (10.8)	0.001#
PF score					
Anterior knee pain	13.9 (2.6)	14.7 (1.2)	14.9 (0.7)	14.3 (2.5)	0.042§
AKS					
Knee score	95.4 (5.1)	96.2 (4.6)	95.6 (5.3)	95.2 (6.5)	0.802
Function score	96.8 (7.0)	94.5 (11.7)	97.4 (7.2)	95.2 (10.3)	0.359
WOMAC					
Pain	2.6 (3.0)	1.4 (2.2)	1.8 (2.1)	2.4 (2.9)	0.073
Stiffness	1.7 (1.4)	1.2 (1.2)	1.2 (1.2)	1.7 (1.4)	0.120
Function	17.2 (10.4)	13.3 (9.9)	14.9 (8.1)	14.3 (9.3)	0.226

** Data are presented as means with standard deviations in parentheses.*
+ There was significant difference between FB-CR group and MB-PS group. #There were significant differences between FB-CR group and FB-PS group, and between FB-CR group and MB-PS group. §There was significant difference between FB-CR group and MB-CR group.
Abbreviation: PCO = posterior condylar offset; FB = fixed bearing; MB = mobile bearing; CR = posterior cruciate ligament retaining; PS = posterior cruciate ligament substituting; ANOVA = Analysis of variance; PF = patellofemoral; AKS = American knee society score; WOMAC = Western Ontario McMaster Universities Osteoarthritis index

Table 3. Correlations between the PCO alterations and functional outcomes among the four groups divided by types of implants.*

Parameter	FB-CR	FB-PS	MB-CR	MB-PS
Maximal flexion+	-0.07 (0.712)	0.11 (0.557)	-0.18 (0.253)	0.16 (0.308)
PF score				
Anterior knee pain	-0.24 (0.185)	-0.05 (0.808)	-0.44 (0.003)	0.14 (0.351)
AKS				
Knee score	0.03 (0.880)	-0.34 (0.063)	-0.18 (0.255)	0.12 (0.440)
Function	-0.02 (0.937)	0.19 (0.299)	0.02 (0.891)	0.05 (0.755)
WOMAC§				
Pain	-0.08 (0.648)	0.14 (0.448)	-0.41 (0.007)	0.27 (0.074)
Stiffness	-0.07 (0.706)	0.08 (0.668)	-0.12 (0.441)	0.12 (0.442)
Function	-0.18 (0.317)	0.05 (0.802)	-0.30 (0.054)	0.11 (0.461)

** Data are presented as partial correlation coefficients between PCO alteration and each functional outcome variable with posterior tibial slope and joint line elevation set as covariates, and respective p-values are presented in parentheses.*
+ Preoperative maximum flexion, posterior tibial slope, and joint line elevation, which potentially influenced maximum flexion, were entered as covariates for the partial correlation analysis between PCO alteration and postoperative maximal flexion.
§ To make correlation coefficients indicate the same direction, WOMAC scores were converted to a 0-100 point system where 0 point indicates the worst score and 100 point indicates the best score scores, and the converted scores were used in the partial correlation analyses.
Abbreviation: PCO = posterior condylar offset; FB = fixed bearing; MB = mobile bearing; CR = posterior cruciate ligament retaining; PS = posterior cruciate ligament substituting; PF = patellofemoral; AKS = American knee society score; WOMAC = Western Ontario McMaster Universities Osteoarthritis index

Discussion

Maximal flexion is one of the major determinants of the ultimate functional outcome of TKA, and PCO has been a subject of substantial research partly because it may be one of the surgeon-controlled factors that influence knee flexion. Indeed, multiple authors reported that the magnitude of PCO alteration affects maximal postoperative flexion achieved after TKA [1,5,23,24]. However, our careful literature review found that the effects of PCO alteration on maximum flexion vary with the implant design [1,12,14,22]. Thus, the present study was conducted to determine the influence of PCO alteration on functional outcomes including maximal postoperative flexion in knees replaced with four different types of implant.

The findings of this study need to be interpreted in context of several limitations. First, our patient population was predominantly female, which should be considered when extrapolating our findings to populations with a different gender composition. Nonetheless, it should be noted that the female gender dominance reflects the actual gender balance of patients undergoing TKA in Korea [7,19]. Thus, findings of the present study are generalizable to Asian female patients. Second, knee ROM was measured as non-weight-bearing passive motion arc in this study. However, most activities of daily living are performed under weight-bearing condition and therefore measurement of knee ROM under weight-bearing condition may be more appropriate [9,31]. Third, the clinical data were obtained 12 months after surgery. Although clinical status after TKA typically plateaus after 1 year, somewhat different results may have been found after a longer follow-up. Fourth, although we took into account the effect of posterior tibial slope and joint line elevation when evaluating the effect of PCO alteration, the combined effects among other kinematic parameters such as anteroposterior translation and axial femorotibial rotation were not evaluated. Future studies are warranted to elucidate the confounding effects of the other kinematic factors.

Our findings do not support our hypothesis that PCO alteration after TKA correlates

with maximal postoperative flexion angle. No significant association was found between PCO alteration and maximal flexion in any of the four implant groups. As mentioned above, contradictory findings regarding the effects of PCO alterations on maximum flexion have been reported in previous studies [1,5,14,17,23,24,29]. In a videofluoroscopic study of knees replaced with FB-CR prosthesis, Bellemans et al. [5] found that in deep flexion, the tibial insert directly impinged against the back of the femur, blocking further flexion, and that accordingly PCO was correlated with maximum flexion. Several subsequent studies echoed the proposed correlation between PCO alteration and maximum flexion in knees replaced with CR prosthesis [1,23,24]. In contrast, other studies found no correlation in knees with MB-CR prosthesis [17,29], with FB-PS prosthesis [1,20,32], and with MB-PS prosthesis [3,14,17]. Our findings agree with these latter studies denying the correlation between PCO alteration and maximum flexion. Several interpretations are possible as to why no correlation was found in the current study. First, differences might have existed in the extent of PCO alteration and other factors influencing maximum flexion. For example, in the study by Bellemans et al. [5], the mean PCO alteration was -2.2 mm and mean posterior tibial slope was 3° whereas in the FB-CR group of our study, the mean PCO alteration was 0.2 mm and the mean posterior tibial slope was 6.1°. Previous studies found that other kinematic parameters including posterior tibial slope and condylar roll back affected maximal flexion in CR knees [6,23,24]. Second, Asian patients may have different kinematic patterns that minimize the effects of PCO alterations on maximum flexion. Previous studies reported that compared to Caucasian knees, earlier and more backward movement of the medial femoral condyle in full flexion was observed in Asian knees [18,25]. These may mask the postoperative effect of alterations in PCO on maximal flexion in Asian patients. In addition, preoperative maximal flexion in Asian patients is typically greater than that in Western patients [2,5,27,28], and the degree of preoperative knee flexion is the strongest predictor for postoperative knee flexion [27,28]. The profound contribution of greater preoperative knee flexion may negate the effects of PCO alteration on maximum flexion. On the other hand, in the present study, the knees replaced with PS prosthesis whether FB or MB, had greater postoperative maximum flexion than the knees with corresponding CR prosthesis. This finding, taken together with the lack of a correlation between PCO alteration and maximum flexion angle, suggests that the choice of prosthesis type in terms of PS versus CR is a more important surgeon-controlled factor to increase postoperative knee flexion.

Our findings support our hypothesis that the effects of PCO alterations on the functional outcomes of TKA vary by implant type. Only the MR-CR group had inverse correlations between PCO alteration and two outcome scales (anterior knee pain and WOMAC pain score), and no other three groups had significant correlations. In the knees replaced with MB-CR prosthesis, PCO increase was associated with a worse anterior knee pain score and worse WOMAC pain score. It is also worthy of note that PCO increase had a marginally significant correlation with worse WOMAC function score (CC=-0.03, p=0,054). Our findings of no correlation between PCO alteration and outcome scales in the knees replaced with PS prosthesis corroborate the previous studies reporting no effect of PCO alterations on maximum flexion in knees replaced with FB-PS prosthesis [1,20,32] or with MB-PS prosthesis [3,14,17]. These findings are also intuitively explainable by the fact that the kinematics in knees replaced with PS prosthesis are more profoundly dictated by the post-cam mechanism, which may minimize the kinematic effects of PCO alterations. On the other hand, it is not clear why such correlation does not exist in the knees replaced with FB-CR prosthesis, for which the kinematic effects of PCO alteration should be similar to the MB-CR prosthesis. We speculate that the presence of the correlation only in the knees replaced with MB-CR is attributed to the bearing mobility in conjunction with the retention of PCL. It is conceivable that PCO increase causes tightness across the anterior portion of the knee and subsequently leads to impinge on anterior soft tissue. These kinematic scenarios consequently result in anterior knee pain or knee discomfort when boosted by the soft tissue irritation with mobile polyethylene insert. Relatedly, a previous study reported that synovitis and recurrent effusion occurred in 60% of patients with MB-CR prosthesis (anterior-posterior-glide LCS TKA prosthesis) [26]. However, our interpretations are purely speculative and certainly future studies are recommended.

In conclusion, the alterations in PCO have no effect on maximal postoperative flexion angle regardless of the implant type used. Rather than PCO alteration, whether the implant is either PS or CR type is a better predictor of the final flexion achieved. However, PCO increase is associated with worse outcome in MB-CR prosthesis, and thus surgeons should take caution not to significantly increase the PCO when implanting MB-CR systems.

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ORIGINAL ARTICLE

Functional Outcomes of Revision Total Knee Arthroplasty Following Failed Unicompartmental Knee Arthroplasty

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Abstract

Introduction: Unicompartmental knee arthroplasty (UKA) can be used to treat medial compartment osteoarthritis of the knee. Some of these knees will eventually fail, and need to be revised. There is controversy about using UKA in younger patients as a definitive procedure or as a means to delay total knee arthroplasty (TKA) because the outcomes of subsequent revision surgery may be inferior to a primary TKA.

Methods: We retrospectively reviewed a series of 46 revision TKA patients following failed UKA (UKA revisions) using functional outcomes questionnaires and compared the results with a cohort of age and gender matched primary TKA patients. Our hypothesis was that UKA revision surgery would be inferior to primary TKA surgery.

Results: Data was collected on 33 knees after a mean follow-up period of five years. There was no significant difference in the Oxford Knee Score (33.7 vs 37.1, p = 0.09) or the Western Ontario and MacMasters Universities Arthritis Index (WOMAC) (24.8 vs. 19.1, p = 0.22). A subgroup analysis demonstrated that UKAs, which fail early, are more likely to produce an inferior outcome following revision surgery than those that survive more than five years.

Discussion: We conclude that UKA can be used effectively in appropriately selected patients, as the functional outcome of their subsequent revision to TKA is not significantly inferior to a primary TKA.

Keywords: *unicompartmental knee arthroplasty, revision knee arthroplasty*

Introduction

Over the past three decades unicompartmental knee arthroplasty (UKA) has been used as a treatment for monocompartment arthritis of the knee. In the 1970's the cemented unicompartmental prostheses resembling modern devices emerged [1,2] and with new prosthetic technology and strict patient selection criteria, UKA has been developed as a successful treatment specifically for osteoarthritis and osteonecrosis [3]. The early selection criteria set out by Kozinn and Scott in 1989 required the patient to be of low activity demand, over the age of sixty, weight less than 82kg and with monocompartment disease. However, many studies have subsequently concluded that UKA can be used in patients under sixty years old [4-6] and in pa-

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tients up to 90kg in weight [4] with outcomes comparable to the early selection criteria.

UKA has been shown to have better post-operative range of motion (ROM), less perioperative morbidity [7] and biomechanics closer to that of a normal knee [8] when compared to TKA. In a 15-year prospective trial, Newman found that Bristol Knee Scores remained superior to TKA 15 years after surgery[9]. Furthermore, UKA has even been shown to be functionally comparable to a normal knee [10]. With this knowledge in mind, UKA is becoming more frequently used as a treatment for younger patients with the plan to revise the UKA to a TKA when failure occurs [11].

When the UKA does fail, revision to a TKA is superior than revision to another UKA [12,13]. Usually, the revision to TKA can be performed using a primary unconstrained prosthesis [4] and is considered a straightforward procedure although stems and augments may be required when there is significant peri-prosthetic bone loss [14].

Several studies have looked at the functional outcomes when a UKA is revised to a TKA. However, most are small case series and there is little consistency in outcome measures, comparators and follow-up periods. Many of the more recent series compare UKA revision with primary TKA, and these have found the functional result of UKA revision surgery to be inferior to that of primary TKA [13, 15-19]. Based on this result, Pearse et al. and Chou et al. conclude that UKA should not be used to delay TKA. The purpose of this study was to review the long-term functional outcomes of UKA revision surgery and compare this to a cohort of primary TKA patients, and use subgroup analyses to determine prognostic indicators. This will provide information on the success of UKA revision and thus the role of UKA in younger patients with medial monocompartment arthritis. Our hypothesis was that UKA revision surgery would be inferior to primary TKA surgery.

Methods

A retrospective, matched-pair, cohort design was used to evaluate the functional outcome and survivorship of TKA converted from failed UKA. Ethics approval was gained from the Nepean and Blue Mountains Local Health District human research and ethics committee (12/04 – LNR/12/NEPEAN/9). Patients were identified from the surgical records of two orthopaedic surgeons for the period between 1997 and 2011. Patients were selected for inclusion if they had had a UKA revision following a UKA that had failed for any cause. Patients who had gone on to have further surgical procedures on the same knee were also included. Patients undergoing primary TKA were chosen as the control group, and were selected from the same surgeons' records and matched for surgeon, gender, time of surgery (within six weeks of corresponding UKA revision) and age (within ten years of corresponding UKA revision). Two control patients were chosen for each UKA revision. All patients were cross-referenced with the Australian Orthopedic Association National Joint Replacement Registry to determine if any further surgery (re-revisions) had been performed at another institution and to compare our cohort with the same knee replacement population across Australia.

Patients were mailed a package containing a small questionnaire to identify current body mass index, comorbidities and any further surgical procedures performed on their knee as well as the Oxford Knee Score (OKS) and Western Ontario and MacMasters Universities Arthritis Index (WOMAC). Patients were asked to return the questionnaires in the self-addressed envelope provided.

Subjects who returned their questionnaire were included in the final analysis. The medical records of these patients were analysed to identify the type of implant used, the components used in the revision surgery, survivorship of the original UKA and further surgical procedures.

The OKS and WOMAC were chosen because they are both self-reporting questionnaires. The OKS has been shown to have good correlation with the American Knee Society Score [20] and produces a score between zero and 48 with 48 being the best score.

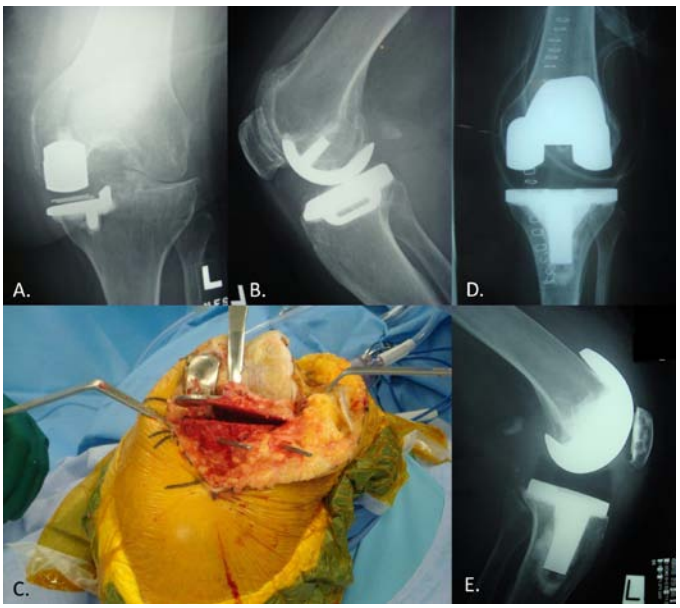

Fig 1. Failed cemented Oxford UKA at seven years. A) Pre-operative radiograph showing progression of disease to the lateral compartment. There is no loosening or collapse of the UKA. B) Sound fixation of the UKA from the lateral view. C) Intraoperative photograph of the tibia being prepared. Resection is performed at the level of the bone-implant interface to minimise bone loss and allow the revision component to be seated directly on host bone. D) and E) Post-operative radiograph showing good fixation. The larger bone resection on the tibia required a thicker polyethylene insert.

