# Knee Pain, Swelling and Stiffness after Total Knee Replacement: A Survey of South African Knee Surgeons.



Benjamin R Garrett

Department of Orthopaedic Surgery

University of Cape Town

MMed dissertation

# *Knee Pain, Swelling and Stiffness after Total Knee Replacement: A survey of South African knee surgeons.*

Submitted to the Faculty of Health Science, University of Cape Town, in fulfillment of the requirements for the MMed Part III (minor dissertation) for the degree FCS(Orth).

**Author:** Dr B.R.Garrett
**Student no:** GRRBEN001
**HPCSA:** MP0537624

**Supervisor:** Prof J.Walters
Professor and Head
Department of Orthopaedic Surgery
University of Cape Town

**Departmental Research Committee:** Project 2009 / 115

**Research Ethics Committee:** REC REF: 345 / 2009

**Declaration**

I, Benjamin Garrett, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that no part is being submitted for another degree in this or any other University.

I empower the University to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.



Signature Signed by candidate

Date 27/10/2010

# Part A: Protocol

Department of Orthopaedics
H49 Old Main Building
Groote Schuur Hospital
404 5175

**Protocol for submission**

# *Knee Pain, Swelling and Stiffness after Total Knee Replacement: A survey of South African knee surgeons.*

**Author:** Dr B.R.Garrett (MP0537624)

**Supervisor:** Prof J.Walters

## Introduction:

Total Knee Replacement (TKR) surgery has revolutionized the care of patients suffering from degenerative or inflammatory arthritis of the knee. The goal of treatment being a pain-free, stable knee joint which allows good function for activities of daily living.

There are many causes for a poor outcome following knee replacement arthroplasty. However this is a surprising finding when no obvious intra- or post-operative complications have been encountered and a good functional result is anticipated. Recently the orthopaedic literature has numerous publications reporting the pain and stiffness as a troublesome outcome.

Similarly, in the Orthopaedic Department at U.C.T. it was found that some patients, for whom the results were predicted to be excellent after a "simple and straightforward" TKR, had much more pain and swelling than was expected. This delayed their rehabilitation, prolonged their hospital stay, and correlated with a poor medium-term outcome. In many of them a cause for these problems was not identified.

To investigate possible causative factors, a Literature Review and a Survey of current practices in South Africa was planned. A Questionnaire to be sent out to all members of the South African Orthopaedic Association (SAOA) was compiled.

The prevalence of post-operative stiffness has been examined extensively, and varies in the literature. Older studies quote figures from 1,3% (Kim) to 12% (Daluga). More recent studies quote 3.7% (Gandhi) and 5,3% (Yercan). Throughout these reports the use of the term 'stiffness' and its definition are inconsistent.

More recently the Natural History of pain after TKR has been investigated by Brander et al. They show that pre-operative pain decreases to half its level by three months post-operatively, but at one year, one in eight patients still has pain. It is also shown that patients with significant pre-operative pain (VAS>40) have increased post-operative pain, and that pre-operative anxiety and depression result in increased post-operative pain and increased use of resources.

The most likely reasons for pain and swelling in the immediate post-operative period are the inflammatory process instituted by the surgical assault, retained haematoma or infection. Technical and mechanical factors such as mal-direction of bone cuts, incomplete removal of osteophytes, ligament balancing, component mismatch or malposition and overstuffing the joint are all reported causes of post-operative pain and stiffness. Some less well understood causes like Regional Pain Syndrome and Arthrofibrosis have also been reported.

The understanding of the mechanisms of pain is becoming clearer, and more emphasis is being placed upon Preemptive and Multimodal analgesia. Ranawat et al have recognized an improvement in swelling when better pain control has been achieved. The decrease in pain permits accelerated rehabilitation programs which result in an earlier uncomplicated recovery of function.

A recent survey in the USA which sought to understand the Orthopaedic surgeon's perspective on pain management showed that opiods are still seen as the most reliable intervention, although local and regional techniques also had high levels of satisfaction. Surgeons were amenable to changing their protocols, based on proven clinical trials.

## Objectives:

The aim of the study is to conduct a survey of the Orthopaedic community in South Africa to assess the perceived incidence of these problems, and to see which, if any, surgeon or peri-operative interventions or variables play any role. If so recognized, we aim to devise recommendations to avoid or minimize their occurrence.

## Methods:

**Study design:**

A Survey of peri-operative management practices of Orthopaedic Surgeons performing TKR's. Focusing on the perceived incidence of post-operative pain and swelling.

**Subject identification:**

South African Orthopaedic Surgeons. Members of the SAOA, the South African Knee Society and the Arthroplasty Society.

**Excluding:** Registrars, Retired and Honorary members, Surgeons with no available email address on SAOA database.

**Including:** Generalist Surgeons and Specialist Arthroplasty Surgeons.

**Measurement:**

Questionnaire (original on MSWord, converted to Excel for ease of completion and analysis).Data capture and evaluation on MSExcel.

List of variables (see questionnaire: Including patient demographics, surgeon experience, surgical techniques, weight threshold, medical management, pain and swelling parameters, rehabilitation program..)

Quality control (no proven validity studies for questionnaire)

**Pilot study:** Several versions of the questionnaire were trialed by 3 Orthopaedic Surgeons until an acceptable format was finalized. Layout and format for data capture received input from a biostatistician. No formal pilot study was performed.

**Analysis:**

Microsoft Excel tables and graphs used for initial data analysis.

The chi-squared test of association will be used for statistical analysis of categorical data.

**Report of findings:**

Results will be submitted for publication in peer review journals. Results will also be discussed at the South African Orthopaedic Association congress and research or faculty meetings.

## Ethics:

No consent form from surgeons needed, as questionnaire subject to voluntary return.

Disclosure that results would be used for analysis was made. Anonymity of respondents was maintained other than to principal investigator to prevent duplication of results.

## Risks / Benefits:

No financial benefits or sponsorship implications.

No risks to participants.

Privacy and confidentiality of results ensured.

Benefit of raising awareness of these problems within our discipline, and offering some shared insights and observations into their occurrence, prevention and management.

