



## Development of a lower limb arthroplasty service in a developing country : Lessons learned after the first 100 cases (joints)

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**There is emerging evidence that total hip arthroplasty (THR) can be safely practiced in developing countries but scant evidence of safety of total knee replacement (TKR). The purpose of this study is to evaluate the outcomes of these procedures focusing on procedure related complications. This is a retrospective study of the first 100 arthroplasties (92 patients) consisting of 58 TKR and 42 THR with a minimum follow-up of 26 months (range of 26 to 47 months). Major complications included deep infection in one TKR and dislocation of one THR and one TKR. Two patients died in the second post-operative week from cardiac events following TKR. Blood transfusion rate for hips and knees was 13.7% and 5.6% respectively. THR can be safely performed in less than ideal circumstances in carefully selected patients. More importantly this study demonstrates that TKR can be safely practiced under the same circumstances.**

**Keywords :** hip replacement ; knee replacement ; developing countries.

### INTRODUCTION

Total joint arthroplasty of the hip and knee rank among the most successful medical interventions of the 20<sup>th</sup> century (5). Both surgical interventions have been shown to be highly cost effective in terms of increased quality-adjusted life expectancy and cost per quality-adjusted life year gained (8,22). The ever improving advances in prosthesis and instrument

design, adoption of improved surgical and anaesthetic techniques have led to less physiological stress to the patient with quicker recovery, earlier discharge and return to independent ambulation and work (33,38).

These major advances of THR and TKR which are relatively routine in developed countries have not been enjoyed by patients in developing countries stemming from unavailability of both financial and human resources (6,16,19,23,24). Botswana is a middle-income country (Gross domestic product per capita of \$6,780 US) in Southern Africa with a population of 2 million (13). The Government of Botswana's expenditure on health as a percentage of GDP currently stands at 5.3%, translating to total expenditure on health per capita of approximately

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USD \$872 (12,30). Prior to 2009, no hip or knee replacements were performed in public hospitals in Botswana and only a handful of procedures were performed in Botswana private hospitals. An average of 150 patients were referred annually to specialized medical facilities for this type of surgery in South Africa.

Botswana was adversely affected by the global recession of 2009 and this necessitated major cut-backs in all government expenditure. Despite the budgetary constraints there was recognition that demand for joint replacement was increasing. This led to an agreement between the University of the Witwatersrand division of orthopaedics (Johannesburg, South Africa) and the ministry of health of Botswana to establish an outreach arthroplasty service at the main referral hospital in Botswana. A collective decision was made to start the program with relatively uncomplicated primary joint replacement cases.

The purpose this paper is to report our experience and lessons learned with this initial cohort of selected patients.

## MATERIALS AND METHODS

This is a retrospective study of the first 92 patients (100 joints) who had primary total hip and knee arthroplasty between February 2009 and November 2010. All patients had a minimum of 26 months follow-up (range of 26 to 47 months). Ethics clearance was obtained from Princess Marina Referral Hospital ethics committee to conduct the study (REF : PMH 5/75).

All patients who had degenerative hip and knee joints (primary or secondary) were offered joint replacement. We excluded the complicated and revision cases. These included patients with complicated medical history (haemophilia etc.), HIV positive and severe deformities.

General doctors (non-specialists) and nurses working in orthopaedics at the main referral hospital in Botswana were invited to observe the pre-operative and intra-operative preparation and management of arthroplasty patients at the Johannesburg Teaching Hospital associated with the University of Witwatersrand. Emphasis was placed on infection prevention strategies, post-operative care and patient rehabilitation.

A wait list was established consisting of patients who were candidates for total hip and knee replacement surgery. Routine bloods inclusive of full blood count ; urea

and creatinine ; HIV status ; inflammatory markers (CRP/ESR) and (rheumatoid factor/ACCP) where indicated ; urine for microscopy, culture and sensitivity were assessed and acted upon. Anteroposterior x-rays of the pelvis and lateral of the affected hip was done for hip pathology while for the knees 3 views were done, these are weight-bearing anteroposterior of both knees, lateral and skyline view. Patients with medical co-morbidities were referred to physicians for pre-operative assessment and optimization.