The WOMAC is a validated questionnaire that has been used for many years as a disease specific instrument for hip and knee osteoarthritis [21]. The questions are divided into pain (five items), stiffness (two items) and function (17 items) categories. Using a five-point Likert scale the WOMAC produces a score between zero and 96 with zero being the best result.

Student's t-test was used to compare the means of each variable in the two groups. Kruskal-Wallis tests were used to compare the data of the subgroups within the UKA revision group. This test was chosen because of the small numbers in each group, differences in sample size between groups and because it was assumed there was an uneven distribution. The level of significance was set at 0.05.

Results

Forty-three patients (46 knees) who had had UKA revision surgery were identified from the records of the authors. Ninety-two control patients (92 primary TKAs) were identified in the same way and matched to the study group. These patients were cross-referenced with the Registry of Births, Deaths and Marriages and 18 (six UKA revision patients) were found to be deceased. Thirty-one UKA revision patients (33 knees, 72%) and 56 (61%) control patients responded to the follow-up questionnaire. The mean follow-up time after revision surgery was 5.1 years (9 months to 14 years).

The commonest reason for failure of the UKAs requiring revision surgery was progression of disease (18) followed by loosening (12), ongoing pain (6), worn polyethylene (4), fractured tibial component (3), bearing subluxation (1), periprosthetic fracture (1) and recurrent haemarthrosis (1). The mean age of the original UKA was 61.5 and the mean time to failure was 5.7 years. There were no statistically significant differences in the baseline characteristics in the patients who responded to the questionnaire (table 1).

Table 1. Comparison of baseline biometric data between the two groups.

	UKA† revision	Primary TKA‡	P-value
Number	33	56	
Mean age at operation	65.1	66.1	0.58
Gender (%female)	54.6	53.6	0.92
Mean follow-up (years)	5.1	4.2	0.12
Mean BMI§ (kg/m2)	30.04	31.26	0.51

† Unicompartmental Knee Arthroplasty
‡ Total Knee Arthroplasty
§ Body Mass Index

The OKS was not significantly different between the UKA revision and primary TKA groups (33.7 vs. 37.1 p=0.09) after a mean follow-up period of 5.1 years. Similarly, the total WOMAC was not significantly different between the two groups for the same follow-up period (24.8 vs. 19.1 p=0.22). However, analgesia use was found to be significantly different with 27% of the UKA revision group using regular analgesia specifically for knee pain compared to only 5% of the primary total group (p=0.003) (table 2).

Table 2. Outcome variables comparing the two groups.

	UKA† revision	Primary TKA‡	P-value
Mean follow-up (years)	5.1	4.2	0.59
OKS§	33.7	37.1	0.09
WOMAC‖	24.8	19.1	0.22
-Stiffness	2.3	1.8	0.19
-Pain	4.4	3.0	0.17
-Function	18.1	14.6	0.25
Analgesia (%)	27.3	5.4	0.003

† Unicompartmental Knee Arthroplasty
‡ Total Knee Arthroplasty
§ Oxford Knee Score
‖ Western Ontario and MacMasters Universities Arthritis index

The 33 UKA revision knees were further divided into three subgroups. Firstly, revisions from Oxford unicompartmental components (n=17) were compared to revisions from all other unicompartmental components (n=16) and no statistical difference in the outcome measures was found for either OKS (34.7 vs. 32.8 p=0.65) or WOMAC (21.4 vs. 28.0 p=0.40). Likewise, there was no statistically significant difference found when revisions using primary total knee components (n=22) were compared with revisions requiring stems or augments (n=11) for OKS (32.3 vs. 36.7 p=0.46) or WOMAC (30.3 vs. 13.8 p=0.22). There was, however, a statistically significant difference when revisions that were considered early failures (i.e.

Table 3. A comparison of UKA revision surgery for early and late failure.

	Revision for early failure (<5yrs)	Revision for late failure (>5yrs)	P-value
Number	14	19	
Flexion ROM† (degrees) 6 months post-op	109	116.9	0.20
OKS‡	26.7	39.1	0.003
WOMAC§	41.1	12.8	0.001
-stiffness	4.0	1.6	<0.001
-pain	7.6	2.1	<0.001
-function	29.5	9.7	0.001
Analgesia (%)	50	11	0.01

† Range Of Motion
‡ Oxford Knee Score
§ Western Ontario and MacMasters Universities Arthritis index

UKA failure earlier than five years) were compared to late failures. The early failure group had poorer results in both the OKS (26.7 vs. 39.1 p=0.003) and WOMAC (41.1 vs 12.8 p=0.001) scores after a mean follow-up of five years as well as reporting higher rates of analgesia use (table 3).

Of the UKA revision patients there were two re-revisions. The first required a two-stage revision two months after revision surgery due to uncontrolled sepsis. The second re-revision was done 17 months following revision surgery in a patient who had ongoing pain and stiffness as a result of recurrent haemarthrosis while on Warfarin. In the control group one patient required revision 11 months after primary TKA and was revised with revision implants for ongoing symptoms.

Discussion

Our results show that after an average of five years follow-up there are no statistically significant differences in the function of patients following revision surgery for failed UKA patients compared to primary TKA patients as assessed by OKS and WOMAC scores. There is, however, a significant increase in analgesia use in the UKA revision cohort.

As UKA revision is a relatively uncommon procedure and there is a long time period between the original UKA and the follow-up after revision to TKA, the statistical power of this study is limited by sample size. It is possible that the lower functional scores in the UKA revision group is a true difference, but the sample size was not large enough to show statistical difference. The numbers in our study were comparable to other non-registry studies on the subject. Our study included UKA failure of any cause, including infection, as we wanted our results to reflect real life decision-making. There were however, no UKAs that failed due to infection.

The mean OKS in the UKA revision group was 33.7 (vs. 37.1 in the primary TKA group), which is slightly better than other studies of similar design. Pearse et al. [13] found a mean OKS of 30.02 (vs. 37.16 in the primary TKA group) and Chou et al. [16] found a mean OKS of 29 (vs. 39 in the primary TKA group). Both of these studies found that the index procedure was significantly poorer than primary TKA, and although the differences in our study were narrower, we concede that a greater sample size may have shown statistical significance. However, these studies have a shorter follow-up time of 6 months and 12 months, respectively. The study by Pearse et al. examined 122 patients through the New Zealand National Joint replacement registry and therefore looks at a large number of surgeons whilst Chou et al. looked at a series of 33 UKA revisions performed by eight surgeons. The two surgeons involved in our study are high volume arthroplasty surgeons, which may explain the higher outcomes scores.

We found a mean WOMAC score of 24.8 (vs. 19.1 in the primary TKA group [lower score indicates better result]), but again this was not a significant difference. This was similar to that found by Rancourt et al. [19] who reported a mean WOMAC score of 25.8 (vs. 19.8 in the primary TKA group) in their study of 63 UKA revisions after 3.1 years mean follow-up. It is also significantly better than Oduwole et al. [22], who found a mean WOMAC score of 33.3 in their series.

Several subgroup analyses were conducted on the data yielded from our study to help identify prognostic indicators. We found there was no significant difference in knees revised from an Oxford unicompartmental prosthesis compared with all other unicompartmental prostheses. The Oxford unicompartmental prosthesis has a mobile bearing on a keeled, polished tibial prosthesis. The other unicompartmental prostheses are a number of fixed bearing prostheses, which either have an all polyethylene tibial component or modular tibial components with small pegs for fixation. At the start of the study we had hypothesised that a prosthesis with a deeper tibial keel (such as the Oxford) may cause greater bone loss and hence result in a poorer revision. However, the results of our study demonstrate a slightly better result for revisions of the Oxford prosthesis (all except for one were cemented), although this was not significant. The keel of the Oxford tibial component leaves a small cavitary defect when performed well provided that it has not loosened or migrated. However, if done poorly or there is bone collapse has the potential to leave larger defects.

We also hypothesised that when a knee required revision components and/or grafts for revision it would also produce a poorer result than primary TKA components. Again, our results do not show a significant difference and even demonstrated a trend toward the contrary. This result might indicate that using revision components may actually produce a better outcome than trying to revise to primary implants at all costs, however, this would need to be examined in larger numbers. The general approach of the surgeons in this series was to use the least level of constraint required to produce a stable revision but given these results it is possible that a more stable prosthesis may have been indicated in some cases where only primary components were used.

Our final subgroup analysis showed a clear difference in revisions of unicompartmental knees that had failed early (within five years) and those that had failed later. Those

that had failed later produced revisions with mean OKS and WOMAC scores similar to (or even better than) that of primary TKA.

Several recent studies have found that UKA revision is inferior to primary TKA and concluded that UKA should not be used as a conservative procedure to delay TKA [13, 16]. As the functional scores in our study were not significantly different between groups, we cannot concur with this conclusion. By using primary TKA as the control group we are able to compare UKA revision surgery to a well-known and successful procedure. It is also consistent with previous studies on this subject. However, it is still not an ideal comparison because it fails to recognise that joint disease has been occurring in the knees that initially received the UKA for a much longer period than those receiving a primary TKA. A slightly inferior result in the UKA revision group, as other studies have found [13,15-19], might be acceptable to surgeon and patient, as the original UKA has treated the symptoms of joint disease for many years.

Overall, we believe that UKA can be a definitive procedure and should not be treated as an interim solution. It can provide many years of symptomatic relief and in the majority of cases will not require revision. If a UKA does fail, our study shows that it can be converted to TKA with results that are equivalent to primary TKA but potentially 5 to 15 years after the original presentation.

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Reconstructive Review
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ORIGINAL ARTICLE

Management of Complex Knee Deformities in Asian Population: Our Experience of 11 Cases

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Introduction

Osteoarthritis (OA) of the knees and non specific lower back pain are one of the most common disorders of population of Asia Pacific region [1]. Knee OA has significant effect on the quality of life of patients [2], as they are not able to perform their daily activities with ease and gradually develop dependence on other family members. This leads to eventual disconnection from the social life and development of depression in patients. Incidence of knee OA is well documented in Asian countries [3-5] with figures reaching up to 28% in the urban population of Pakistan [3]. Incidence is found to be greater in patients of female gender [6,7] and those with greater body mass index (BMI) [8]. Population of Pakistan has tendency to develop OA earlier than the European population mostly having isolated involvement of the knee joints only [9].

Total Knee Arthroplasty (TKA) is a life changing procedure for such patients. Great improvements in quality of life [10] and outcome measure scores [11] have been observed in patients undergone TKA. Our patients are challenging further as compared to western population because they present late for consultation when the disease and deformity is advanced. Their expectations are high, as they wish to resume their ground base activities such as kneeling for prayers. Furthermore with financial constraints present with most of the patients, one has to be careful in choosing the type of implant and keep in consideration other alternative available options. This case series encompasses our experience of TKA on patients with variety of challenging deformities, their short term outcome and a review of the literature.

Case Series

Case 1 and 2: Mild Varus Deformities (Figure I)

These 52 (Figure I, case A) and 59 (Figure I, case B) year old females both suffered from bilateral knee OA for more than 5 years. Both of these patients underwent TKA via standard surgical technique comprising medial parapatellar approach, soft tissue balancing in flexion and extension, special emphasis on correct patellar tracking, and use of Johnson and Johnson Rotating Platform High flexion

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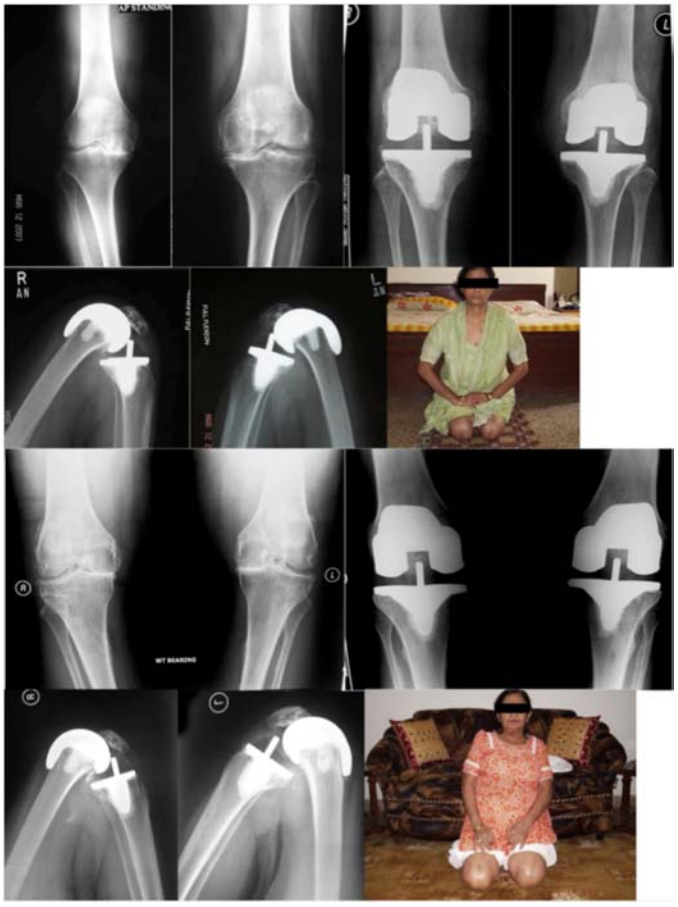


Figure I: Cases of bilateral knee OA with mild varus deformities and achieved end results

implant. These patients also underwent cycles of physiotherapy in the pre-operative period to build up quadriceps and enhance range of motion. During peri-operative period, they had multi-modality pain management protocol including continuous epidural infusion, intravenous and oral analgesia. At home sessions of physiotherapy were also scheduled for these patients to enhance recovery and all above management helped these patients in achieving their goal of kneeling for prayers post TKA. Both are in regular follow up for 6 years now and have no complications.

Case 3: Moderate Varus Deformity: (Figure II)

This 65 year old hypertensive female had bilateral knee OA for 12 years. The angular deformity in the coronal plane was 15°. She underwent initial phase of physiotherapy to improve quadriceps strength followed by bilateral TKA. Special attention was given to soft tissue release that lead to correction of deformity and good post operative results. The surgical technique involved medial parapatellar arthrotomy, subperiosteal release of the soft tissue envelope starting from the tibial tuberosity all the way upto posterior aspect of the tibia preserving the superficial medial collateral ligament within the soft tissue envelope that is raised. Removal of medial and posterior tibial osteophytes and the attachment of semimembranosis at posteromedial aspect of tibia was also released. She achieved a range of motion of 130° and was still symptom free at 7 years follow up.