## Budget and funding:

**Costs not requiring funding:**

- Departmental and personal computer usage.
- Paper and photocopying supplied by the Orthopaedic Department of the University of Cape Town.
- Stationary, telephone and postal services, if required, will be funded by the Orthopaedic Department.
- Researchers will not be remunerated and will do the research as part of their current academic appointments.

**Costs possibly requiring funding:**

- Travel and accommodation expenses expected to present at the National congresses: R5000.
- Costs expected in publication process: R500.

## References:


**Toms AD, Mandalia V, Haigh R, Hopwood B**, The Management of patients with a painful Total Knee Replacement. *J Bone Joint Surg [Br]* 2009;91-B:143-50.

**Mandalia V, Eyres K, Schranz P, Toms AD.** Evaluation of patients with a painful total knee replacement. *J Bone Joint Surg [Br]* 2008;90-B:265-71.

**Walter B. Beaver Jr and Thomas K. Fehring.** Prevention and treatment of stiffness following total knee arthroplasty. *Current Opinion in Orthopaedics* 2008, 19:72–74

**Brander V, Gondek S, Martin E, Stulberg SD.** Pain and depression influence outcome 5 years after knee replacement surgery. *Clin Orthop* 2007;464:21-6.

**Harry N. Herkowitz, MD, Douglas R. Dirschl, MD, and David H. Sohn, MD.** Pain Management: the Orthopaedic Surgeon's perspective. *J Bone Joint Surg Am.* 2007;89:2532-5

**Scott S. Reuben, MD, and Asokumar Buvanendran, MD**. Preventing Cronic Pain after Orthopaedic Surgery. *J Bone Joint Surg Am.* 2007;89:1343-58

**Amar S. Ranawat, MD, Chitranjan S. Ranawat, MD**. Pain Management and Accelerated Rehabilitation for Total Hip and Total Knee Arthroplasty.
*The Journal of Arthroplasty* Vol. 22 No. 7 Suppl. 3 2007

**David A. Fisher, MD, Brian Dierckman, MD, Melanie R. Watts, ATC/L, CSCS, and Kenneth Davis.** Looks Good But Feels Bad: Factors That Contribute to Poor Results After Total Knee Arthroplasty.
*The Journal of Arthroplasty* Vol. 22 No. 6 Suppl. 2 2007

**Yercan HS, Sugun TS, Bussiere C, et al.** Stiffness after total knee arthroplasty: prevalence, management and outcomes. *Knee* 2006;13:111-17.

**Gandhi R, de Beer J, Leone J, Petruccelli D, Winemaker M, Adili A**. Predictive risk factors for stiff knees in total knee arthroplasty. *J Arthroplasty*. 2006;21:46-52.

**Javad Parvizi, T. David Tarity, Marla J. Steinbeck, Roman G. Politi, Ashish Joshi, James J. Purtill and Peter F** . Management of Stiffness Following Total Knee Arthroplasty.
*J Bone Joint Surg Am.* 2006;88:175-181.

**Douglas A. Dennis, MD**. Evaluation of Painful Total Knee Arthroplasty.
*The Journal of Arthroplasty* Vol. 19 No. 4 Suppl. 1 2004

**Kim J, Nelson CL, Lotke PA**. Stiffness after total knee arthroplasty: prevalence of the complications and outcomes of revision. *J Bone Joint Surg* 2004; 86A:1479.

**Richard S. Laskin, MD, and Burak Beksac, MD** .Stiffness After Total Knee Arthroplasty. *The Journal of Arthroplasty* Vol. 19 No. 4 Suppl. 1 2004

**Evan F. Ekman and L. Andrew Koman** . Acute Pain Following Musculoskeletal Injuries and Orthopaedic Surgery. Mechanisms and Management.. *J Bone Joint Surg Am.* 2004;86:1316-1327

**Brander VA, Stulberg SD, Adams AD, et al.** Predicting total knee replacement pain: a prospective, observational study. *Clin Orthop* 2003;416:27-36.

**Scranton PE Jr.** Management of knee pain and stiffness after total knee arthroplasty. *J Arthroplasty* 2001;16:428-35.

**Harvey IA, Barry K, Johnson R, Elloy MA**. Factors that affect the range of movement of total knee arthroplasty. *J Bone Joint Surg Br* 75:950, 1993.

# Part B: Literature review

This review focuses on specific areas within a potentially vast subject matter in order to provide background information which is pertinent to this dissertation.

# LITERATURE REVIEW

## i. The Inflammatory Response to Surgery

The inflammatory response to surgery is equivalent to the stress response of hormonal, neural and metabolic changes which initiate and propagate a local and systemic reaction to injury.[1-3.] From the site of injury, afferent impulses travel via the spinal cord and medulla to the hypothalamus, and then activate the pituitary-adrenal axis and the sympathetic autonomic nervous system. The overall metabolic effect is increased catabolism and water and salt retention.[4]

The local response is proportional to the degree of tissue trauma and is initiated by the clotting cascade resulting in the migration of inflammatory cells to the site of injury. Many chemicals are released including histamine, bradykinin, serotonin, substance-p and prostaglandins.[5] Cytokines are the major mediators and maintainers of the inflammatory response.[6] Interleukin-1 (IL-1) and Tumour necrosis factor-α (TNF-α) are released by activated macrophages and monocytes which stimulates release of IL-6 which is the main cytokine responsible for the systemic changes known as the acute-phase response.[7] Cytokine levels are maximal at 24 hrs and remain elevated for 48-72 hrs. The acute phase proteins (CRP, fibrinogen and $\alpha^2$-macroglobulin) act as mediators, anti-proteinases and scavengers in tissue repair.[8,9]

**ii. Mechanisms and Treatment of Pain**

Acute pain results from mechanically-, chemically- and thermally-induced damage to tissue integrity. Skin, capsule, synovium and bone nociceptors all are activated in response to noxious stimuli, and lead to neurotransmitter release in dorsal horn nuclei of the spinal cord, and relay information via the thalamus to the cerebral cortex.[10]

The local chemical inflammation further sensitizes nociceptors to noxious stimuli, and sensitization lowers the nociceptive threshold to painful stimuli. If inflammation persists, biochemical modulations alter the peripheral sensory neurons (peripheral sensitization). If increased afferent input to dorsal horn nuclei persists, then post-synaptic secondary sensory neurons are also sensitized (central sensitization) causing amplified responses to all sensory input.[11]

Our understanding of the mechanisms of pain is becoming clearer, and more emphasis is being placed upon preemptive and multimodal analgesia with the focus on local and regional techniques.[12] Multimodal analgesia addresses multiple mechanisms of pain, and has been shown to decrease systemic analgesia requirements and the side-effects of individual agents, especially opiods.[13] Preemptive analgesia is aimed at preventing the development of pain, especially central sensitization, but may work less well in patients with pre-operative pain.