A total of 8 sessions were done every 2 to 3 months over the 20 months period. A minimum of 16 patients and up-to 20 patients, were assessed and summaries of their medical records including radiographs were emailed to the surgeons in Johannesburg a week before operation. This allowed logistics planning, compilation of a final list and ordering of implants. Patients on the final list were invited for final assessment by the team of surgeons from Johannesburg a day before commencement of the surgical campaign. Informed consent was obtained at this time and the limb to be operated was marked.

The lists were divided into knee and hip “operating theatres” mainly because of only one available pelvic support. Most patients were operated under regional anaesthesia (spinal and epidural) with a minority of patients receiving only general anaesthesia. We encouraged regional anaesthetic but the final decision regarding the type of anaesthetic was left to the anaesthetist. All patients had insertion of a urinary catheter inserted following induction of anaesthetic. Skin preparation was done with betadine solution and limb draping was in a standard manner with **3M™ Ioban™** (3M South Africa). Prophylactic antibiotics (1gram Cefotaxime) and Tranexamic acid (1 gram) were given to patients on induction of anaesthetic. All the procedures were performed by experienced orthopaedic surgeons (authors ML, KN, LM) using anterolateral approach in the lateral position for the hip replacements and standard midline skin incision for the knee replacements with medial para-patellar deep approach. The visiting team of three orthopaedic surgeons (ML, KN, and LM) included two scrub sisters and the rest of the team were local doctors (anaesthetists and assistants in theatre). All patients received *Smith and Nephew porous Synergy™ hip prosthesis* (41 patients) and *Spectron hip prosthesis* (1 Patient). For acetabular shells we used 15 *Reflexion spiked acetabular cup system* and 27 *R3 Acetabular System. Profix Total Knee System (Smith and nephew, Memphis, USA)* were used for all knee replacements. We made a conscious effort to limit theatre personnel to ten individuals throughout the duration of surgery.

All patients were sent to the ward post-operatively except one diabetic patient who was sent for intensive monitoring in ICU in the absence of a high care facility. Postoperatively patients had morphine Patient Controlled Analgesia (PCA) for the first 24 hours and thereafter opiates and paracetamol. Haemoglobin was checked on the first post-operative day and prophylactic antibiotics were continued for 24 hrs. All operated patients received daily injections of low molecular weight heparin (clethane) for the duration of their in-hospital stay. The urinary catheter was removed once patients regained mobility. Physiotherapy was commenced on post-operative day one in majority of cases and all patients had physiotherapy by day two. There was no physiotherapy service over weekends and public Holidays.

All patients were discharged home with a six week course of aspirin and those at high risk of developing deep venous thrombosis were given additional two weeks of injectable anti-coagulant. Wound clips or sutures were removed at local hospitals and clinics two weeks from the date of operation. Health care practitioners at clinics were requested to contact the orthopaedic clinic with any concerns. Arrangements were made to continue physiotherapy in clinics and local hospitals for those patients with sub-optimal range of knee motion.

All patients were reviewed at 6 weeks, 3 months and 6 months intervals and yearly afterwards with x rays on arrival.

## RESULTS

There were 41 and 51 patients who had THR and TKR respectively as shown in Table I. The average age of patients in years for both procedures were similar been 66.2 for THR and 65.6 for TKR as shown in Table II. All patients were HIV negative.

With respect to THR, 76% of patients were diagnosed with osteoarthritis, 22% with avascular necrosis and 2% previous tuberculous infection. For

Table I. — Demographics

Variable	THR	% total	TKR	% total
Male	24 (1 bilateral)	59	5	10
Female	17	41	46 (7 bilateral)	90
Total no patients	41		51	
Right side	26	62	30	52
Left side	16	38	28	48

TKR, 92% of patients had osteoarthritis and the rest had rheumatoid arthritis.

Where M-PE : metal on polyethylene, OX-PE : oxinium on polyethylene, C-C : ceramic on ceramic.