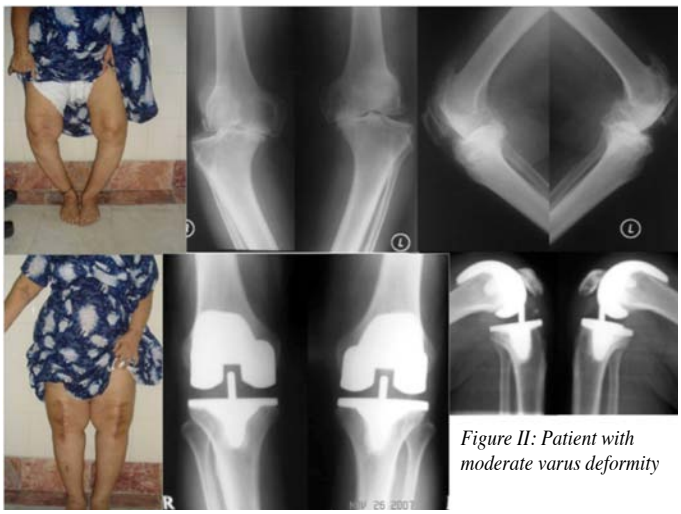


Figure II: Patient with moderate varus deformity

Case 4: Severe Varus Deformity: (Figure III)

63 year old lady with lady with bilateral knee OA for 15 years presented to our outpatient clinic when she was unable to walk for more than few steps without support. She had both severe varus deformity along with moderate flexion contractures bilaterally. After adequate discussion of outcome and possible need of constrained implant she underwent TKA with extensive soft tissue release at medial sides. Medial release was similar to case 3; whereas fixed flexion contractures were corrected by removal of osteophytes from posterior femoral condyles and release of the posterior capsule. After balancing of gaps at trial there was no ligamentous instability noted, so a primary implant was used and post operatively rehabilitation program was start-

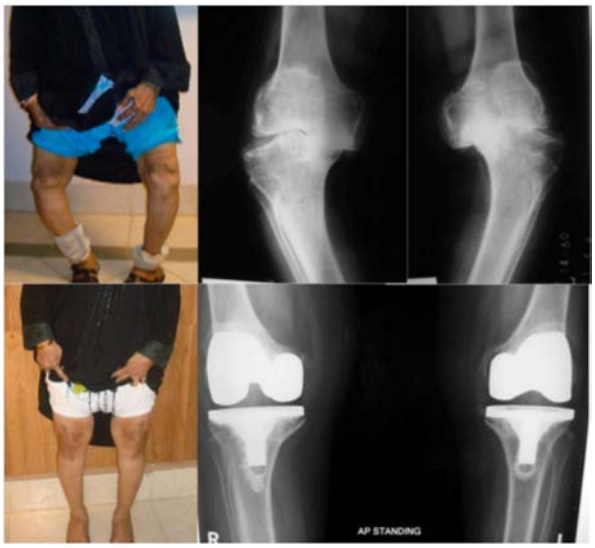


Figure III: Case with severe varus deformity

ed. She achieved 90° of range of motion and had no problems till her last follow up at 5 years.

Case 5: Unilateral Severe Varus Deformity (Figure IV)

68 year old female had right knee deformity of 45° varus angulation in the coronal plane. We had arranged for constrained implant considering the extensive deformity but with after the required medial release, we were able to achieve a balanced knee in both flexion and extension with Posterior stabilized type of implant with a long stem. She has a 8 year follow up with active life and good functional outcome.

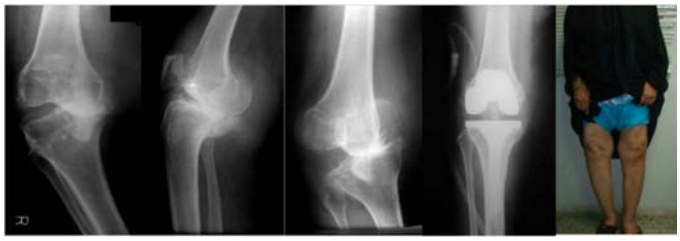


Figure IV: Severe varus of unilateral knee

Case 6: Unilateral Severe Varus Deformity (Figure V)

This 49 year old diabetic and hypertensive obese female had a history of OA for last 8 years. She had bilateral varus knee deformity more pronounced in left knee. Radiographs revealed bone loss in both knees more worse in the left side. Pre-operative planning included the availability of augments and stems. After dissection and surface cuts, the final defect was effectively dealt with autologous bone grafting and use of long stem tibial component for stability. She had no complaints at her last 4 year follow up.

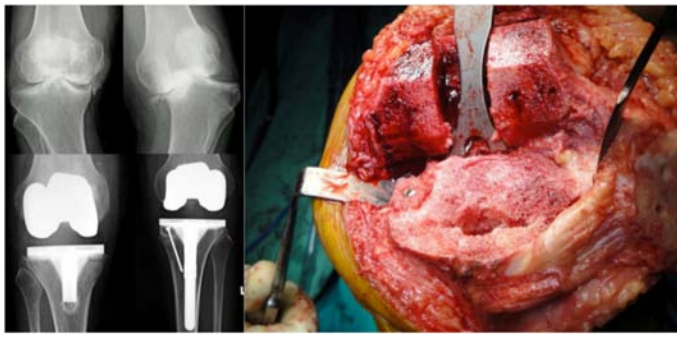


Figure V: Varus deformity treated with bone grafting

Case 7: Challenging Varus Deformity (Figure VI)

70 year old female was referred to the outpatient clinic with extreme deformity of left knee. She had bilateral knee OA for 20 years and was wheel chair bound for last one year as she was not able to stand without support. There was a past history of surgery for deformity correction of left tibia at the age of 55 years of age. She had 55° of varus angulation which was calculated on anteroposterior radiographs on left side. Intra operatively right side was easily managed; and at the left side after medial release, the posteromedial bone loss was managed with the tibial cut. We had metal augments and long stem implants available in the operating theatre but a larger spacer was the only requirement that provided adequate stability along with primary tibial and femoral components. She achieved mobility and good range of motion after an extensive period of physiotherapy and rehabilitation and was symptom free at two years follow up visit.

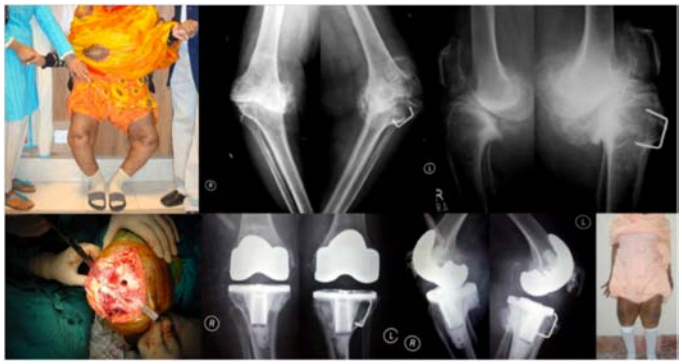


Figure VI: Severe varus treated successfully with primary TKA implant

Case 8: Challenging Varus Deformity (Figure VII)

60 years old lady with high BMI and bilateral knee OA presented with severe varus deformities, especially on the left side. Intraoperatively right knee was dealt with medial soft tissue release and a primary TKA implant but left side had significant bone defect on the medial tibial condyle for which metal augment and long stem implant was used. Post operatively she was having good recovery and rehabilitation. At 3 months she suffered a fall in which her right patella got fractured and there was left anterior tibial plateau fracture. For these injuries she underwent tension

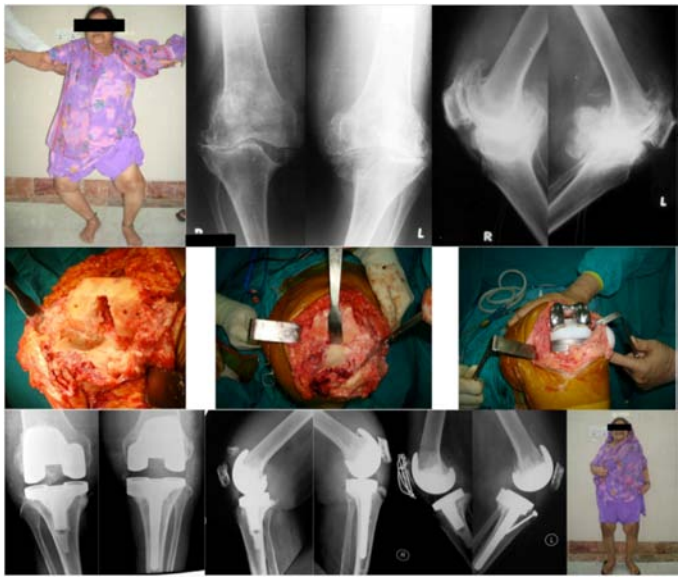


Figure VII: Varus deformity with progression to recovery and later complication alongwith final result

band wiring of right side and screw fixation of left side. She started full weight bearing mobilization immediately in the post operative period. She still needs a stick to walk at 1 year follow up.

Case 9: Valgus Deformity (Figure VIII)

62 year female presented to our clinic with left sided severe valgus knee and OA. She underwent closing wedge osteotomy of left femur 20 years back at some other institute. Radiographs revealed deformity and plate applied over medial aspect of femur. After pre-operative planning TKA was carried out through midline incision. First the implant was removed and lateral release left the knee was carried out. Instability was noted and a need of constrained knee was felt and same was implanted. She is doing well at 3 years follow up.

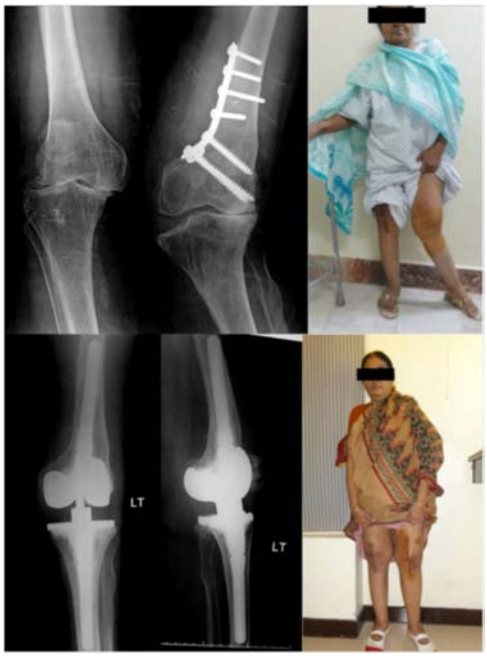
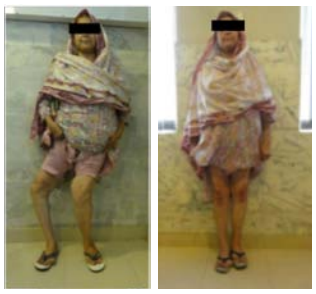


Figure VIII: Valgus deformity with successful correction after TKA

Case 10: Wind Swept Deformity (Figure IX)

This 55 year old lady had severe varus deformity in her right and moderate valgus deformity of her left knee along with different degree of bilateral flexion contractures. The valgus left knee was managed with soft tissue release and bone grafting of the defect along with a primary implant. Right side after release of the varus resulted in instability and therefore constrained condylar knee was used to solve the issue. She still walks without support after 4 years of TKA.



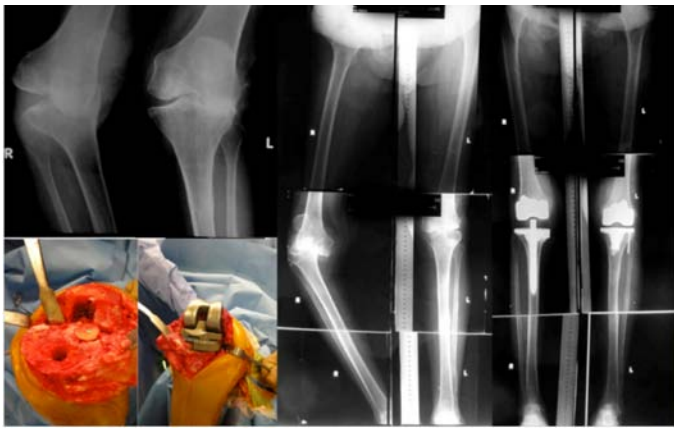


Figure IX: Wind swept deformity corrected with TKA

Case 11: Fixed Flexion Contractures (Figure X)

70 year gentleman presented with bilateral knee OA and inability to walk for last 3 years. He had bilateral knee contractures of more than 60° on both sides. Intraoperatively careful posterior release was carried out and he was able to mobilize again without support after 3 months of aggressive rehabilitation and physiotherapy. He lost to follow up after 7 years.

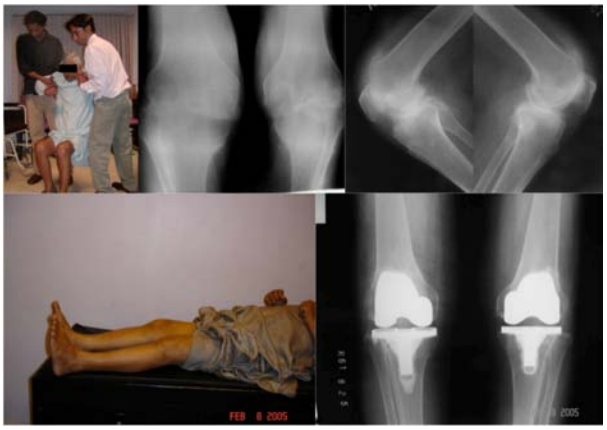


Figure X: Fixed flexion deformity treated with TKA

Discussion

Asian patients with knee OA vary from western population as described earlier. In fact there are various differences in between Asian population of different regions. Siow et al observed that Indians show lower functional outcome scores when compared to Chinese population after TKA [12]. Moreover there were also differences in ages at which TKA were performed and BMI of the patients, however post operative Knee range of motion was comparable.

Our series of cases include a vast variety of deformities that require individual attention to minute details of that single patient. Despite of that, one must be clear in mind that the steps of achieving a successful TKA can never be bypassed. These include:

- Correction of deformity in all planes

- Restoration of mechanical axis
- Balanced flexion and extension gaps
- Restoration of joint line and
- Correction of patella-femoral tracking

A varus knee is the most common deformity one encounters while performing TKA. It may be due to either primarily OA of the knee or due to extra articular deformity of femur or tibia. Varus deformity can be effectively dealt with soft tissue release in most of the cases. Structures described to release medial gap include deep medial collateral ligament, Superficial medial collateral ligament, posterior oblique ligament, attachment of the semimembranosus tendon and the pes anserinus tendon. Different authors have recommended different order in which the release of tissues is carried out to achieve gap balancing. Seo et al preferred posterior oblique ligament release followed by deep medial collateral ligament to achieve varus correction [13]. He observed good results with this pattern of release and the size of spacer used was also smaller. Sim et al has advocated the use of adjunct medial epicondylar osteotomy along with soft tissue release to achieve varus correction [14].

Valgus knees are more difficult to manage as compared to varus since release of soft tissue leads to instability easily and use of constrained variety of implant is then unavoidable. Rajgopal et al observed good long term outcome of TKA of valgus knees with soft tissue release of iliotibial band and popliteus, and use of constrained implants wherever necessary [15]. Moreover there may be hypoplastic condyles and deficient tibial bone stock in severse deformities. In such cases cement made augments, metal augment and autologous bone grafting are valuable options. Autologous bone grafting is beneficial in particular as it also provides with future bone stock if revision is required [16].

Ankylosis of the knee can be very difficult to manage. The cause of ankylosis (whether arthritis or infection) must be established and detailed outcome and procedure should be discussed with the patient. Ankylosis is common in extension [17], but there have been case reports where ankylosis in extreme flexion is also dealt appropriately and good results attained [18]. It is important to keep in consideration that wide range of motion is usually not attainable and there is a chance of extension lag.

Fixed flexion deformity is another entity that is usually dealt in knee arthroplasty most commonly in conjunction with varus or valgus. Severe flexion contractures can be first managed by skeletal traction followed by TKA as in our case, whereas there are authors advocating application of traction in post operative period for management of residual contractures after correction [18]. Patients with fixed flexion contractures achieve better improvement in functional results when compared to those patients without contractures [19].

Conclusion

Severe deformities of knees in Asian patients can be predictably corrected to improve and transform their quality of life. This requires advance surgical skill, careful pre operative clinical and radiological assessment and planning. Post operative pain management and extensive rehabilitation are also an essential component for achieving good results and patient satisfaction.