It is believed that the control of initial post-operative pain, which is due in part to the acute inflammatory response, will prevent sensitization and ongoing pain and inflammation. Thus maximal mobilization is possible before fibrosis and stiffness can occur. Each practitioner or institution tends to follow a different protocol, employing varying combinations of agents and techniques.

Herkowitz et al.[14] reported on a Survey of pain management amongst orthopaedic surgeons in the USA. In this paper it is shown that opioids are still considered the most reliable means for post-operative pain management, and are widely used despite their side-effect profile. Epidurals and nerve blocks also had high levels of satisfaction with arthroplasty surgeons. However interest was expressed in employing alternative agents and placing less reliance on conventional analgesics.

Traditional post-operative pain management includes neuraxial analgesia with indwelling epidural catheters and parenteral opiod analgesia with patient-controlled analgesia (PCA) pumps. These methods are relatively easy to use, but have many adverse effects and may result in suboptimal pain control.[15]

The multimodal regimen consists of peripheral nerve blocks, local periarticular injections and a combination of oral non-opiod agents.[16]

The main groups of analgesic agents are as follows.

- *Opioids:* Morphine acts at the hypothalamus to suppress the Hypothalamic-Pituitary-Axis. It can be delivered either intravenously, intramuscularly or orally. Side-effects (nausea, vomiting, somnolence, pruritis, constipation, urinary retention) are fewer with the lower doses used in multimodel approaches.

- *Neuraxial analgesia* inhibits the stress response to surgery by blocking the afferent pathway. Spinal or Epidural techniques as a singe-dose or as a continuous infusion may be used. A Cochrane review[17] found no difference between epidural and systemic analgesia in the frequency of nausea and vomiting and respiratory depression. Urinary retention, pruritis and hypotension were more frequent with epidurals compares to opiods, but sedation was less frequent. Epidural analgesia had lower pain scores at rest and with leg movement 18-24 hours after surgery. The use of low molecular weight heparin for thrombo-prophylaxis was found to increase the chance of epidural haematoma by 50%. [18-19]

- *Peripheral Nerve Block.* These are often more technically difficult to perform than upper limb blocks, but advances in ultrasonography and nerve stimulating needles have made them more reliable. Their unilateral nature and the fact that they can be used in conjunction with an indwelling peripheral catheter are advantages. Studies have shown better pain scores and better knee flexion when compared with systemic analgesia, and equivalence to epidural analgesia.[20,21] Their main risks are neurologic dysfunction and inadvertent intravascular injection. The femoral nerve block or fascia

iliaca block should be supplemented by a sciatic nerve block for the posterior structures.

-*Local Peri-articular injections* are gaining favor for their low side-effect profile and ease of use. These contain long-acting local anaesthetics with or without other agents such as morphine, ketorolac and epinephrine. Several authors[22,23] have found that this technique led to lower pain scores, better early functional recovery and earlier discharge from hospital. They suggest that a cocktail of agents has a synergistic effect.

-*Paracetamol* is believed to act by inhibiting prostaglandin synthesis in the central nervous system, although the exact mechanism has not been elucidated. Side-effects are limited if the daily dose is less than 4000mg.

- *Tramadol* is a centrally-acting drug structurally related to opiods which binds opiod receptors and prevents re-uptake of norepinephrine and serotonin. It has a lower incidence of side-effects than morphine. It should be avoided in patients taking antidepressants.

- *NSAIDS* inhibit prostaglandin production in the Arachidonic Acid pathway affecting both COX1 (loss of protection for gastric mucosa, and inhibiting platelet aggregation causing bleeding) and COX2 (analgesic effects) receptors.

- *COX2 specific inhibitors* have fewer gastric side-effects, but some have increased cardiac side-effects. Ketorolac is a frequently used parenteral agent in this group.

- *Glucocorticoids* have a small effect on depressing IL-6 concentrations, and are well known for their local anti-inflammatory effects, but may increase wound and infective complications. Their use in orthopaedics was recently reviewed by Salerno.[24]

- *Clonidine* activates $\alpha^2$-adrenergic receptors providing haemodynamic stability with its sympatholytic activity and reducing anaesthetic requirements by sedation.



**iii. Measurement of Swelling**

The measurement of swelling of the knee is not a simple process, especially in the post-operative patient who has pain, bulky dressings over fresh incisions, and where anatomical landmarks are difficult to consistently identify. Most authors evaluate swelling by simple circumferential measurement using a tape measure at some point around the knee, but this has not been standardized or validated for the knee region. A figure-of-eight method has been shown by Maudsley[25] and Peterson[26] to be useful, reliable and valid for ankle swelling, and to be comparable to the use of water volumetry. A technique of multiple measurements at prescribed levels around the knee is currently being evaluated in our Department.

Mathematical models have been used to calculate volume, which rely upon several circumferential tape-measurements, such as the truncated cone 'frustrum method' described by Stranden.[27] This measures the circumference at 2 points and the distance between them. A mathematical formula is used to calculate the volume. The disc model method of Kuhnke et al.[28] measures circumference in relation to a series of discs 3cm in height, and then adds them together.

Water volumetry[29] which involves water displacement from a Plexiglas container, is the gold-standard, It has been shown to have acurate intraobserver reproducibility and low interindividual variability.[30] However its use is impractical in the post-operative setting, with patients with pain and surgical wounds having to immerse their limbs in tanks of water.

Optoelectronic systems require a metal frame fitted with 240 to 300 infrared phototransistors to measure circumference between 2 points at multiple levels, and a microprocessor connected to the chassis bearing the frame. These devices, such as Stanton's 'Perometer'[31] and Verraat's 'Volumeter'[32], have been shown to be comparable to water volumetry, [33,34] but are expensive and not readily available.