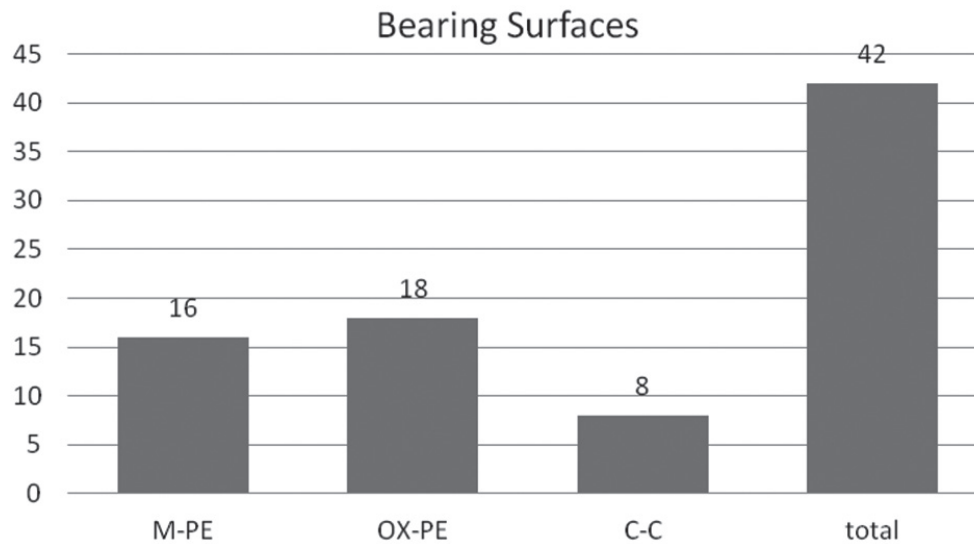
Regarding the bearing surfaces of hips, the first 16 patients had metal on polyethylene with head size of 28 as that was the only available bearing couple in the first 3 sessions. Oxinium on polyethylene and ceramic on ceramic bearing surfaces were gradually introduced later after the 3rd session to 18 and 8 patients respectively as shown in figure 1 based on age. Patients who were younger than 50 years had ceramic on ceramic bearings implanted while the majority between 50 and 65 years old had ceramic on polyethylene and over 65 year olds had metal on polyethylene. Bigger femoral heads (size 36) were used in 57.1% of patients and (size 32) was used in 4.8% of patients. The rest of patients had size 28 femoral head.

In the TKR group 26 patients had cemented femoral component and tibial tray, 26 had an uncemented femoral component and a cemented tibial tray and 6 had both uncemented femoral component and uncemented tibial tray. This was based on

Table II. — Average age and duration of operation

Variable	Hip Replacement	Knee Replacement
Average age in years	66.2	65.6
Age range in years	43-86	46-81
Range of operation time in minutes	60-65	65-73

With respect to THR, 76% of patients were diagnosed with osteoarthritis, 22% with avascular necrosis and 2% previous tuberculous infection. For TKR, 92% of patients had osteoarthritis and the rest had rheumatoid arthritis.



*Fig. 1.* — Bearing surfaces for hip replacement

the quality of the bone and the age of the patients. Younger patients with good bone quality had uncemented knee components while patients with poor bone quality had cemented components irrespective of age. Hybrid fixation was used interchangeably with fully cemented implants based on availability of inventory in the rest of the patients.

For hip replacement 13.7% (4/29) patients were transfused with packed red blood cell while for knee replacement 5.55% (2/38) were transfused. One patient was not cross-matched because she didn't want transfusion for religious purposes. We had a total of seven theatre cancellations. The first two were male patients whom we failed to catheterize in theatre after spinal anaesthesia was given. They were subsequently done in later sessions after the urethral strictures were released by Urologists. Two cancellations were due to lack of time and three for exhausted implant inventory.