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Reconstructive Review
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CASE STUDY

Total Hip Arthroplasty in Failed Hip Fractures: A Case Series

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Introduction

Osteoporosis is epidemic in Asian countries. It is a major cause of fractures that orthopaedic surgeons deal in Pakistan, though proper epidemiological data is not available. Habiba U et al found that 75.3% of post menopausal women of Pakistan were predisposed to Osteoporosis [1]; whereas Baig L has described an average T - score of -1.833±0.65 on bone mineral density calculation of post menopausal females of Pakistan [2]. Osteoporotic hip fractures constitute a major cause of elderly mortality worldwide and recent figures supporting the idea that these patients have survival rates comparable to breast and thyroid cancer patients [3]. Pakistan is a developing country with large burden of hip fractures. Patients living in remote areas are the ones which suffer more because of inadequate awareness, fear of surgical treatment and lack of availability of standard treatment. These patients are dealt by surgeons of various expertise and levels of experience. Lack of facilities in hospitals is well known and usage of sub-standard implant is a major cause of failure. Therefore these patients either because of their bone fragility or mal-treatment suffer frequently from failure of hip fracture surgeries. Being in a tertiary care centre we come across these types of cases very frequently. Six to eight such cases present to outpatient department of Liaquat National Hospital every month being referred from every part of the country. These patients may have been operated once, twice or even multiple times. Special attention is required to acquire an informative history from these cases and perform a comprehensive examination. Moreover previous records and radiographs provide invaluable information regarding cause of failure and deciding course of further treatment. We herein discuss few of the cases of failure of hip fractures which were treated by hip arthroplasty.

Case Series

Case 1 (Figure I)

59 year old female presented with left hip pain. She had an intertrochanteric fracture of left femur fixed with a Dynamic hip screw (DHS) 8 months back. Recent radiographs revealed lag screw cut out superiorly in the acetabulum. After planning and consent she received a primary cemented total hip arthroplasty after removal of DHS. At five year follow up she was still an independent walker

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without support and pain free.

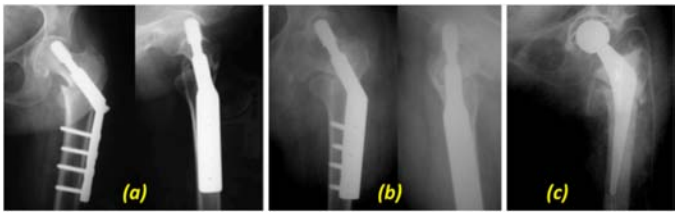

Figure I: *(a) Initial post op radiographs; (b) Lag screw cut out; (c) After arthroplasty*

Case 2 (Figure II)

63 year old female suffered an intertrochanteric fracture which was fixed with a DHS 16 months earlier to presentation. After 6 months of fixation she still had pain and radiologic exam revealed screw cut out. Cemented total hip arthroplasty was planned but during surgery after acetabular cup placement, there was a loss of lateral proximal femoral shaft while placement of femoral component. So surgery was converted to staged procedure. Later on with availability of revision arthroplasty equipment, she received an uncemented wagner femoral component with fibular strut graft and cancellous bone graft from posterior superior iliac spine with large head metal on metal bearing surface. At 10 months of follow up, she had no active complaints and used a cane for walking.

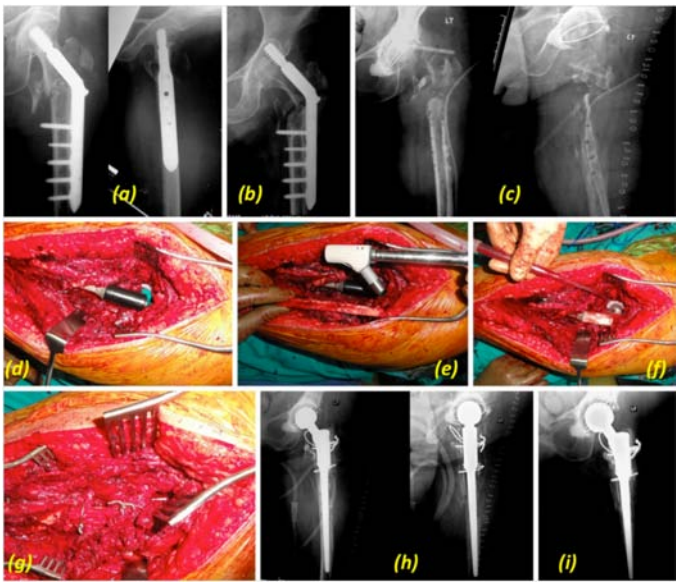

Figure II: *(a) after fixation; (b) after 6 months of fixation; (c) after removal and debridement of first arthroplasty; (d) trial of long stem modular femoral component; (e) implant being placed; (f) implant in situ; (g) after cerclage; (h) immediate post operative radiographs; (i) at 10 months follow up.*

Case 3 (Figure III)

42 year old male after a cannulated hip screw procedure for neck of femur fracture, presented with pain and inability to bear weight on affected limb 10 months after the surgery. X-rays showed improper placement of screws that further penetrated the head and tips of screws migrating superiorly to the acetabulum. He underwent an uncemented total hip replacement (uncemented stem and cup with large head metal on metal bearing surface which was in common practice at that time) and is now free of symptoms at 5th year of follow up.

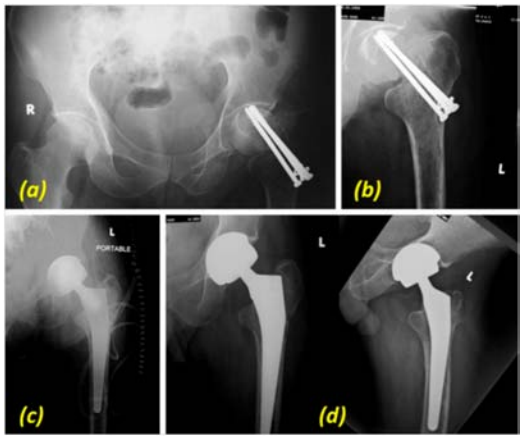

Figure III: *(a) (b) post cannulated hip screw images; (c) immediate post arthroplasty; (d) at 5 year follow up.*

Case 4 (Figure IV)

50 year old diabetic male suffered neck of femur fracture for which he was managed conservatively in his village by a local uncertified medical practitioner for first 4 months. Later he came to an institution where he underwent cannulated hip screws which was also not able to solve the prob-

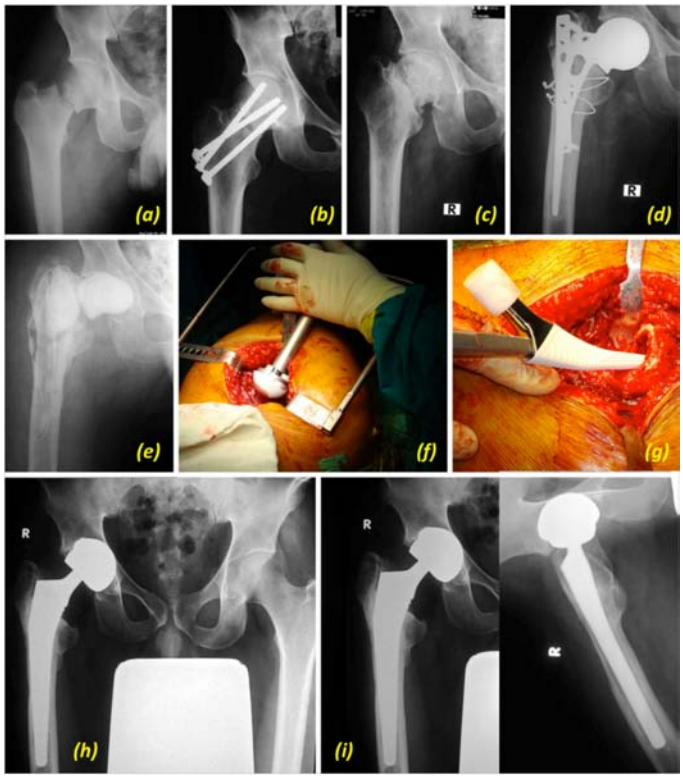

Figure IV: *(a) Pre operative image; (b) after first surgery; (c) post removal of screws; (d) Austin moore and non locking plate for iatrogenic fracture; (e) antibiotic cement spacer to treat infection; (f) placement of non cemented cup and (g) femoral component; (h) immediate post operative image and (i) results after 3 years.*

lem. He was bed bound for further 3 months. He changed his consulting doctor and was managed by another institution where the screws were removed at one stage and later Austin Moore hemiarthroplasty was performed along with a non locking dynamic compression plate to the lateral aspect of femur for iatrogenic fracture. With all these procedures even his primary complaint did not resolved. When he presented to our institution he had fever, an elevated CRP and white cell count and warm hip region. After thorough planning a first stage surgery was performed comprising removal of implant, surgical debridement and placement of antibiotic cement spacer. Tissue cultures revealed resistant strains of Staphylococcus Aureus. After appropriated treatment with antibiotics management of diabetes he was again prepared for surgery and underwent uncemented total hip arthroplasty (uncemented femoral stem and cup with large head metal on metal bearing surface). At 3 years follow up he is still clear of infection and able to walk independently.

Case 5 (Figure V)

60 year old female came with osteonecrosis of right hip which she suffered after 18 months of fixation of her right acetabulum reconstruction. She was treated with uncemented total hip arthroplasty. She was able to mobilize full weight bearing after surgery and was doing well at 4 years of follow up.

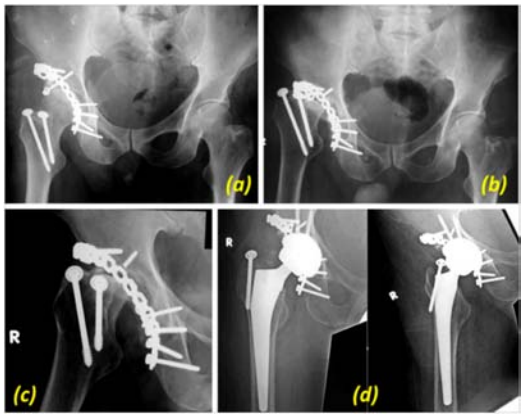

Figure V: *(a) after fixation of fracture; (b) damage to head evident (c) broken screw appreciable; (d) after arthroplasty*

Case 6 (Figure VI)

48 year old male came to our outpatient clinic with fever and pain in left hip. He had a Jewett nail plate for proximal femur fracture at the age of 40 years. Recent radiographs showed gross infective changes involving the proximal 1/3rd of femur. Initially the implant was taken out and handmade antibiotic cement spacer by mixing cement with 2 gram of vancomycin was placed. Cultures revealed staphylococcus aureus. After 6 weeks of intravenous vancomycin therapy, removal of spacer was done and total hip arthroplasty was carried out with large head metal on metal bearing surface along with uncemented wagner stem supported with a fibular strut graft and cancellous bone graft from posterior superior iliac spine.

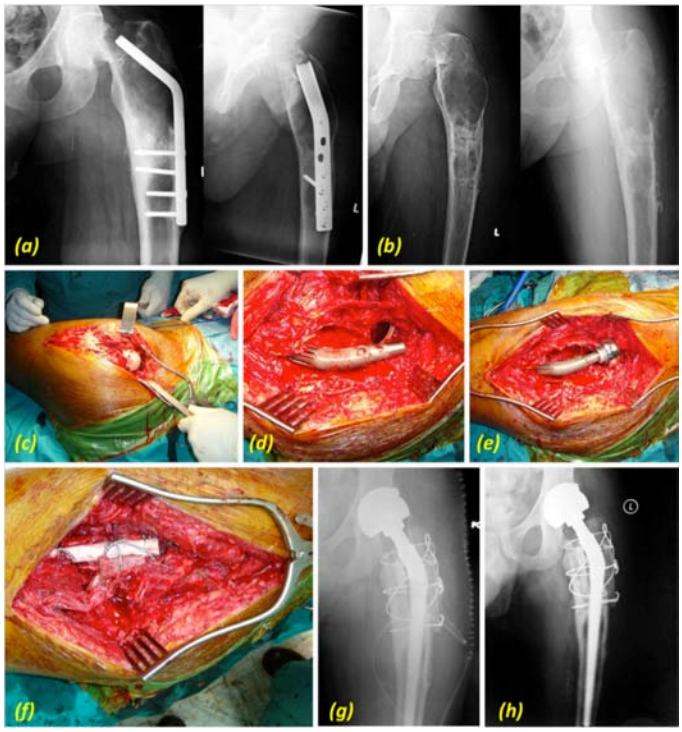

Figure VI: *(a) infection evident in images; (b) after implant removal and debridement; (c) removal of necrotic bone and (d,e) placement of long stem implant; (f) after cerclage; (g) post operative x-ray and (h) follow up image after 2 years.*

Case 7 (Figure VII)

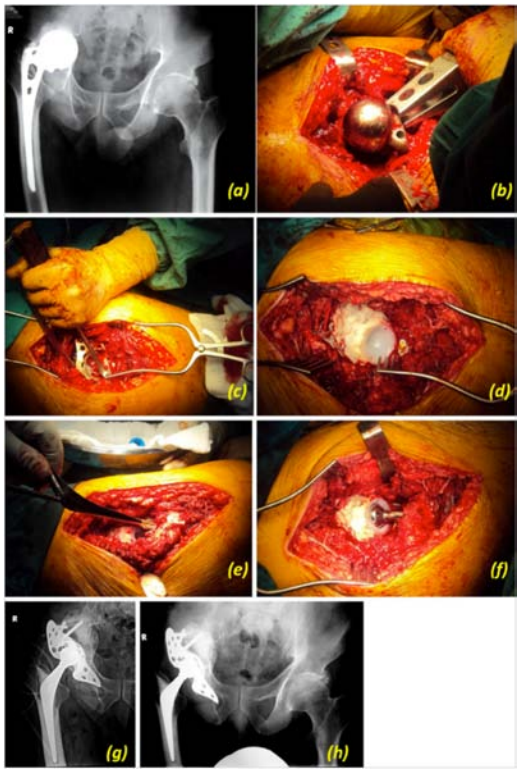

Figure VII: *(a) significant migration of implant; (b) removal of Austin moore; (c) placement of Burch Schneider cage; (d) after cementing and placement of cup; (e) placement of femoral stem; (f) final image before closure; (g) immediate post operative x-ray; (h) after 1 year follow up.*

58 year old male received an Austin moore hemiarthroplasty after a neck of femur fracture 15 years back elsewhere. He developed pain on weight bearing 2 year before presenting to us. Radiographs showed migration of prosthesis superiorly towards the pelvic cavity. He was offered surgery and a cemented total hip with normal femoral stem and cemented acetabular component with Burch Schneider cage and bone graft was used. Follow up of 6 years is uneventful.

Case 8 (Figure VIII)

75 year old male suffered a failure of DHS for intertrochanteric fracture evident at 5 months follow up radiograph. In another institution he underwent removal of DHS and a redo fixation with locking proximal femur plate was done. 6 months later the pain increased and x-rays showing broken metal plate and osteonecrosis of femur head. With this situation he consulted our clinic. After initial workup the implant was removed and a cemented cup and a long stem uncemented modular femoral stem was used. His 4 year follow up is free of complaints and he now walks without any support.