**iv. Stiffness and Arthrofibrosis**

The functional requirements of a knee joint are to be able to fully extend, which decreases the work of the quadriceps muscles and reduces patello-femoral loads, and to flex to various degrees for different functions. For walking on level ground a range of 45-55° is required, 85° for stair climbing, 95° to rise from a seated position, 125° to kneel for prayers, and 135° for squatting on the floor.[35,36] Different ethnic and cultural groups require varying arcs of motion for religious or hygiene purposes.

The definition and interpretation of 'stiffness' is inconsistent between authors. An acceptable flexion range may be 75° for one report (Kim et al.[36] who noted a prevalence of 'stiffness' of 1,3% in their series), yet 95° for another (Yercan et al.[37] who report 5,3% postoperative stiffness). Flexion to 90° seems to be the most commonly recognized limit of acceptability.[37-39,42,48,49]

There are many reports on the prevalence, the risk factors and the management of postoperative stiffness. The primary patient factors influencing the postoperative range of motion are multi-factorial.

Scranton[39] reports that 85% of their patients who developed stiff knees had previous surgery or had diabetes mellitus. Ritter et al.[40] showed that pre-operative flexion most strongly predicted post-operative flexion. Lam et al.[41] demonstrated that knees with a pre-operative flexion deformity alone had an increased risk of developing stiffness

afterwards. Gandhi and de Beer[42] revealed that pre-operative flexion, and flexion at closure, at 6 weeks and at 6 months post-operatively were all predictive of a stiff TKR at 1 year.

Harvey et al.[43] and other authors [44,45] have found that generally there is a gain in rheumatoid knees and a loss in osteoarthritic knees, and that stiffer knees gain some flexion, while more mobile knees often lose some of it.

Dennis[46], Laskin[47]and others[38,39,42,49,50] stress that intra-operative factors which may result in stiffness are numerous, and that surgical technique and component positioning are critical. Improper flexion-extension gap balancing, over-sizing or mal-positioning of components, inadequate femoral or tibial resection, inadequate osteophyte removal, a persistently tight posterior cruciate ligament, joint line elevation or failure to restore posterior femoral offset are all possible causes of decreased range of motion. (Table I)

Stiffness may also be due to muscle tightness from prolonged disuse, or muscle inhibition from painful stimuli. It may be due to intra-capsular or inter-fascial adhesions and fibrous band formation and soft tissue-impingement.

Table I : Possible causes of pain and stiffness after knee replacement surgery.

| **Common Articular Causes of Pain** | **Causes of Stiffness** |
|---|---|
| Infection | Pre-operative stiffness |
| Prosthetic loosening | History of previous surgery |
| Instability | Excessive pain |
| Component failure | Poor patient motivation |
| Patello-femoral disorders | Reflex sympathetic dystrophy |
| Peri-prosthetic osteolysis | Heterotopic ossification |
| **Common non-articular causes of Pain** | PCL tightness |
| Hip disease | Instability |
| Spine disease | Peripheral obesity |
| Vascular disease | Technical error |
| Tendonitis/bursitis | Anteriorly shaped femoral cuts |
| Reflex sympathetic dystrophy | Improper component position |
| Psychological illness | Oversized components |
| **Less common Causes of Pain** | Patello-femoral dysfunction |
| Patella clunk syndrome | Patella baja |
| Lateral patella facet syndrome | Joint line mismatch |
| Soft-tissue impingement syndromes | Overstuffing |
| Fabellar impingement | Osteophytes |
| Popliteus tendon dysfunction | |
| Tibial component overhang | |
| Heterotopic ossification | |
| Recurrent haemarthrosis | |
| Particulate-induced synovitis | |
| Cutaneous neuroma | |

Parvisi et al.[48] analysed their database of 10 000 total knee replacements, and found 112 (1.1%) to be stiff (<90 flexion). 98 required manipulation under anaesthesia and 14 underwent revision surgery. Gender-based stratified analysis determined that age, body-mass-index, femoral flexion and patella baja were significant predictors in females, but only patella baja was a predictor of stiffness in male patients.

In an analysis of specimens taken from the stiff knees which underwent revision arthroplasty, Parvisi et al.[48] suggest a genetic predisposition to the condition due to an

imbalance in the chemical mediators regulating the normal resolution of the inflammatory and fibroblastic proliferative phases of healing. They postulate an exaggerated RONS (reactive oxygen and nitrogen species) production or a deficiency in RONS removal. Their research group is currently investigating treatment with antioxidants.

**v. Investigation of Pain and Stiffness**

When evaluating a patient who suffers from any complication after TKR, one can assess pre-operative, intra-operative and post-operative factors as causes for pain and stiffness. A recent review article compiled by Mandalia et al.[51] describes a logical evaluation which follows a systematic approach, including history, examination, laboratory tests and radiological investigations which should be performed.

It is not always easy to distinguish between septic and aseptic aetiologies.[52] Laboratory tests such as the white cell count (WCC), erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) are useful markers for infection, both alone and in combination. Greidanus[53] reported high sensitivity (0,93 and 0,91) and high specificity (0,83 and 0,86), respectively, for ESR >22.5 mm/hr and CRP >13,5 mg/L, for the diagnosis of infection in patients with painful TKR. However, these values are laboratory dependant, and should be taken in context. Recently Interleukin-6 has shown promise as a serological marker for infection.[54] It increases and returns to normal more rapidly. Di Caesare[55] found it to be consistently elevated (>10ng/L) in patients with peri-prosthetic infection.

Barrack et al.[56] and Duff et al.[57] also showed the value of joint aspiration in determining infection, but others have found this to have poor sensitivity and specificity. Discrepancies exist as to what cell count or what percentage polymorphonuclear cells should be considered abnormal. No antibiotics should be received for two weeks prior to aspiration of the joint, and multiple samples growing the same organism should be reported to be able to make a positive diagnosis of periprosthetic infection.