### Complications

One patient who had bilateral staged total knee replacement had deep wound infection. A 64 year old known hypertensive pensioner had left TKR

followed 11 months later by right TKR replacement. The immediate post-operative period was uneventful and she seemed to be rehabilitating well until she presented with persistent pain in the right knee at 6 months follow-up. Septic markers were moderately elevated and knee aspirate cultured Methicillin Resistant Staphylococcus Aureus (MRSA). She was successfully treated with two-stage revision knee replacement surgery in South Africa.

A 62 year old male from a village 40 km from National referral hospital had left THR for OA in the first operative session. He had 28mm Metal on polyethylene bearings. He had posterior dislocation of the hip while squatting to use a toilet three months after surgery. He had successful closed reduction by local orthopaedic surgeon. The hip was stable in theatre and postoperative x rays showed no signs of subsidence or any fractures. He was then mobilised afterwards full weight bearing as pain tolerated under the supervision of physiotherapist. He did not have any further dislocations.

A 74 year old male with a background history of a cerebrovascular accident affecting the right side 10 years prior to right TKR, fell and dislocated the

knee 7 months post-operatively. Closed reduction was successful and the prosthesis has remained stable and continues to function well.

There were two mortalities following total knee replacement and both occurred in the second post-operative week. A 78 year old female with hypertension and bilateral osteoarthritis of knees died on the eighth post-operative day as she was being prepared for discharge. The second mortality, patient was a 65 year old female known to have hypertension and an unclear history of post-natal depression had an uneventful post-operative course. Awaiting transportation home when she collapsed and died despite intensive resuscitation attempts. Both patients' post mortem examination showed moderate cardiomyopathy but no pulmonary embolism.

We did not have any intra-operative fractures and none of our patients sustained peri-prosthetic fractures at the time of this study. Similarly none of our patients presented with symptomatic deep vein thrombosis.

## DISCUSSION

THR and TKR in developing countries is limited due to limited capital, human resources and facilities to carry out this procedures. The ever spiralling cost of health care led to establishment of several THR and TKR initiatives in several African countries and also rural settings in Australia (6,16,19,23,24,36). Dossiche *et al* established a similar initiative in Burkina Faso where they performed 155 THR at a district hospital with no previous relevant experience from 2004 to 2011 (6). They encountered multiple intra-operative technical problems that included extensive fibrosis and narrow femoral canals. The presence of patients with narrow canals led them to use flexible reamers in some cases and to add more implants of smaller sizes to their stock. Technical problems included inexperienced assistants resulting in periprosthetic fractures especially in the initially phase. Despite this challenges they had acceptable complications rates (6). Similarly Stewart *et al* study demonstrated that THR can be successful done in rural setting with acceptable complication rates in less than ideal theatre environ-

ment for joint replacement by low volume surgeons (36). They had high level of patient satisfaction, low infection rate, acceptable manipulation under anaesthesia for stiff knees post TKR and dislocation for THR (36). The challenges encountered by both initiatives in the initially phases were modified leading to more funding and overall better outcomes at the latter stages of the programmes (6,36).

The Swedish registry annual report of 2010 indicated a mean age for total hip THR patients with primary osteoarthritis as 68.3 years (37). In our study it was 66.2 years for THR (and 65.6 years for TKR) inclusive of those with avascular necrosis, which was comparable to the Swedish registry but higher than the Malawian and Zambian study of 52 years and 58 years respectively (19,24). Longer follow-up for these relatively younger patients has been instituted to allow early detection of complications. Currently our yearly follow-up is 100% same as the Stewart GD *et al*'s Australian study but much better than Knigori *et al*'s Kenyan study where they lost 34% to follow-up by six months (16,36). This was made possible by establishing a dedicated weekly arthroplasty clinic and outreach orthopaedic clinics conducted monthly to primary and district hospitals. Transport was arranged with local health facilities and authorities well in advance of next clinic visit. A dedicated nurse in the clinic coordinated follow-up of all the patients.