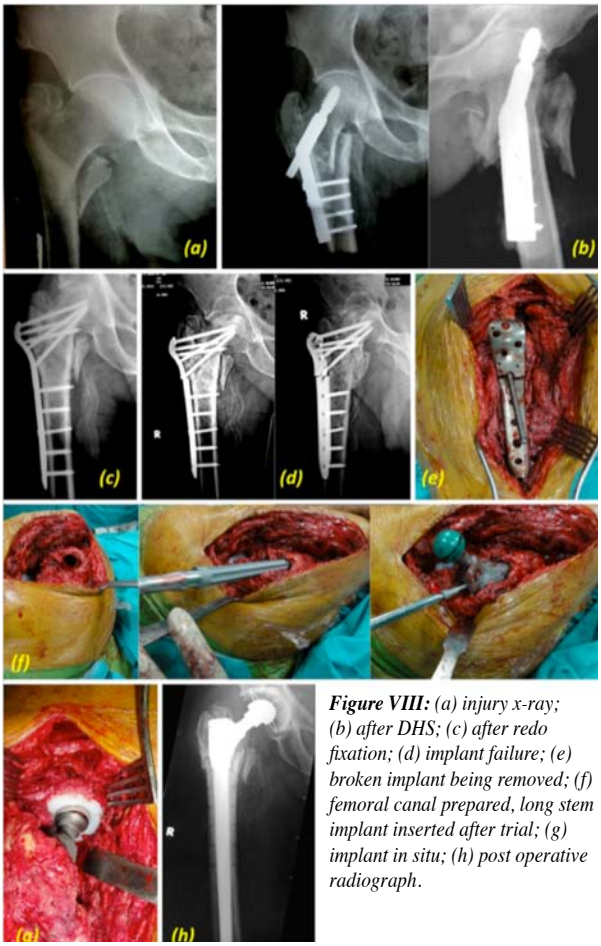

Figure VIII: *(a) injury x-ray; (b) after DHS; (c) after redo fixation; (d) implant failure; (e) broken implant being removed; (f) femoral canal prepared, long stem implant inserted after trial; (g) implant in situ; (h) post operative radiograph.*

Case 9 (Figure IX)

65 year old lady presented with infected non-union of left sub trochanteric femur fracture and broken screws of a dynamic condylar screws done to fix the same. There was gross involvement of proximal femur by the infective process. After a first stage surgery of removal of implant, debridement of dead and infected tissue and placement of handmade spacer comprising vancomycin mixed with bone cement was done. Tissue cultures revealed methicillin resistant staphylococcus aureus (MRSA) sensitive to Polymyxin B. She had intravenous therapy of Polymyxin B for continuous 7 weeks after which her erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) returned to normal. The only option left was a long uncemented modular stem and cemented acetabular cup and she underwent the same. She lost to follow up after 3 years of unremarkable recovery.

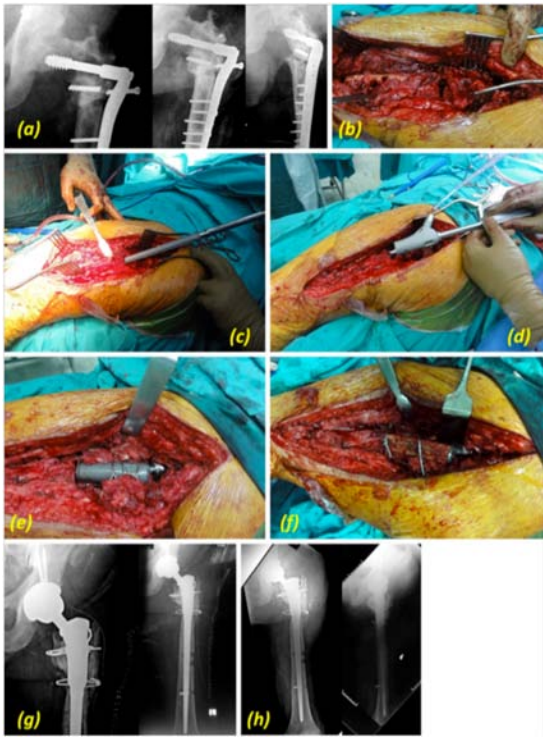

Figure IX: *(a) implant with broken screw and gross bony changes; (b) femoral shaft and removal of implant and clearance; (c, d, e, f) long stem modular femoral implant inserted; (g, h) immediate post operative and 3 year follow up radiographs.*

Case 10 (Figure X)

68 year old male presented with left hip pain to our clinic. He had undergone Austin moore hemiarthroplasty of the left side 1 year back while cannulated hip screw on right side 4 years back for neck of femur fractures. Upon obtaining the full length femur radiographs of left side it was noted that the tip of Austin moore prosthesis has broken inside the shaft and there was an element of protrusio as well. After proper counselling of patient regarding the condition, he underwent surgery in which extended tro-

chanteric osteotomy of the shaft was done to retrieve the broken implant and a long stem modular uncemented wagner SHR was done and osteotomy held in place with cerclage wires. At 1 year follow up this gentleman is doing well and has no complaints.

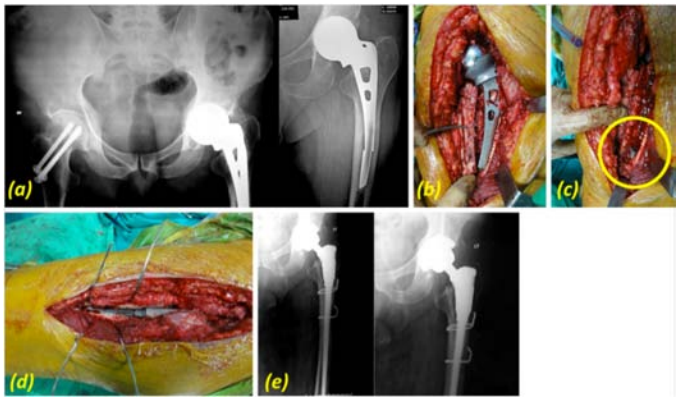

Figure X: (a) Broken Austin moore with protrusion evident; (b) implant visible after extended trochanteric osteotomy; (c) tip of implant in situ; (d) final implant position before osteotomy closure; (e) post operative x-rays.

Discussion

Hip arthroplasty after failure of hip fracture surgery is often termed as Salvage hip arthroplasty (SHA) [4]. Borderick et al described incidence of failure of fixation as being 5% in peritrochanteric fractures, 15% in undisplaced neck of femur fractures and 41% in the displaced ones [5]. Various factors for failure of hip fracture surgeries have been defined in the literature including osteoporosis, unsatisfactory fracture reductions, choice of implant used, early post operative weight bearing and occurrence of infections. In our region we face added difficulties. At various non teaching small health care centres, there is lack of care and facilities, and usage of sub standard implants. Moreover surgeons of various levels of expertise deal with such fractures and patients are not adequately dealt by them with respect to follow up and fracture care. Most of these patients have undergone more than one surgical procedure before presentation. Pachore and Weiss both encountered patients who had undergone multiple surgical procedures with a range of 1-4 which is similar to our observation [6, 7].

A careful history from the patient and past record review may reveal an obvious cause of fixation failure. Wound healing problems during previous surgeries point out to possibility of occult infection and extra care should be taken in such cases with respect to growing cultures from tissues taken from various sites and planning definitive surgery in two stages [8, 9]. However Klatte preferred single stage procedure and observed good outcomes [10]. Weiss reported a high reoperation rate after SHA because of infection [7].

Thorough and attentive pre operative planning is also an unavoidable part of the surgical procedure when considering SHA. One must be wary to analyse the radiographs properly as it will reveal many aspects of operative planning such as quality of bone stock, previous hardware configuration, fracture status and possible hindrances in retrieval of the old and placement of the new implant. All arrangements shall be made for removal of implant including universal nail extractor and broken screw extraction set. Small cannulated reamers should also be made available as sometimes one may encounter fibrosis in the femoral canal and reaming over a guide wire may be necessary. In cases of trochanteric non-union, Pachore et al [6] has reported satisfactory results with tension band wiring whereas Petrie et al [11] has recommended a trochanteric slide technique in order to preserve abductor function and facilitate implant placement for mal-united greater trochanter. He also prefer clearance of sclerosis around screw holes with a high speed burr, so broaches may not get deviated while canal is prepared for stem insertion.

Every case of SHA is unique in its own kind and a full range of implant should be available to operating surgeon. In cases where there is no acetabular damage or cartilage wear, a bipolar hemiarthroplasty is ideal [12]. However in many cases there may be damage to acetabulum due to lag screw migration of previous implant, previous repeated surgical trauma and presence of weakness secondary to osteoporosis. In these situations a total hip arthroplasty is a feasible option either cemented or uncemented one with options of bone grafting and screw fixation as per the case requirement. Similarly collared femoral stems are preferred by many to attain adequate fixation, whereas other are advocates of well uncemented long stem modular implants that will have a stable hold in distal shaft that is mostly unaffected by the previous surgeries [11]. Haidukewych has recommended a distal insertion of long modular implant of about double the diaphyseal diameter of shaft (approximately 6 cm) in order to prevent stress riser [12]. Cerclage wires can also be used to ensure stability.

Patients undergoing SHA are affected by age, decreased mobility, osteoporosis and previous trauma by repeated surgeries. Therefore these patients tend to develop more complications. Intraoperative fractures and iatrogenic injuries to the bone and soft tissues while extracting the previous implant is a possibility. Zhang et al encountered an overall complication rate of 47% while treating intertrochanteric fractures with hip arthroplasty [13]. Co-morbidities pose an anaesthetic risk to such patients, while post operatively venous thromboembolism, infection, dislocation,

subsidence and heterotopic ossification are highly likely. Petrie encountered 5 deep wound infections out of 30 operated patients for which a further surgical debridement was carried out [11].

Finally SHA though has a good overall satisfaction rate as per patients but functional outcome varies due to various contributing factors. These include age and health status of the patient, presence of other systemic illnesses, number of previous surgical procedures undergone and if suffered from infection or not. Harris hip scores vary between Fair to Good values in multiple studies [6, 13].

Conclusion

Failed internal fixation after hip fracture is a difficult problem to deal with especially as the life expectancy of patients and associated osteoporosis is increasing in the current age. It is possible to improve their quality of life with SHA by experienced arthroplasty surgeon. Our observation also concludes that meticulous debridement and staged procedures for infected fixations of hip fractures can yield good functional outcome after hip arthroplasty with minimal chances for revision.

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ORIGINAL ARTICLE

Blood Conservation Strategies in Total Hip and Knee Arthroplasty

David Liu, FRACS[1]; Michael Dan, MBBS[2,3]; Natalie Adivi, BN[1]

Abstract

Peri-operative blood management is one of a number of components important for successful patient care in total joint arthroplasty and surgeons should be proactive in its application. The aims of blood conservation are to reduce the risks of blood transfusion whilst at the same time maximizing haemaglobin in the post-operative period, thereby leading to a positive effect on early and long term outcomes and costs. An individualized strategy based on patient specific risk factors, anticipated blood loss and co-morbidities is useful in achieving this aim. Multiple blood conservation strategies are available in the pre-operative, intra-operative and post-operative periods and can be utilised either individually or in combination. Recent literature has highlighted the importance of identifying and correcting pre-operative anaemia, salvaging peri-operative red cells and the use of tranexamic acid in reducing blood loss. Given total hip and knee arthroplasty is an elective procedure, a zero allogenic blood transfusion rate should be the aim and an achievable goal.

Introduction

One of a number of critical components for successful patient care in joint arthroplasty surgery is a blood management strategy. Hip and knee arthroplasty can result in substantial peri-operative blood loss, rendering the patients at increased risk of requiring a blood transfusion [1,2]. Total joint arthroplasty and fracture surgery is the number one reason for transfusion in patients undergoing surgery and accounts for 9.8% of all transfused red blood cell units [3]. Complications of allogenic blood transfusion include the risk of disease transmission, haemolytic reactions, fluid and haemodymanic overload, acute lung injury, coagulopathy, allergic reactions and febrile non-haemolytic reactions [4]. There is evidence that allogenic transfusions are associated with immunomodulation, and an increased incidence of infection [5]. Bierbaum reported transfusion rates of 57% for total hip arthroplasty (THA) and 39% for total knee arthroplasty (TKA), with an increased risk of fluid overload, infection rate and duration of hospitalization in the patients who received allogenic transfusion [6]. Several studies have highlighted the disadvantages of allogenic blood including a negative effect on postoperative complications, length of hospital stay, cost and mortality [7,8,9].

The fundamental aim of a blood management strategy is to eliminate the need for allogenic blood whilst at the same time preventing anaemia. Thereby the risks of transfusion are removed, haemaglobin (Hb) status is maximized and this leads to a positive effect on the patient's recovery and early and long-term outcomes. Such a strategy should be individualized and based on patient specific

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risk factors including pre-operative Hb level, anticipated difficulty of the procedure and blood loss, and associated medical co-morbidities. Haemaglobin loss in routine primary THA has been calculated to be 4.0g/dL and in TKA to be 3.8g/dL [10]. The ultimate transfusion trigger should also be individualized based on the risks and benefits for each patient. Multiple strategies, used either in isolation or combination, are available to reduce the need for allogeneic blood in joint arthroplasty patients. Available strategies can be broadly divided into 3 stages: pre-operative assessment and optimisation, intra-operative and post-operative protocols [11]. These are summarized in table 1.

Table 1. Summary of blood management interventions available to reduce allogenic transfusion rates in THA and TKA patients.

Pre-operative	Intra-operative	Post-operative
Correcting anaemia - Iron supplements - Erythropoietin	Acute normovolaemic haemodilution	Post-operative cell salvage
Pre-operative autologous blood donation	Intra-operative cell salvage	Re-infusion drain No drain use
Ceasing antiplatelet and anticoagulant mediactions	Tranexamic acid - Intravenous - Topical - Oral	Tranexamic acid - Intravenous - Oral

Pre-operative Strategies

Predicting the risk and need for transfusion pre-operatively has been shown to be an important element of an effective blood management program in joint arthroplasty surgery. Several studies have highlighted the significant influence of pre-operative Hb on the requirement for transfusion in total joint arthroplasty [10,12]. Salido et al demonstrated that very few patients with Hb greater than 150g/L pre-operatively required allogenic blood whilst patients with pre-operative Hb level less than 110g/L had a 100% transfusion rate [12]. Similarly, Pierson et al showed that an algorithmn based strategy aimed at improving pre-operative Hb level was the most effective in reducing transfusion rate [10]. Other risk factors associated with an increased need for transfusion include weight, age greater than 75 years, male gender, hypertension and body mass index less than 27 [13]. Whilst many of these factors are non-modifiable, Pola showed having more than one risk factor had a compounding effect on transfusion rate [14]. Therefore in patients with multiple risk factors, it is vitally important to correct anaemia and maximize pre-operative Hb. Correcting anaemia not only reduces the risk of allogenic transfusion but also has a positive impact on the patient's rehabilitation and functional recovery. Patients with post-operative Hb of between 8 to 10 g/dl may not be low enough to warrant transfusion but often feel lethargic, with a higher risk of syncopal episodes, impairing their ability to mobilize and undergo their rehabilitation.

In order to correct pre-operative anaemia, the cause needs to be fully investigated and corrected as necessary. A common reason, especially in the elderly arthroplasty patients, is iron deficiency due to a combination of poor dietary intake and peptic disease secondary to NSAID use. The typical pattern seen in these patients is low Hb, with a low ferritin. In our centre, patients are screened 3 months prior to surgery with full blood count, proceeding to iron studies if the pre-operative Hb is less than 120g/dL. The parameters measured to investigate pre-operative anaemia are listed in table 2 with the minimum cut-off values. Any patient who is identified as anaemic is referred to the haematology unit for further investigation and management.

Table 2. *Pre-operative iron studies and critical values used at our institution for patients with pre-operative anaemia requiring correction prior to THA and TKA.*

Parameter	Critical Value
Haemaglobin	12 g/dL
Haematocrit	0.38
Iron	5 μmol/L
Total Iron Binding Capacity	45 μmol/L
Transferrin Saturation	20 %
Ferritin	50 μg/L
Vitamin B12	150 pmol/L
RBC folate	150 nmol/L

The options for maximizing Hb in preparation for surgery include iron supplements or erythropoietin. Iron supplements can either be given orally or intravenously. Both have been shown to be effective however oral iron may not be efficacious in patients with malabsorption such as coeliac disease. Another disadvantage of oral iron supplements is the slow effect and therefore it needs to be implemented well in advance of surgery. A cohort study of 156 patients treated with ferrous sulphate 256mg / day in with combination vitamin C which enhances iron absorption, for 1 month preoperatively showed reduced a transfusion rate for non anemic patients [15]. For our patients with deficient iron stores, the haematologists administer 500-1000mg ferritin carboxymaltose as an intravenous infusion over 15 minutes. Dosage depends on the duration and severity of iron deficiency. The infusion needs to be given a minimum of 3 weeks pre-operatively to enable enough time for red blood cells to regenerate.