Plain radiographs are essential in all cases and should be long leg standing antero-posterior, lateral and merchant views of the knee. These can exclude surgical errors as a cause, and can evaluate loosening, fracture, wear and heterotopic ossification in the chronic problematic knee.[51]

Nuclear medicine scans are not helpful in the acute phase, where it may take over a year to return to normal. Sometimes the third 'delayed' phase may never return to normal. The triple-phase bone scan has high sensitivity, but poor specificity.[58] These scans, especially gadolinium enhanced and white blood cell labeled, may be helpful in late presenting knee pain to help distinguish between infected and loose TKRs, with a negative scan being a strong predictor of the absence of infection, but a positive scan is of limited value.[59]

MRI scanning with metal subtraction software and optimized pulse sequence parameters can circumvent much of the artifact generated by total knee arthroplasty, yielding diagnostic information about the prosthesis, the periprosthetic soft tissues, and the

adjacent osseous structures. In a study by Sofka et al.[60] The MRI findings led to surgical or other therapeutic interventions in 21 of 40 patients with a painful TKR and influenced clinical management in all cases.

**vi. Management of Stiffness (with /without Pain)**

After thorough evaluation of the painful or stiff joint, a management plan can be formulated depending on the cause.[52] Manipulation is an effective form of management for the stiff TKR, although care needs to be taken not to rupture the patella tendon or cause a fracture.

Both Daluga et al.[61] and Yercan et al.[38] have shown that an earlier manipulation under anaesthesia(MUA), less than 3 weeks post-operatively, yields better results. Arthroscopic arthrolysis can be successful in selective cases within 6 months post-operatively.[62,63] Open debridement with or without polyethylene replacement yields modest improvements in range of motion.[64-66]

Formal revision is most frequently undertaken for persistent pain and swelling. However, unless a specific cause is being addressed, its effectiveness has had mixed success.[67,68] Yercan et al.[38] felt that if problems with the patella (loosening and clunk syndromes) were identified, these should always be corrected, as surgical treatment for these problems had a good outcome. Mont et al.[65] and Jacobs et al.[69] advise that revision surgery for patients in whom a cause cannot be found, specifically those with

unexplained pain, performs poorly as opposed to revision for those with an identifiable cause for their pain and/or stiffness.

### vii. Prevalence of Pain and Stiffness

The prevalence of post-operative pain and stiffness varies in the literature. Studies quote figures from 1.1% to 10.8% (Table II).[37-39,42,48,49,75] The overlap between pain and stiffness vary between researchers, and there is an inconsistent definition of stiffness (between 70 – 95 degrees of flexion).

Table II: Prevalence of pain and stiffness reported by surgeons

| *Author* | *Year* | *Knees* | *Outcome: Pain / Stiffness (definition)* | *% P/S* |
|---|---|---|---|---|
| Kim et al.[37] | 2004 | 1000 | Stiffness (<75°) | 1,3% |
| Parvisi et al.[48] | 2006 | 10000 | Stiffness (<90°) | 1,1% |
| Gandhi et al.[42] | 2006 | 1216 | Stiffness (<90°) | 3,7% |
| Scranton[39] | 2001 | 250 | Pain and stiffness (<90°) | 10,8% |
| Yercan at al.[38] | 2006 | 1188 | Pain and stiffness (<95°) | 5,3% |
| Fischer et al.[49] | 2007 | 1024 | Pain and stiffness (<90°) | 6,9% |
| Elson et al.[75] | 2007 | 622 | Unexplained pain at 6/12 | 4% |

In addition, what patients experience and what surgeons report about the procedure is often quite different (Table III).[72-74]

Table III: Prevalence of pain and stiffness experienced by patients

| *Author* | *Year* | *Knees* | *Outcome: Pain / Stiffness* | *% P/S* |
|---|---|---|---|---|
| Brander et al.[73] | 2003 | 149 | Unexplained pain at 6/12 | 18% |
| Brander et al.[74] | 2003 | 149 | Unexplained pain at 1 yr | 13% |
| Baker et al.[71] | 2007 | 10000 | Dissatisfied at 1 yr | 18,2% |
| Nunez et al.[72] | 2009 | 146 | Pain/ poor function | 15,7% |

Baker and Gregg[71] performed a survey of 10,000 patients from the UK national joint registry, with a response rate of 87%. One year after TKR, only 82% of patients were satisfied with the outcome of their total knee replacement. The patients who were not satisfied (18%) had poorer scores in both the 'pain' and 'function' elements of the Oxford knee score.

Nunez et al.[72] reported that almost 16% of patients would not have their operation again citing difficult recovery, increased pain, and insufficient improvement as the main reasons.

The natural history of pain after TKR has been investigated by Brander et al.[73] who show that the of patients with significant pre-operative pain (72%) almost one quarter 22,6% still had excessive pain by 3 months, which reduced somewhat to 18,4% at six months post-operatively. However at 12 months, one in 8 patients (13%) still had unexplained pain.

These authors also indicated that patients with significant preoperative pain (Visual Analogue Scale, VAS >40) have a higher rate of manipulations, and suggested instituting aggressive pain management including drugs, physiotherapy and education before surgery. Psychosocial factors such as anxiety and depressive symptoms preoperatively were associated with higher pain levels post-operatively and increased use of resources.

In their follow-up study, Brander et al.[74] showed that patients with heightened, unexplained pain at 1 year had progressive improvement in pain over several years and, by 5 years, 95% of these patients were satisfied, but 5% still had unexplained pain.

Elson and Brenkel[75] evaluated their series of 622 TKRs and found an incidence of 4% unexplained pain at 6 months. They report that half of these patients recovered over the subsequent 5 years, and that surgery for unexplained pain had a poor outcome.

**viii. Summary**

In conclusion, the mechanisms for pain are complex and multi-factorial. Multimodal regimes have been developed to address the problem of postoperative pain. Once obvious causes have been excluded, more subtle reasons for some patients to have continued problematic postoperative pain have not yet been fully elucidated. Swelling is difficult to quantify in the postoperative patient, and its relationship to pain and resultant stiffness has also has not been shown. There are numerous causes for postoperative stiffness, which has been reported to be less than 75-95° flexion. The reason for arthrofibrosis is postulated to be genetic, with an imbalance in the chemical mediators of inflammation. If a cause cannot be found, revision arthroplasty yields poor results. Despite good results being published by surgeons, surveys of patients reporting their own outcomes regarding pain and stiffness are not as positive.

Portions of this review and the manuscript which follows were combined and condensed and have been published in the South African Orthopaedic Journal. Winter 2010;vol 9 (no2):59-66. (Appendix F)

## ix. References


1. Cuthbertson DP. Observations on the disturbances of metabolism produced by injury to the limbs. *Q J Med* 1932;**1**:233–244.