Osteoarthritis was the main indication for surgery for 76% of THR and 92% of TKR. This is comparable to both the Swedish registry study (recording a rate of 78%) (Australian) and Zambian study (recording a rate of 70.6%) but higher than the Malawian and Burkina Faso studies where 30.5% and 36.8% was indicated (6,19,21,24,37). The second most common indication for THR was avascular necrosis accounting for 22% compared to 13.7% for the Zambian study, 38.7% for the Burkina Faso study and 47.9% for the Malawian study (6,19,24). Several factors might account for these discrepancies with regional countries i.e. Zambian and Malawian studies. Firstly our cohort of patients was highly selected and is not representative of Botswana which has similar disease profile and also high prevalence of HIV. All HIV positive patients and complicated cases were excluded as already stated. These might

Table III. — Comparison of hip dislocation rates

Study	No. of patients	Percentage
Dossche <i>et al</i> (12) (Burkina Faso)	2/155	1.3%
Kingori <i>et al</i> (8) (Kenya)	2/97	2.06%
Lubega <i>et al</i> (10) (Malawi)	2/73	2.7%
Stewart GD <i>et al</i> (16) (Australia)	4/69	5.8%
Mulla <i>et al</i> (11) (Zambia)	3/43	6.97%
This study (Botswana)	<b>1/42</b>	<b>2.4%</b>

have skewed our AVN cases secondary to HIV compared to Malawian study where 44% AVN were HIV positive (10). In the Zambian study, HIV status was unknown for 86.3% of the patients. In the Burkina Faso study the high prevalence of avascular necrosis is attributed to sickle cell disease (6). Interestingly we had no patient with inflammatory arthritis for THR but 8% of our TKR were done secondary to rheumatoid arthritis.

Our hip dislocation rate was 2.4% (1/42) and for knee replacement 1.7% (1/58). Our hip dislocation is comparable to similar regional studies as shown in Table III. This relatively low hip dislocation rate could be explained by the use of antero-lateral to the hip in all cases and bigger femoral head (sizes 36) in the majority of the patients (59.5%).

We had 1.7% (1/58) deep infections for TKR and nil for THR. Infection rate following TKR has been quoted to be between 0.5% to 1.8% (14,15,18,25,31). Several patient risk factors for sepsis includes male sex, pre-operative co-morbidities, diabetes, obesity and rheumatoid arthritis and surgeons risk factors include taking longer operation time (25). The cause of sepsis in our case could be explained by poorly controlled temperatures in our theatres. This case was operated during the height of summer in the 8th session. Our theatres are relatively small, have central air conditioners and the doors are not automated. In addition, at that stage we still kept implants just outside the operating room. This practice contributed directly to increased traffic and the repeated opening and closing of the operating room door was in violation of strict rules of theatre sterility. Since then we keep limited inventory inside the operating room based on pre-operative templating. There is also now a shared responsibility amongst all theatre

personnel to limit traffic in the operating room to the barest minimum. The introduction of laminar airflows by Charnley resulted in significant reduction in early infection (4). This together with all other factors includes complete aseptic technique and limiting theatre traffic, surgeons experience have resulted in less infection rates. In modern theatres Hooper *et al* New Zealand retrospective registry study showed that there was actually increased in early infection in patients in those performed in theatres with laminar flow and space suits for both hip and knee replacement (9).

The 30 day mortality rate reported in the literature following total joint replacement is reported to be Less 1% (1,26,29,34,35). Parry *et al* found a 30 day mortality rate of 0.37% in 2675 patients who underwent knee replacement in comparison to 0.07% in 5857 patients on waiting list suggesting an increase in mortality rate associated with knee replacement (29). With regards to knee replacement Belmont *et al* study had a 30 day mortality of 0.18% following unilateral knee replacement of 15321 patients between 2006 and 2010 (3). The risk factors which includes cardiovascular disease, pulmonary embolism, cerebrovascular accident are well documented in the literature (1,11,29,35). We had 3.4% (2/59) mortality after TKR in these highly selected group that occurred during the second week post-op while patients awaited transport to go home. Post mortem results revealed cardiomyopathy but no evidence pulmonary embolism.

There were many challenges especially in the first 3 sessions compared to the last 5 sessions. Limited and faulty anaesthetic equipment led to cancellations of other surgical disciplines list as the working machines had to be borrowed from their list.