Erythropoeitin is a synthetic hormone, which stimulates progenitor cells in the bone marrow to differentiate into red blood cells and thereby stimulating haematopoi-

esis. Erythropioetin is definitely a powerful agent in correcting anaemia and extremely effective in reducing allogenic blood requirement in joint replacement surgery. In a systematic review, Spahn [16] showed erythropoietin to be successful in improving mean preoperative Hb and post operative Hb with reduced transfusion rates when combined with iron therapy in patients undergoing orthopedic operations including hip fracture surgery, THA and TKA. Its main disadvantage remains cost and at this stage, its routine use in Australia is not approved in the joint replacement patients unless the patient suffers from anaemia secondary to chronic renal failure.

A large part of blood conservation in surgery is aimed at limiting blood loss. Patients undergoing THA and TKA frequently take antiplatelet and anticoagulant medications that affect the risk of bleeding. The decision and timing of cessation of antiplatelelet and anticoagulant therapy needs to take into consideration the risks of thrombosis versus the risk of bleeding. Platelet activation occurs with non-cardiac surgery, making myocardial infarction the most common major vascular complication after surgery. Under usual circumstances, warfarin should be discontinued 5 days prior to arthroplasty surgery [17] and recommenced postoperatively when the risks of acute bleeding are believed to be stable. Bridging anticoagulation therapy is commonly used in the interim period with agents such as low molecular heparin, which have a shorter half-life [18]. There are no clear guidelines or consensus on the optimal bridging therapy for patients on warfarin for conditions such as atrial fibrillation, previous embolic cerebrovascular events or mechanical valve replacement and further clinical trials are required to clarify the optimal regime.

With regards to aspirin and antiplatelet therapy, its cessation prior to surgery is believed to result in an increased risk of cardiovascular complications and major cardiac events [19,20]. However a recent large randomized controlled trial of 10010 patients of which 39% underwent orthopaedic procedures, comparing aspirin versus placebo with 30 days follow up after surgery, found conflicting results [21]. There was no difference in the primary outcome of death or myocardial infarction between the 2 groups, regardless of whether the patient was taking aspirin prior to surgery or not. Aspirin increased the risk of major bleeding compared with placebo. The most common reported site of bleeding were the surgical site in 78.3% and gastrointestinal tract in 9.3%. The authors concluded aspirin administration before surgery and throughout the early postsurgical period had no significant effect on the rate of a composite of death or nonfatal myocardial infarction but increased the risk of major bleeding. We now cease aspirin prior to THA and TKA.

Once popular in elective joint replacement surgery was pre-operative autologous donation. Autologous donation has been demonstrated to be effective in reducing allogenic blood requirements. Allogeneic transfusion rates were reduced from 40%, 52% and 91% in the non-preoperative autologous donation group to 3%, 18% and 9% respectively in the preoperative autologous donor group in three cohort studies [22,23,24]. However pre-operative autologous donation is associated with a high rate of wasted blood units and is no longer deemed to be cost effective. There remains the potential for the wrong blood being returned to the patient due to clerical errors [25,26]. The process itself necessitates the inconvenience of having to donate blood in advance of scheduled surgery. The Australian Blood Bank as a consequence currently imposes a cost to patients if they wish to utilize this service. The use of preoperative autologous blood donation has therefore fallen out of favour.

Intra-operative Strategies

A major element of intra-operative blood management is limiting the amount of blood loss. The risk of bleeding depends on the difficulty of the procedure and patient risk factors such as obesity, co-morbidities and bleeding disorders. Regardless of what additional strategies are incorporated, maintaining steady blood pressure and normothermia are both recommended in reducing blood loss. Crucial to blood loss management is meticulous efficient surgical technique with careful dissection, soft tissue handling and bleeding control.

The technique of acute normovolaemic haemodilution attempts to achieve a similar effect to pre-operative autologous blood donation but without the inconvenience of preoperative donation. Blood is collected from the patient in the immediate pre-operative period and volume is replaced with colloid or crystalloid fluid. The rationale behind the technique is surgical blood loss will have a lower haematocrit. The pre-operatively collected whole blood is transfused in the immediate post-operative period negating the downsides of blood storage. However the effectiveness of acute normovolaemic haemodilution in reducing transfusion need is debatable [16]. Its use may be appropriate in selected cases where cross matching of blood is difficult due to the presence of antibodies.

Peri- operative red cell salvage is another strategy available to minimize the effects of blood loss following total hip and knee arthroplasty. Blood lost during the operative procedure and immediate post-operative period can be salvaged and returned to the patient. This technique has sev-

eral advantages over the previously described methods of pre-operative autologous donation and acute normovolaemic haemodilution. Peri-operative red cell salvage re-infuses fresh blood and avoids the problems with storage of red blood cells seen with autologous pre-donation and allogeneic red blood cells. This translates to more efficacious oxygen carrying red blood cells with a higher mean erythrocyte viability [27] and increased preservation of 2-3 diphosphoglycerate [28]. The technique also incorporates washing the blood loss volume. Washing the blood removes biochemical, cellular and non-cellular debris [29]. Unwashed cell salvage has been associated with adverse post-operative effects due to the presence of cytokines including hypotension, hyperthermia, increased postoperative bleeding and non-cardiogenic pulmonary edema. [30, 31] We have been using intra-operative red cell salvage in our unit for the past 4 years for primary and revision hip and knee replacement. An audit of our transfusion rates in comparison to other studies in the literature is listed in table 3 for THA [32,33,34] and table 4 for TKA. [35,36,37] Peri-operative red cell salvage definitely reduces but does not eliminate the need for allogenic blood, especially in patients who have a low baseline haemaglobin pre-operatively.

Table 3. Effects on Allogenic Transfusion Rates of autologous retransfusion of salvaged blood cells in randomized controlled trials and cohort studies for THA compared to historical rate reported by Bierbaum without intervention.

Study	Bierbaum [6]	del Trujilo [32]	Smith [33]	Moonen [34]	Our Data
Allogenic Transfusion Rate	57%	15%	8%	6%	23.7%

Table 4. Effects on Allogenic Transfusion Rates of autologous retransfusion of salvaged blood cells in randomized controlled trials and cohort studies for TKA compared to historical rate reported by Bierbaum without intervention.

Study	Bierbaum [6]	Shenolikar [35]	Thomas [36]	Munoz [37]	Our Data
Allogenic Transfusion Rate	39%	16%	7%	11%	11.9%

Post-operative Strategies

The routine use of intra-articular wound drainage in THA and TKA has been shown to increase blood transfusion requirement [38]. This needs to be balanced with the reported increased risk of persistent ooze, bruising and haematoma formation [39]. The evidence for use of an intra-articular drain therefore remains inconclusive and very much an individual decision based on surgeon preference.

Post-operative reinfusion drains are also commonly employed in orthopaedic practice and reported results suggest it does reduce allogeneic transfusion rates. A meta-analysis by Huet et al [30] showed a relative risk reduction of 0.35 for the need for allogeneic transfusion with re-infusion drains. Zacharopoulos performed a prospective randomized controlled trial with reinfusion drains, leading to a decrease in allogenic blood transfusion [40]. In contrast, Hazarika showed reinfusion drains had no significant benefit with the downside of additional costs [41]. Reinfusion drains carry the potential for transfusion reactions as the unwashed blood contains fibrin degradation products and other potential contaminants [42,43]. The drained blood needs to be reinfused with 6 hours of commencement to avoid the potential for haemolysis.

A logical strategy in blood conservation is to enhance haemostasis during the peri-operative period. Recently a multitude of publications have highlighted the use and benefits of antifibrinolytic agents. Tranexamic acid (TXA) is one such agent being a synthetic plasminogen-activator inhibitor, showing both clinical efficacy and an acceptable safety profile. TXA inhibits the activation of plasminogen to plasmin by blocking the lysine binding sites of plasminogen to fibrin. This results in a decrease in proteolytic action on fibrin monomers and fibrinogen, leading to clot stabilization [44]. The use of TXA in primary THA and TKA patients has been associated with reduced transfusion rates, increase discharge rate to home, and reduced costs [45].

Tranexamic acid has the desirable features of ease of administration, minimal effect on operative procedure flow, and extremely low cost as a generic medicine. Intravenous TXA has been demonstrated to significantly reduce the amount of blood loss and blood transfusion requirements without an increase in venous thromboembolic risk in multiple studies for both THA and TKA [46,47,48]. Oral TXA has also shown similar effectiveness in orthopadic surgery [49]. Several contra-indications preclude the use of intravenous TXA at the time of surgery, including renal insufficiency, history of previous deep venous thrombosis, cerebrovascular and cardiac disease. One study reported 28% of patients were contraindicated to intravenous TXA [50] and in these patients topical administration nay be more appropriate due to the delay in systemic absorption after application into a joint. Intra-articular application limits systemic exposure and maximizes drug concentration and activity directly at the site of bleeding. Wong et al proved the efficacy of intra-articular TXA in a double-blind, placebo-controlled randomized trial in TKA [51]. The authors demonstrated a significant difference in Hb reduction and blood loss using 3.0g of TXA in 100mls of normal saline compared to placebo, with no difference in thrombo-embolic complications. Plasma levels of TXA

following topical administration were 70% less than an equivalent dose of intravenous injection. More recently, a retrospective study found intra-articular and pericapsular injection of TXA after capsular closure resulted in a transfusion rate reduction from 17.5% to 5.5% as well as a significantly higher post-operative Hb in the TXA group [45]. Alshryda et al performed a systematic review and meta-analysis showing topical TXA to significantly reduce the rate of blood transfusion in both THA and TKA and was safe [52]. Indirect comparison of placebo-controlled trials indicated topical administration to be superior to the intravenous route.

There is however no clear consensus on ideal dosage, timing, frequency and routes for administration of TXA in joint arthroplasty surgery. Additionally there may be differences in the efficacy and response of different regimes between THA and TKA. A number of studies have now compared intravenous TXA with topical TXA demonstrating the efficacy and safety of topical administration in TKA [53,54,55]. Both Patel at al [50], using a single intravenous dose and Soni et al [56], using a 3 dose intravenous regimen concluded topical TXA had similar efficacy to intravenous TXA in terms of perioperative change in haemaglobin, lowest postoperative haemoglobin, total drain output and transfusion rate, together with no increase in complications in randomized prospective studies. In a study comparing 3 methods of administration in TKA, single dose intravenous TXA was more effective than topical and intra-articular TXA injected via the drain in reducing Hb drop [57]. Local administration through the drain yielded least blood drainage post-operatively compared to intravenous and topical application, with 80% reduction drainage volume compared to 45% and 18% respectively. In contrast, Maniar et al found single intravenous dose did not give effective results [58]. A 3-dose regimen of pre, intra and post-op doses of 10mg/kg produced maximum effective reduction of drain loss and total blood loss in TKA. The authors concluded a pre-operative dose prior to tourniquet inflation was important to inhibit the activation of the fibrinolysis cascade.

There are fewer studies examining the utility of topical TXA in THA. Wind et al showed a significant reduction in transfusion rate with intravenous TXA in THA but not with topical TXA [59]. Alshryda et al in contrast published a significant reduction in rate of transfusion with topical TXA in THA, comparable to that achieved with TKA [60]. Studies from Konig et al and Tuttle et al both revealed topical TXA to be efficacious in THA as well [45,61].

Another form of pharmacotherapy used to reduce blood loss is topical fibrin sealant. These agents are composed of fibrinogen and thrombin, which when mixed together during the application process, mimic the final step of the coagulation cascade. Randelli performed a randomized trial of topical fibrin versus a control group but found no difference in Hb levels, postoperative decrease in Hb, drainage or mean total blood loss [62]. In particular, the transfusion rate was 32.3% in the control group compared with 25.8% in the fibrin group and this was not significantly different. The authors concluded the topical application of fibrin sealant was not effective in reducing peri-operative blood loss in total knee arthroplasty. Another randomized study comparing topical fibrin spray to intravenous TXA demonstrated comparable reduction in blood loss but the cost of the fibrin spray was significantly greater [63].

Conclusions

A blood management strategy in total joint arthroplasty aims to reduce the need for allogenic blood and avoid the risks of transfusion, whilst at the same time maximizing haemaglobin level and preventing anaemia in the acute post-operative period. Effective blood conservation encompasses pre-operative identification of patients at high risk for transfusion, correcting pre-operative anaemia with haemopoietic agents, salvaging blood lost during the perioperative period, limiting post-operative blood loss with haemostatic measures and individualizing the transfusion trigger according to the patient's symptoms and medical co-morbidities. The algorithm used in our unit is shown in figure 1. A proactive approach to blood management will lead to a positive effect on early and long-term outcomes and greater success in care of the joint arthroplasty patient.

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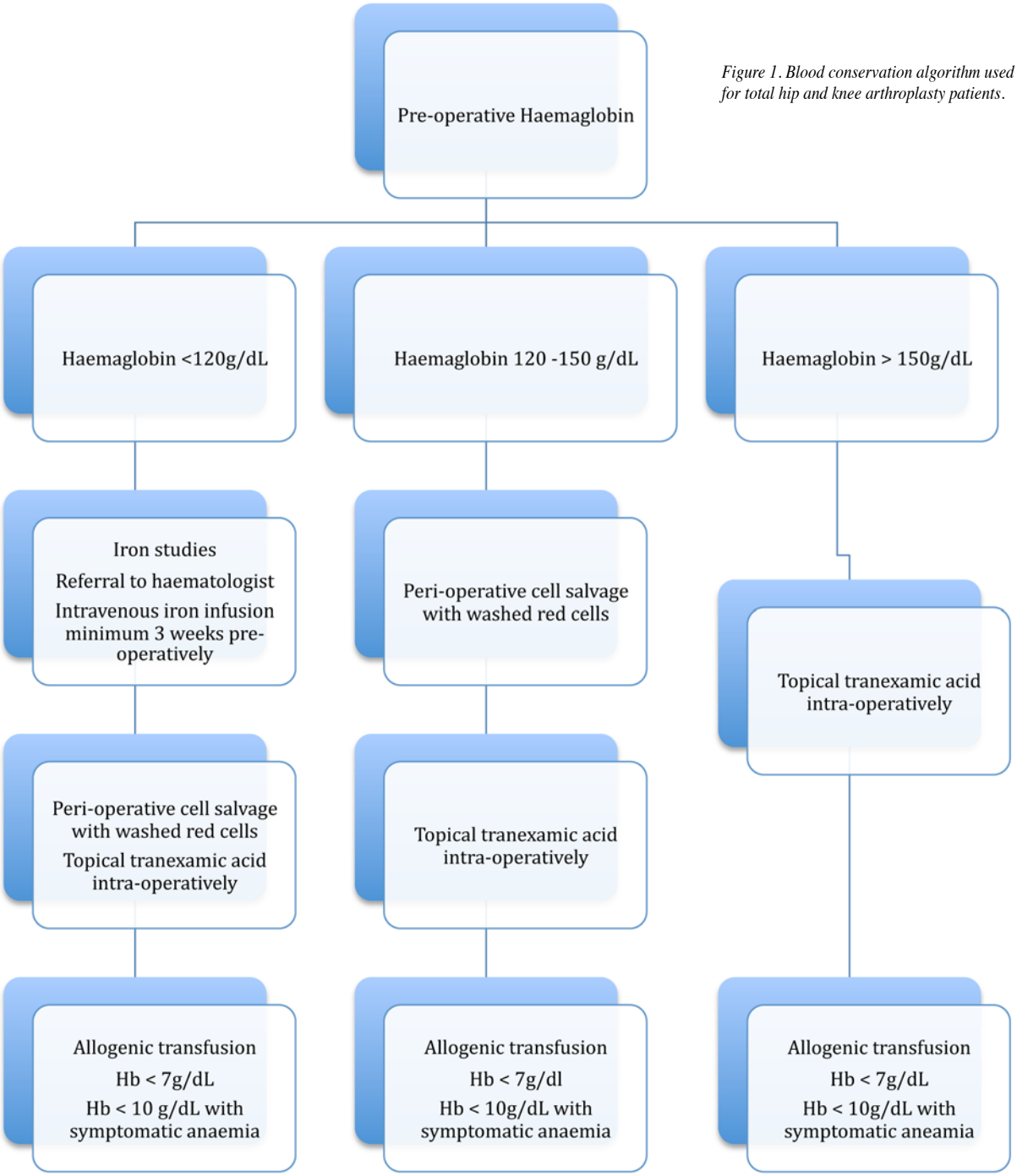

Figure 1. Blood conservation algorithm used at our institution for total hip and knee arthroplasty patients.