2. Cuthbertson D, Tilstone WT. Metabolism during the post injury period. *Adv Clin Chem* 1969;**12**:1–55.

3. Moore FD, Olsen KH, McMurrey JD. The body cell mass and its supporting environment. Philadelphia: WBSaunders;1978.

4. Desborough JP. The stress response to trauma and surgery. *Br J Anaesth* 2000;**85**:109-17.

5. Kohl BA, Deutschman CS. The inflammatory response to surgery and trauma. *Curr Opin Crit Care* 2006;**12**:325-332.

6. Sheeran P, Hall GM. Cytokines in anaesthesia. *Br J Anaesth* 1997;**787**:201-19.

7. Choileain NN, Redmond HP. Cell response to surgery. *Arch Surg* 2006;**141:1132**-40.

8. Baumann H, Gauldie J. The acute phase response. *Immunol Today* 1994;**15**:74-80.

9. Baigrie RJ et al. Systemic cytokine response after major surgery. *Br J Surg* 1992;**79**:757-760.

10. Ekman EF, Koman LA. Acute Pain Following Musculoskeletal Injuries and Orthopaedic Surgery. Mechanisms and Management.*J Bone Joint Surg Am* 2004;**86**:1316-1327.

11. Reuben SS, Buvanendran A. Preventing Cronic Pain after Orthopaedic Surgery. *J Bone Joint Surg Am* 2007;**89**:1343-58.

12. Skinner HB. Multimodal acute pain management. *Am J Orthop* 2004;**33**(5 Suppl):5.

13. Peters CL, Shirley B, Erickson J. The effect of a new multimodal peri-operative anesthetic regimen on postoperative pain, side effects, rehabilitation, and length of hospital stay after total joint arthroplasty. *J Arthroplasty* 2006;**21**(6Suppl2):132.

14. Herkowitz HN, Dirschl DR, Sohn DH. Pain Management: the Orthopaedic Surgeon's perspective. *J Bone Joint Surg Am* 2007;**89**:2532-5

15. Filos K, Lehmann K. Current concepts and practice in postoperative pain management: Need for a change? *Eur Surg Res* 1999;**31**:97-107.

16. Krych A et al. Contemporary pain management strategies for minimally invasive TKA. *Instr Course Lect* 2010:**59**:99-109.

17. Choi PT, Bhandari M, Scott J et al. Epidural analgesia for pain relief following hip pr knee replacement. *Cochrane Database Syst Rev* 2003;**3**:CD003071.

18. Heit J. Low-molecular-weight heparin: Biochemistry, pharmacology and concurrent drug precaytions. *Reg Anaesth Pain Med* 1998;**23**:135-139.

19. Leclerc JR, Geerts WH, Desjardins L et al. Prevention of venous thromboembolism after knee arthroplasty. *Ann Intern Med* 1996;**124**:619-626.

20. Capdevila X, Bartholet Y, Biboulet P et al. Effects of perioperative analgesic technique on the surgical outcome and duration of rehabilitation after major knee surgery. *Anaesthesiology* 1999;**91**:8-15.

21. Chelly JE, Gregor J, Gebhard R et al. Continuous femoral blocks improve recovery and outcome of patients undergoing total knee arthroplasty. *J Arthroplasty* 2001;**16**:436-445.

22. Busch CA, Shore BJ, Bhandari R et al. Efficacy of periarticular multimodel drug injection in total knee arthroplasty. *J Bone Joint Surg Am* 2006;**88**:959-963.

23. Ranawat AS, Ranawat CS. Pain Management and Accelerated Rehabilitation for Total Hip and Total Knee Arthroplasty. *J Arthroplasty* 2007;**22**(7)Suppl.3:12-15.

24. Salerno A, Hermann R. Efficacy and safety of steroid use for postoperative pain relief: Update and review of the medical literature. *J Bone Joint Surg Am* 2006;**88**:1361-1372.

25. Mauwdsly R et al. Criterion-Related Validity of the Figure-of-Eight Method of Measuring Ankle Edema. *Journal of Orthopaedic & Sports Physical Therapy* 2000;**30**(3):149-153.

26. Petersen E et al. Reliability of Water Volumetry and the Figure of Eight Method on Subjects With Ankle Joint Swelling. *Journal of Orthopaedic & Sports Physical Therapy* 1999;**29**(10) :609-615.

27. Stranden E. A comparison between surface measurements and water displacement volumetry for the quantification of leg edema. *J Oslo City Hosp* 1981;**31**:153-155.

28. Kuhnke E. Volumbestimmung aus Umfangmessungen. *Folia Angiolica* 1976;**24**:228-232.

29. Perrin.M, Guex J. Edema and leg volume: Methods of assessment. *Angiology* 2000;**51**,1,9-12.

30. Vayssairat M, Maurel A, Gouny P et al. La volumetrie: une methode precise de quantification en phlebologie. *J Mal Vasc* 1994;**19**:108-110.

31. Stanton AWB, Northfield JW, Holroyd B et al. Validation of an optoelectronic limb volumeter (Perometer). *Lymphology* 1997;**30**:77-97.

32. Veraart JC. Neumann HA. Leg volume measurements with a modified optoelectronic measurement system. *Phlebology* 1995;**10**:62-64.

33. Man IO, Markland KL, Morrissey MC. The validity and reliability of the Perometer in evaluating human knee volume. *Clin Physiol Funct Imaging* 2004;**24**:352–358.

34. Manetal I. Validity and reliability of the Perometer. *Clin Physiol Funct Imaging* 2004:**24**,352–358.

35. Laubenthal KN, Smidt GL, Kettlekemp DB: A quantitative analysis of knee motion during activities of daily living. *Phys Ther* 1972;**52**:34.

36. Kim JM, Moon MS. Squatting following total knee arthroplasty. *Clin Orthop* 1995;**313**:177–186.

37. Kim J, Nelson CL, Lotke PA. Stiffness after total knee arthroplasty: prevalence of the complications and outcomes of revision. *J Bone Joint Surg Am* 2004;**86A**:1479.