Cross match blood was not readily available especially during school holidays as the national blood bank is heavily dependent on students for donors. Because of unavailability of physiotherapist during weekends most patients stayed longer in the hospital. The frequent change of assistants as they get assigned to other departments led to always having to retrain every second session. After the first 3 challenging sessions we then scheduled the next 5 sessions during school term when students were available to donate blood. As for assistants, general doctors who didn't rotate through other medical departments were trained and retained as assistants for the following sessions. We failed to secure weekend physiotherapy due to limited personnel. Patients with relatively limited pre-operatively range of movement were operated on Monday rather than Tuesday to give them an extra day of rehabilitation. An attempt to set up a pre-operative anaesthetic clinic was unsuccessful because of few anaesthetists and nurse anaesthetists in the hospital and the country. All patients with medical co-morbidities were routinely referred to medical clinics for optimization. All these modifications led to overall improvement towards later sessions.

Immediate benefits were monetary as patients were done locally and the associated costs of transport and private hospital fees were significantly reduced by up to 60%. Patients also benefitted significantly by having not travel a round trip of up-to 800 km for health care. The presence of family in the immediate post op care motivated patients (7). Lectures were given and short courses were done to familiarize local staff with these new procedures. All theatres were renovated and new equipment (e.g. drills) bought that benefitted all orthopaedic patients. New attitudes like strict adherence to aseptic protocol were developed. Also many patients with inflammatory arthritis were picked up in this dedicated clinic and commenced on appropriate medication. The success of this outreach program was the benchmark for setting up the cardiac surgery outreach program which is also currently running very well.

Subsequently after our first hip dislocation, all patients are advised against squat toilets and where possible simple modifications to raise toilet seats

must be done prior to surgery or post-op care arrangements to reside with other family members with those facilities. To avoid late presentation all patients were advised to seek medical attention to the nearest health facility if they experience any problem with their replaced joint. Botswana has very severe shortage of blood for transfusion. With our current transfusion rate we can safely stop the current practice of cross matching all patients 2 units of blood except for high risk patients. Rodgers *et al* showed significant reduction in cross matching of blood for elective hip and knee replacement and not transfused by up-to 96% (32).

Due to unavailability of prosthesis sizes during the first two sessions, three patients were cancelled. From these cancellations, we recognized that there was a preponderance to using smaller implant sizes with a limited spread of sizes and we subsequently adjusted our inventory accordingly with subsequent visits.

The role of pre-operative bladder catheterization in total hip replacement is not clear (17,28). Post-operative urinary retention (POUR) has been reported to be between 0 to 75% (2). The risk factors for POUR includes obstructive urinary symptoms and epidural anaesthesia leading to pain prohibiting mobilization, predisposing to UTI and sepsis with devastating results (20,27). However catheterization prevents POUR at the expense of risk of UTI and sepsis (27). Initially we catheterized all patients prior to epidural/spinal anaesthesia but this led to failure of catheterization in 2 male patients that led to cancellation of the operation. All male patients with prostatic obstructive urinary symptoms are referred to Urologist to avoid failure to catheterize. The catheter is removed once the patient is mobile usually day 1 to 2 post-operative.

Following the first 100 joint replacements, we have started operating on more complex cases including patients with avascular necrosis secondary to HIV. Countries within our region including Zambia, Malawi and Kenya are doing larger numbers of lower limb joint replacements and reporting their experiences (16,19,23,24). This presents us with an opportunity to establish a regional joint registry tailored to populations with similar disease profiles (10).

THR can be safely performed in developing countries with limited resources in carefully selected patients. More importantly this study demonstrates that TKR can be safely practiced under the same circumstances. Careful patient selection and local environment dictates the procedures that can be done safely without comprising outcome.

#### Contribution of authors

All the authors participated in the planning and design of the study and in interpretation of the results. LL wrote the first draft and ML co-wrote the first draft, LM edited the draft and supervised the project. All authors revised, edited and approved the final draft.

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