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Reconstructive Review
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CLINICAL/SURGICAL

Osteolysis In a Well Fixed Acetabular Cup, Retain or Revise?

Mojieb Manzary, MD, CM, FRCSC [1]

Abstract

Wear and Osteolysis are the commonest cause of aseptic loosening in Total Hip Arthroplasty (THA), requiring revision. A less invasive approach could be undertaken in terms of an earlier intervention by isolated the liner change only. Indications and contraindications of each approach are reviewed with some technical tips. Outcome results have shown that isolated liner exchange alone does have a higher risk of instability.

Introduction

There is no doubt that THA has been a very successful procedure in terms of pain relief and improving the overall quality of life of those who receive it. However, it does have a limitation in terms of long-term survivorship which leads to patients undergoing one or more THA revisions in their lifetime.

Osteolysis is the commonest cause of aseptic loosening in contemporary THA. It could be defined as the process of progressive destruction of periprosthetic bone, characterized on serial radiographs as radiolucent lines and/or cavitation at the bone implant or cement bone interface (Figure 1). [4,13,17]

Although traditionally it was called the Cement Disease, it has been agreed that other particles, e.g, metal debris, polyethylene wear particles, and bone fragments, are equally active in generating bone resorbing materials through an inflammatory process. [13,17]

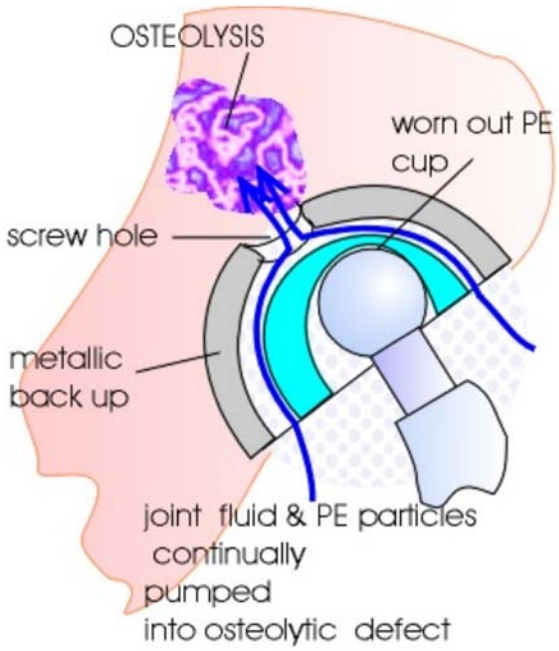

Figure 1. OSTEOLYSIS

1 Adult Joint Reconstructive Surgery
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Discussion

The prevalence of Osteolysis has varied over the years, in the early 1990's, with the ultramolecular high weight polyethylene (UMHWPE) sterilized in gamma irradiation in air, being the dominant poly liner used in THA, the rate of wear and Osteolysis did range from 10%-70%. [9]

The degree of symptomatology varies from being completely asymptomatic to catastrophic failure with periprosthetic fractures with or without instability. The task of the arthroplasty surgeon here lies in identifying the osteolytic process and developing a strategy of when and how to face the osteolytic challenge. In other words, having the right choice(s) to deal with this problem.

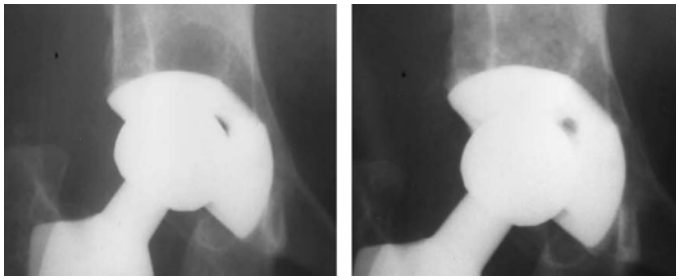

Figure 2. Osteolysis seen on xray

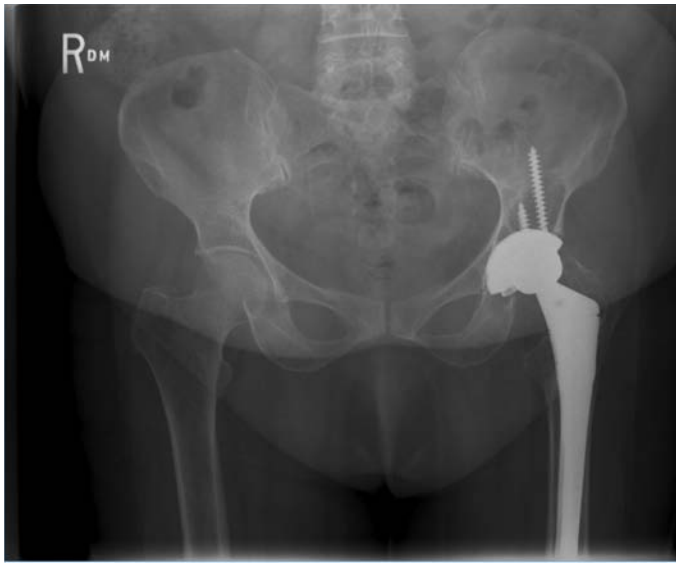

Figure 3. Osteolysis in an uncemented THA

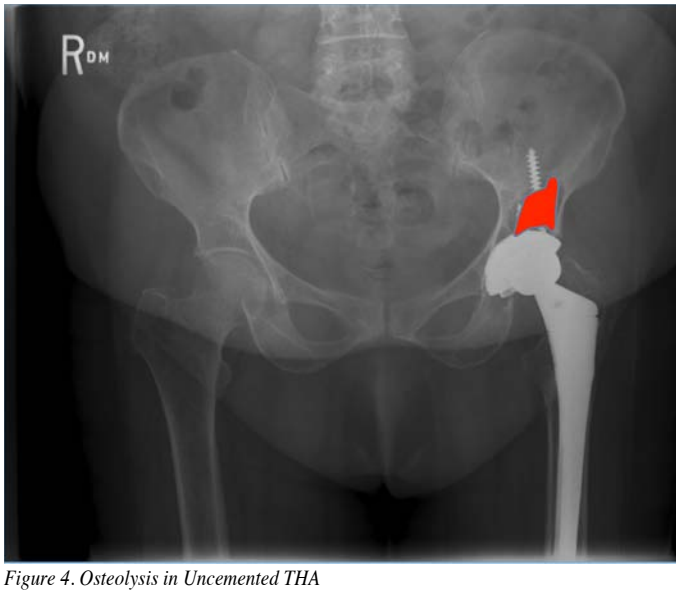

Figure 4. Osteolysis in Uncemented THA
Note the superoacetabular Area

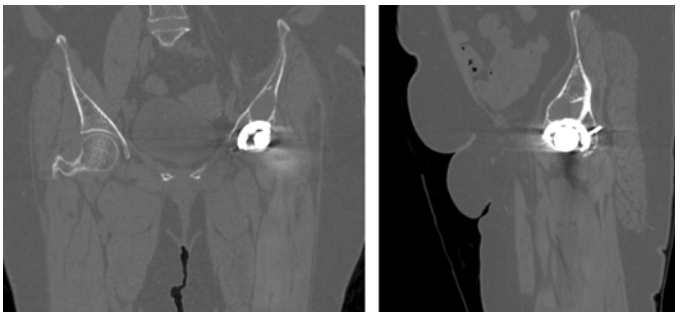

Figure 5. CT scan for Osteolysis

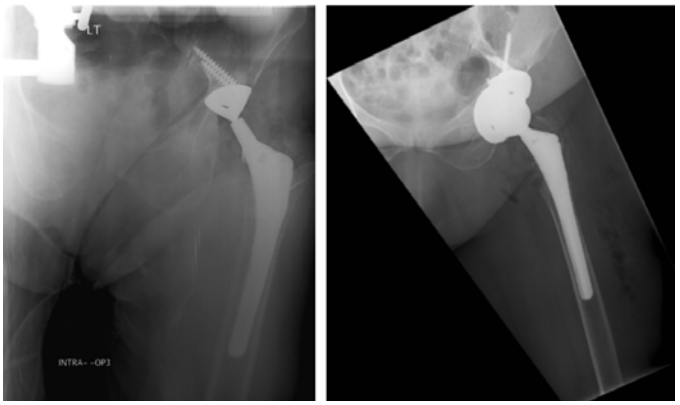

Figure 6. Osteolysis, defect management

The pattern of osteolysis differs between cemented and cementless acetabular cups. [10,18] In the cemented cup it's usually a linear pattern that has been described, whereas in the cups that have been inserted without cement it's an expansile pattern. [10,18] (Figures 2, 3, 4, 6)

A layer of fibrous tissue usually gets formed around the cemented acetabular component that may provide a path of least resistance along the planes of the layer, leading to a linear pattern rather than an expansile pattern. There is also a halo of sclerotic bone that usually develops peripheral to a component encapsulated by fibrous tissue.

This, along with the fibrous layer, may serve as a protective barrier to the expansion of the osteolysis to the more deeper, weaker, and porous cancellous layers of the acetabulum, the pubis & ischium. These differences in the osteolysis between the cemented and cementless cups does cause a more symptomatic loosening of the cemented cups allowing the patient to present early to the surgeon before substantial bone destruction had taken place. (Figure 7, 8)

In contrast, the osteolysis in the cementless cups may present quite late as symptom may not have developed earlier. By that time a substantial expansile pattern would

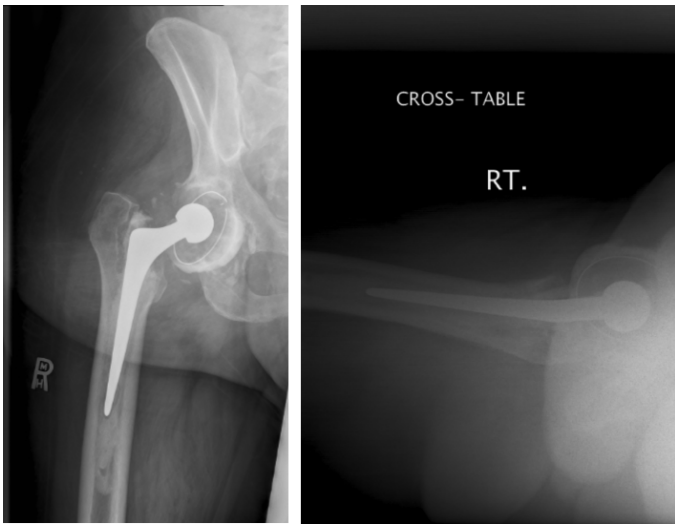

Figure 7. Osteolysis in cemented THA note the linear non expansile pattern

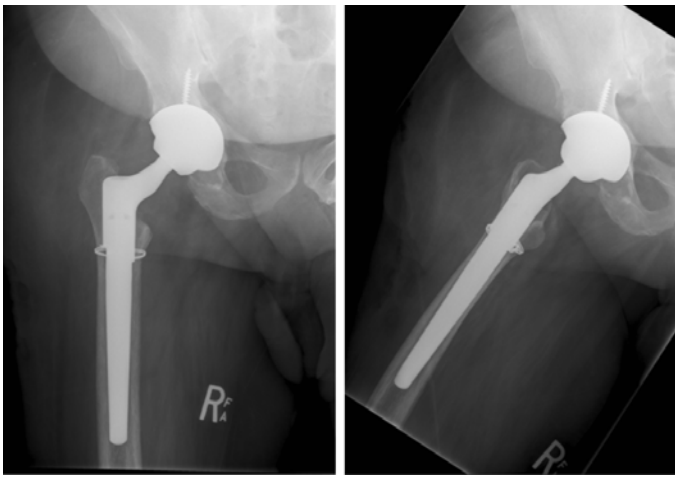

Figure 8. Post op , osteolysis in cemented THA note the simple revision of the cup, no defects.

have had developed with resultant bony defects. Occasionally it could be detected earlier on serial follow up with radiological diagnosis only in an asymptomatic or less symptomatic patient. [10,18] (Figure 7)

A classification system was proposed by Rubash, et al., for the uncemented cups based on the stability of the acetabular shell and the exchangeability of the liner. [2,12,13]

1. Type I, is the well fixed cup with focal osteolysis and the poly liner is exchangeable, in these cases if the cup position is acceptable it could be retained with change of the head an poly liner as well as debridement of the osteolytic defect.
2. Type II, is a well-fixed cup with focal osteolysis but the liner is not exchangeable. For example the locking mechanism is damaged, or the shell is worn out or malpositioned. In these cases the entire cup needs to be replaced.
3. Type III, is a loose cup requiring a complete revision.

The surgical choices that are available to the contemporary hip arthroplasty surgeons are basically one of two options. [2,4,6,10,14] The first option lies in retaining the well fixed acetabular component. This certainly has it's own advantages in terms of being a surgery of lesser magnitude as well as a less financial burden, quicker rehabilitation and return to proper functional level in a short time span. It does, however, carry a risk of limited liner options based on the availability of the liners from the manufacturer if they still exist. The risk of instability has shown to be higher in the cases that were treated with liner change only.

The other option is to revise the cup completely, obviously this is a more extensive surgery with higher associated risks and complications. It does carry, in addition to all the risks of any revision surgery, a risk of possible incomplete Osseointegration, extensive bone stock damage, periprosthetic acetabular fracture or even pelvic discontinuity. But, on the other hand, it also has the advantage of using a larger cup with all the modern liner options, e.g, lateralized offset, harder bearing surfaces, and the ability to use larger head sizes to have a more stable reconstruct. It might be the only option in certain situations, e.g, infection, gross malposition, loose acetabular component, completely worn out and damaged acetabular shell. [2]

With both surgical interventions, addressing the osteolytic defect is of paramount importance, which involves aggressive surgical debridement and bone grafting using either autograft or allografts particulate material or bony substitutes. At the time of surgery if retention of the cup was undertaken, then the osteolytic defects could be accessed either through the screw holes or via trap door made in the ilium in the superoacetabular portion. [13] This is usually coupled with use of the more modern polyethylene liner that has a proven lower linear and volumetric wear rates, e.g, highly cross linked polyethylene liner. (Figure 9)

Figure 9. Liner Options

Preoperative assessment work starts with AP Pelvis & Hip in supine position, with the hip in internal rotation, Judet views. [4] Assessing and quantifying osteolysis should be a critical part of the pre-operative planning and preparation of revision Total Hip Arthroplasty. The earliest hint of the presence of osteolysis should arise from the presence of discrepancy in position of femoral head within the hip joint in serial X-rays. This presence of asymmetric or symmetric wear should incite the surgeon to do a full extensive radiological workup looking for the presence or absence of osteolysis. Conventional X-rays should not be relied upon completely. They frequently miss some areas of osteolysis, a common area is the one posterior to the acetabular cup, which is also known (as the retroacetabular area) as well as that of the posterior wall. (Figure 4, 5)

Conventional X-rays are unlikely to pick the smaller osteolytic lesions. They always tend to underestimate the defect. [16] In terms of imaging modalities to detect and quantify the osteolytic lesion, magnetic resonance imaging (MRI) is considered to be the most sensitive at 95% and specific at 98%, accuracy was found to be 96%. [16] The sensitivity for detecting lesions by commuted tomography (CT) scan is 75%, while for plain X-rays is 52%. [16] The location of the lesion did not affect the sensitivity of the MRI. However, the lesion size did correlate with the likelihood of its detection. Lesions of sizes greater than 3.0 cubic cm were not missed by the MRI. Although Computed tomography (CT) Scan did also detect lesions greater than 3.0 cm3 the MRI emerged to be the most effective study for detecting smaller size lesions, < 3.0 cm3. Unlike in MRI, and just like the conventional radiography, the location of the osteolytic lesion did influence the detection likelihood by the CT scan. The CT scan was more accurate in measuring the lesion volume compared to MRI.