38. Yercan HS, Sugun TS, Bussiere C, et al. Stiffness after total knee arthroplasty: prevalence, management and outcomes. *Knee* 2006;**13**:111-17.

39. Scranton PE Jr. Management of knee pain and stiffness after total knee arthroplasty. *J Arthroplasty* 2001;**16**:428-35.

40. Ritter MA, Harty LD, Davis KE et al. Predicting range of motion after total knee arthroplasty: clustering, loglinear regression, and regression tree analysis. *J Bone Joint Surg Am* 2003;**85**:1278–1285.

41. Lam LO, Swift S, Shakespeare D. Fixed flexion deformity and flexion after knee arthroplasty: what happens in the first 12 months after surgery and can a poor outcome be predicted? *Knee* 2003;**10**:181–185.

42. Gandhi R, de Beer J, Leone J, Petruccelli D, Winemaker M, Adili A. Predictive risk factors for stiff knees in total knee arthroplasty. *J Arthroplasty* 2006;**21**:46-52.

43. Harvey A, et al. Factors affecting the range of movement of total knee arthroplasty. *J Bone Joint Surg Br* 1993;**75-B**:950-5.

44. Anouchi YS, McShane M, Stiehl J. Range of motion in total knee replacement. *Clin Orthop* 1996;**331**:87-92.

45. Maloney WJ. The Stiff Total Knee Arthroplasty: Evaluation and Management. *J Arthroplasty* 2002;**17(4)**:71-73.

46. Dennis D, Komistek R, Scuderi G. Factors Affecting Flexion after Total Knee Arthroplasty. CORR 2007;464:53-60.

47. Laskin RS, Beksac B. Stiffness After Total Knee Arthroplasty. *J Arthroplasty* 2004;**19(4)**:41-46.

48. Parvizi J, Tarity TD, Steinbeck MJ, Politi RG, Joshi A, Purtill JJ and Peter F . Management of stiffness following total knee arthroplasty. *J Bone Joint Surg Am* 2006;**88**:175-181.

49. Fisher DA, Dierckman B, Watts MR, Davis K. Looks good but feels bad: Factors that contribute to poor results after total knee arthroplasty. *J Arthroplasty* 2007;**22**(6)Suppl.2:39-42.

50. Dennis DA. Evaluation of Painful Total Knee Arthroplasty. *J Arthroplasty* 2004:**19**(4)Suppl.1:35-40.

51. Mandalia V, Eyres K, Schranz P, Toms AD. Evaluation of patients with a painful total knee replacement. *J Bone Joint Surg Br* 2008;**90-B**:265-71.

52. Toms AD, Mandalia V, Haigh R, Hopwood B, The Management of patients with a painful Total Knee Replacement. *J Bone Joint Surg Br* 2009;**91-B**:143-50.

53. Greidanus NV, Masri BA, Garbuz DS, et al. Use of erythrocyte sedimentation rate and C-reactive protein level to diagnose infection before revision total knee arthroplasty: a prospective evaluation. *J Bone Joint Surg Am* 2007;**89-A**:1409-16.

54. Bottner F, Erren M, Wegner A, Winkelmann K, et al. Interleukin-6, procalcitonin and TNF alpha: markers of peri-prosthetic infection following total joint replacement. *J Bone Joint Surg Br* 2007;**89-B**:94-9.

55. Di Cesare PE, Chang E, Preston CF. Serum interleukin-6 as a marker of periprosthetic infection following total hip and knee arthroplasty. *J Bone Joint Surg Am* 2005;**87-A**:1921-7.

56. Barrack RL, Jennings RW, Wolfe MW, Bertot AJ. The Coventry Award: the value of preoperative aspiration before total knee revision. *Clin Orthop* 1997;**345**:8-16.

57. Duff GP, Lachiewicz PF, Kelley SS. Aspiration of the knee joint before revision arthroplasty. *Clin Orthop* 1996;**331**:132-9.

58. Palestro CJ, Kim CK, Swyer AJ, et al. Total-hip arthroplasty: periprosthetic indium-111-labeled leukocyte activity and complementary technetium-99m-sulfur colloid imaging in suspected infection. *J Nucl Med* 1990;**31**:1950-5.

59. Love C, Marwin SE, Tomas MB, et al. Diagnosing infection in the failed joint replacement: a comparison of coincidence detection 18F-FDG and 111 In-labeled leukocyte/99mTc-sulfur colloid marrow imaging. *J Nucl Med* 2004;**45**:1864-71.

60. Sofka CM, Potter HG, Figgie M, Laskin R. Magnetic resonance imaging of total knee arthroplasty. *Clin Orthop* 2003;**406**:129-35.

61. Daluga D, Lombardi AV Jr, Mallory TH, Vaughan BK. Knee manipulation following knee arthroplasty: analysis of prognostic variables. *J Arthroplasty* 1991;**6**:119-28.

62. Diduch Dr, Scuderi GR, Scott WN, Insall JN, Kelly MA. The efficacy of arthroscopy following total knee replacement. *Arthroscopy* 1997;**13**:166-71.

63. Klinger M, Baums MR, Spahn G, Ernstberger T. A study of effectiveness of knee arthroscopy after knee arthroplasty. *Arthroscopy* 2005;**21**:731-8.

64. Babis GC, Trousdale RT, Pagnano MW, Morrey BF. Poor outcomes of isolated tibial insert exchange and arthrolysis for the management of stiffness following total knee arthroplasty.*J Bone Joint Surg Am* 2001;**83**:1534–1536.

65. Mont MA, Seyler THM, Marulanda GA, et al. Surgical treatment and customized rehabilitation for stiff knee arthroplasties. *Clin Orthop* 2006;**446**:193–200.

66. Hutchinson JRM, Parish EN, Cross MJ. Results of open arthrolysis for the treatment of stiffness after total knee replacement. *J Bone Joint Surg Br* 2005;**87**:1357–1360.

67. Kim J, Nelson CL, Lotke PA. Stiffness after total knee arthroplasty: prevalence of the complications and outcomes of revision. *J Bone Joint Surg Am* 2004;**86-A**:1479-84.

68. Haidukewych GJ, Jacofsky DJ, Pagnano MW, et al. Functional results after revision of well fixed components for stiffness after primary total knee arthroplasty. *J Arthroplasty* 2005;**20**:133–138.