Since most lesions of clinical concern are more than 3.0 cm3, both CT scan and MRI remain equally good for their detection rate. The choice of the appropriate modality by the treating surgeon remains a matter of cost control, the lesion location, and how symptomatic the patient is. If on plain radiograph an osteolytic lesion is seen and the patient is asymptomatic then further choice of imaging could be done as a preoperative planning tool rather than a diagnostic tool for detection of an osteolytic lesion.

Further preoperative workup in a patient with osteolysis who is being considered for surgery include a complete knowledge of the component(s) implanted, their manufacturer and the availability of compatible liners or any alternate ones that could be still applied to the cup.

The locking mechanism of the implanted acetabular cup needs to be investigated. In some instances the locking mechanism might have become defective or does not have a good enough track record. If the availability of a compatible liner cannot be guaranteed or the locking mechanism is defective, or it's efficiency is questionable, then alternative fixation methods, e.g, cement needs to be considered. [2,14]

The track record of the implanted cup is of paramount importance in preop decision making. For example, the modular ARTHROPOR cup (Joint medical products, Stamford, CT) has shown to be associated with delamination of its porous coating with 10.6% incidence. Although infrequent, delamination has also been reported for Harris-Galante cups. Knowledge of the mode of sterilization and shelf life of the liner will help in assessing the overall quality of the liner. [6]

Intraoperative assessment is the most accurate and reliable method to assess for loosening of the acetabular component. It has to be circumferentially exposed along with the bony edges to assess their relation to each other to enable the surgeon to determine if it's malpositioned or not. [2] The assessment of loosening is determined by surgeon critically examining all areas of bony ingrowth or on growth surfaces, as well as the presence of any tissues at the bone implant interface.

Pressure should be applied firmly through the central axis of the acetabular cup either manually or with the help of an acetabular pusher or inserter, or grasping the acetabular cup with a clamp through screw holes checking for any interface motion or expression of any fluid through the interface. Either of these findings do imply that the cup is loose and needs complete revision.

Isolated Liner Exchange

When this option is chosen by the surgeon several criteria should be met. The acetabular cup should be in an acceptable position and orientation to prevent instability. The compatible liners should be preferably available from the same manufacturer. Intraoperatively the surgeon may notice evidence of subtle malpositioning which he may try to correct by trialing various types of liners, e.g, lipped liner, lateralized (offset) liners, oblique liners, eccentric liners. If the instability cannot be corrected than the cup has to be completely revised. [2] (Figure 9) If the liners could be snapped in with the original intact locking mechanism that should be acceptable, alternatively the liner could be cemented into the preexisting well fixed cup.

The cementation of the liner into the acetabular component requires that the liner should be smaller (undersized) than the cup to allow for a minimum of 2 mm in thickness of the cement mantle. [2,14] In cases of elderly patients

with recurrent instability, who could be of high surgical risk, cementing a constraint liner remains a good salvage option. [2,14] The back of the liner and the inner aspect of the well fixed acetabular cup needs to be scored by a high speed burr to facilitate cement interdigitation. (Figure 10,11)

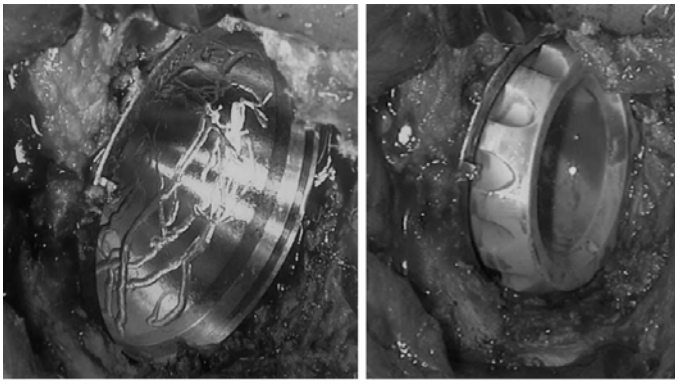

Figure 10. Cementing a Liner, scoring the retained cetabular shell

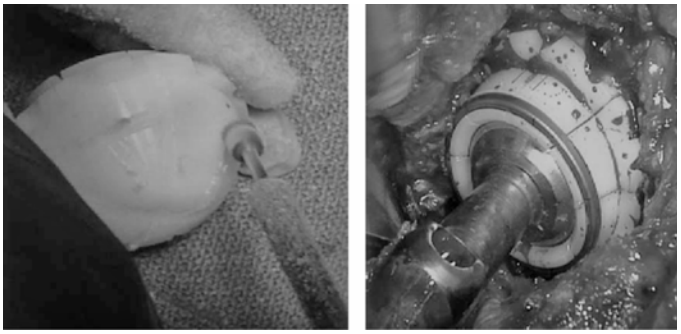

Figure 11. Cementing a Liner, scoring the back of the liner

Figure 12. Explant Instrument for cup removal in revision THA

It needs to be emphasized that the commonest side effects that has been reported by various authors in the literature, is instability. Beaule, et al., reported 22% of dislocation in their series of 32 hips in which a liner was cemented in to a well-fixed socket. [1] Lie, et al., reported 28% incidence of dislocation in their study of a group of 1649 revision total hip arthroplasty from the Norwegian hip registry. [8] Their comparative groups of complete revision in patients with well-fixed cup and/or the patients with completely loose cup had a lower chance of re revision. On the contrary, Blaha, reported on their group of 460 cases of revision THA, in 32 cases out of those, they decided to retain the liners, none of those 32 cases required further re revision. [2]

Few authors recommended using the direct lateral or anterolateral approaches for isolated liner change. O'Brien, et al., reported on their series of 24 THAs that were revised with isolated liner exchange with grafting of the defect, through direct lateral approach, they had no dislocations. [11] Wade, et al., reported on their series of 35 THAs that were revised with isolated polyethylene liner exchange, performed through anterolateral approach, there were 2 dislocations only (6%). [15]

Boucher, et al., reported 25% dislocation in their series of 24 THAs that were revised with isolated polyethylene exchange only through posterolateral approach. [3]

Complete revision of the acetabular component had become much technically easier with less potential of bone loss. The explant devices (Zimmer, Warsaw, IN), explant (Innomed, Savannah, GA), have facilitated the removal of acetabular cup without much damage to the host bone stock. (Figure 12)

Conclusion

In summary, polyethylene wear and osteolysis remains one of the most common causes of failure in contemporary THA. It remains the commonest cause of aseptic loosening in THA. Early identification of poly wear and osteolytic lesion with the option of exchanging the liner may be a useful technique to prevent a more catastrophic failure. Complete revision still remains an acceptable option in late cases, or in cases that the acetabular component is in an unacceptable position, infected, or damaged.

The surgeon should weigh the risks and benefits of both surgical options available to him and be fully prepared to alter the surgical course if the intraoperative findings did not support his original preoperative plan.

Even in cases of preoperatively planned isolated liner exchange only, full preparation must be undertaken to complete revision if it became evident that that's the appropriate choice to be made.

Due to the higher incidence of dislocation with isolated liner exchange, anti-instability measures should be adapted in terms of the surgical approaches, use of liners that decrease incidence of instability, post op rehab, and activity precaution.

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Future Site Selected For This Cutting-Edge Medical Initiative

The Greenbrier America's Resort

Since 1948, the Greenbrier Clinic has been recognized as an industry leader in executive health and wellness through utilizing advanced diagnostics in the early diagnosis, prevention and treatment of disease. Building upon that history of medical excellence, Jim Justice, Chairman and owner of the Greenbrier Resort, has announced the creation of the Greenbrier Medical Institute. The institute's 1st phase is projected to cost about $250 million, employ more than 500 people and include 3 buildings.

This phase will include an expansion of our world renowned executive health and wellness practice, The Greenbrier Clinic, which will be bolstered by a world-class sports medicine program, including an orthopedic surgery center and athletic performance/rehabilitation facility, all led by the Founder of the American Sports Medicine Institute, Dr. Jim Andrews and Chair of Cleveland Clinic Innovations, Thomas Graham. Rounding out the Institute's services will be a first-in-class plastic and cosmetic surgery and Lifestyle Enhancement Academy, helping people look and feel their best. Physicians, universities, research foundations, medical journals and other healthcare industry leaders, all of whom are on the cutting edge of medical technology, research and care, have committed to join the project and establish an international research and education destination or "think tank" to stimulate research, drive innovation, force change and redefine how the world approaches health, wellness and longevity.

The Institute's facility, designed by Willie Stokes, will feature Georgian architecture similar to the resort's façade, a replica of the Springhouse, the site of the famous sulphur springs and special guests suites for patients and their families. Jack Diamond, President and CEO, and Mark Krohn, COO, are leading the development of this exciting project and are actively looking for other physicians and medical thought leaders to be involved.

For more information, please contact:

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Greenbrier Medical Institute, 330-697-6581
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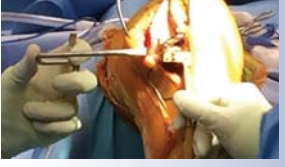


Uni Medial/Lateral Ligament Retractor

Designed by Kurt Kramer, PA-C

Designed to be placed in the medial/lateral tibial recess while making the horizontal tibial cut during unicompartmental knee arthroplasty–helping to retract and protect the medial and lateral collateral ligaments

Ambidextrous, ergonomic design allows for comfortable and natural hand positioning, helping to improve MCL/LCL protection and ease of use, especially in the obese patient.

NEW

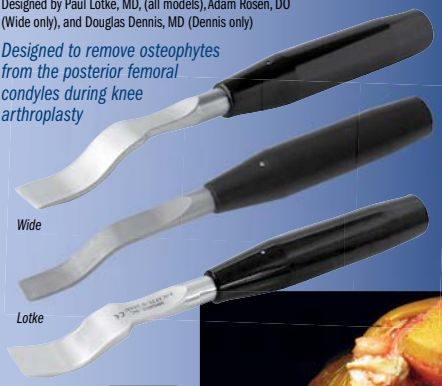
PRODUCT NO:
3632 *Overall Length: 4.25"* *Blade Width: 8.8mm* *Blade Depth: 2.375"*

PROUDLY MADE IN THE USA

Offset Osteotomes

Designed by Paul Lotke, MD, (all models), Adam Rosen, DO (Wide only), and Douglas Dennis, MD (Dennis only)

Designed to remove osteophytes from the posterior femoral condyles during knee arthroplasty



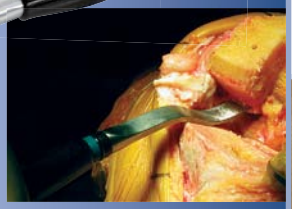
Wide

Lotke

Dennis

PROUDLY MADE IN THE USA

PRODUCT NO:
4920 [Wide] *Overall Length: 9"* *Blade Width: 18.5mm*
4935 [Lotke] *Overall Length: 9"* *Blade Width: 13mm*
4935-W [Dennis] *Overall Length: 9"* *Blade Width: 18.5mm*



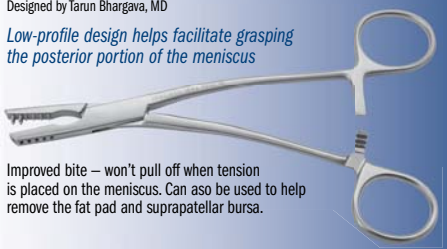
Profile of Wide and Lotke Osteotomes

Profile of Dennis Osteotome

Bhargava Modified Meniscal Clamp

Designed by Tarun Bhargava, MD

Low-profile design helps facilitate grasping the posterior portion of the meniscus



Improved bite – won't pull off when tension is placed on the meniscus. Can aso be used to help remove the fat pad and suprapatellar bursa.

MADE EXCLUSIVELY FOR INNOMED IN GERMANY

PRODUCT NO:
1886 *Overall Length: 7"* *Teeth Length: 1mm* *Jaw Length: 1.125"*

Engh Unicondylar Minimally Invasive Knee Surgery Instruments

Designed for use in unicondylar minimally invasive knee surgery

Rake Retractor
Used to retract soft tissue at the joint line.

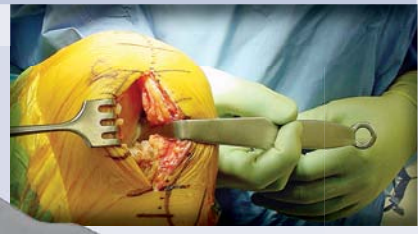
Cement Scrapers
Right and left design used to scrape cement from around and behind the implants.

Offset Osteotomes
Designed to remove the overhanging posterior condyle or osteophytes from the back of the femoral condyle.

PRODUCT NO'S:
4910 [Rake Retractor] *Rake Head: 38mm x 25mm* *Overall Length: 7.5"*
4920-01 [Cement Scraper – Right] *Scraper Head: 5mm x 9mm* *Overall Length: 8.5"*
4920-02 [Cement Scraper – Left] *Scraper Head: 5mm x 9mm* *Overall Length: 8.5"*
4930-01 [Offset Osteotome] *Osteotome Head: 10mm x 10mm* *Overall Length: 8.5"*
4930-02 [Offset Osteotome – Double Bent] *Osteotome Head: 10mm x 10mm* *Overall Length: 8.5"*

Designed by Gerard A. Engh, MD

PROUDLY MADE IN THE USA



Engh Intercondylar Notch Retractor

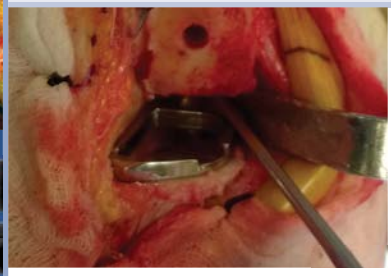
Enhances minimally invasive exposure of the medial femoral condyle

Used for unicondylar arthroplasty.

PRODUCT NO'S:		
Overall Length: 8.125"		
3230-01 [Small] *Blade Width at Teeth: 9mm*	3230-02 [Medium] *Blade Width at Teeth: 10mm*	3230-03 [Large] *Blade Width at Teeth: 12mm*

Designed by Gerard A. Engh, MD

PROUDLY MADE IN THE USA



Scott Uni & Total Knee Cement Removing Curette

Designed by Richard D. Scott, MD

Sized, shaped and angled 90° to help with retrieval of posteriorly extruded cement behind the tibial component in both total and unicompartmental knee arthroplasty

Ultra hard titanium nitride coating helps to extend curette life by increasing surface hardness, prolonging sharpness, and resisting chemicals and corrosion.

NEW

PRODUCT NO:
4247 *Overall Length: 9.625" (24,4cm)* *Overall Length: 5.25" (13,3cm)* *Cup Size: 4/0*

PROUDLY MADE IN THE USA

45° Knee Retractors

Designed for general use around the knee

NEW

PRODUCT NO'S:
6290-00-075 [Large] *Overall Length: 9.125" (23,2cm)*
6290-00-076 [Small] *Overall Length: 7.875" (20cm)*

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