69. Jacobs MA, Hungerford DS, Krackow KA, Lennox DW.Revision total knee arthroplasty for aseptic failure. *Clin Orthop* 1988;**226**:78-85.

70. Mont MA, Serna FK, Krackow KA, Hungerford DS. Exploration of radiographically normal total knee replacements for unexplained pain. *Clin Orthop* 1996;**331**:216-20

71. Baker PN, van der Meulen JH, Lewsey J, Gregg PJ. The role of pain and function in determining patient satisfaction after total knee replacement. *J Bone Joint Surg Br* 2007;**89-B**:893-900.

72. Nunez M. Quality of Life Benefits Seen With Total Knee Replacement. *Arthritis Rheum.*2009;**61**:1062-1069.

73. Brander VA, Stulberg SD, Adams AD, et al. Predicting total knee replacement pain: a prospective, observational study. *Clin Orthop* 2003;**416**:27-36.

74. Brander V, Gondek S, Martin E, Stulberg SD. Pain and depression influence outcome 5 years after knee replacement surgery. *Clin Orthop* 2007;**464**:21-6.

75. Elson DW, Brenkel IJ. A conservative approach is feasible in unexplained pain after knee replacement: a selected cohort study. *J Bone Joint Surg Br* 2007;**89-B**:1042-5.

# Part C: Manuscript

## TABLE OF CONTENTS

# ABSTRACT

## Background and Method

Total Knee Replacement surgery is an efficient treatment modality for Arthritis of the knee, but it is not without its problems and dilemmas. Knee pain, swelling and stiffness after total knee replacement (TKR) surgery are well-recognized complications. There are many possible reasons for a poor outcome; however, in some cases despite investigation the cause may be unexplained.

Similarly, in the Orthopaedic Department at U.C.T. it was found that some patients, for whom the results were predicted to be excellent after a "simple and straightforward" TKR, had much more pain and swelling than was expected.

The aim of this study was to assess the perceived incidence of these problems amongst knee surgeons in South Africa and to see whether any surgical or other peri-operative intervention or variable appeared to play a role. A survey was sent to members of the South African Orthopaedic Association (SAOA), focusing on the surgeon's perception of unexpected and unexplained post-operative pain and swelling.

The pathophysiology of pain and swelling, as well as possible mechanisms for postoperative stiffness is explored, and current outcome reports from the literature are reviewed. Methods of investigation, quantification and treatment of postoperative pain swelling and stiffness are discussed.

**Results and Discussion**

Of the 61 respondents, two-thirds had more than 10 years experience and close to three-quarters performed 20 or more TKRs per annum. Less-experienced surgeons report unexpected pain with greater frequency than more-experienced surgeons (90% vs 53%) ($p<0,05$).

Similarly, surgeons using the visual analog scale (VAS) to assess a patient's pain report a higher incidence for unexpected pain. Unexpected pain was identified as a problem, with two-thirds of surgeons reporting seeing more pain than anticipated in between 6 and 20% of their cases. Unexpected swelling is also an issue. Approximately one half of surgeons could only identify the cause for pain in fewer than 5% of their cases.

Surgeons who use drains and have shorter surgical times reported a reduced incidence of unexpected pain and swelling, although this did not reach statistical significance. No suggestive relationships were found for other peri-operative parameters, such as analgesic regimens, thrombo-embolic prophylaxis or mobilization protocols.

The reported perceived incidence of postoperative pain and swelling is higher than was anticipated, and intimates that our experience in Cape Town is echoed around South Africa, however, management protocols vary widely between surgeons. No direct correlations can be made from this data, but it confirms that our future investigations will be into a difficult and as yet incompletely explained problem for arthroplasty surgeons.

# I. INTRODUCTION

Total knee replacement (TKR) surgery has revolutionized the care of patients suffering from degenerative or inflammatory arthritis of the knee. The goal of treatment is a pain-free, stable knee joint which allows good function for activities of daily living.

There are a myriad of causes for a poor outcome. Often the clinical picture is a spectrum of both pain and stiffness, but many authors report one or the other as the predominant symptom. The prevalence of postoperative pain and stiffness varies in the literature. Studies quote figures from 1.1% to 10.8%.[37-39,42,48,49,75.] Whilst there is an overlap between pain and stiffness, the definition of stiffness is loosely defined as knee flexion ranging from 70° to 95° of flexion. Swelling may be associated with both of these findings, but was not specifically reported on as an outcome in our literature search.

In the Orthopaedic Department at the University of Cape Town it has been recognized that some patients - for whom the results were anticipated to be excellent after a nominally 'simple and straightforward' TKR - had much more pain and swelling than was expected. This delayed their rehabilitation, decreased their range of motion, prolonged their hospital stay, and correlated with a poor medium-term outcome. For many of these patients a specific cause for their pain and swelling could not be identified.

The aim of this study was to assess the perceived incidence of these problems amongst knee surgeons in South Africa and to see whether any surgical or other perioperative

intervention or factor appeared to play a role in the presence of post-operative pain, swelling and stiffness.

This study was conducted via a survey dealing with perioperative management practices of South African Orthopaedic Surgeons performing TKRs. A comprehensive questionnaire was sent to members of the South African Orthopaedic Association (SAOA), focusing on the surgeon's perception of unexpected and unexplained post-operative pain and swelling.

# II. MATERIALS AND METHODS

## i. Participants

A survey of South African knee surgeons was performed using the database for the South African Orthopaedic Association (SAOA). Of the 550 members, 150 were either still in training or no longer actively performing knee arthroplasty surgery. 120 surgeons on the database had incomplete or inaccurate contact email addresses. Thus 280 questionnaires were sent to generalist and specialist surgeons who may perform total knee replacements.

## ii. Procedures

A questionnaire (Appendix B) was designed to include all the factors which could be considered important in contributing to causing excessive pain, swelling and stiffness. Several versions of the questionnaire were tested by three knee arthroplasty surgeons in order to develop a comprehensive and user-friendly format. Assistance for the design and data content was obtained from a biostatistician.



The questions covered multiple aspects of perioperative assessment and care of a patient after a total knee replacement (TKR), including the following: surgeon demographics, implant variations, operative techniques including use of tourniquets, haemostasis and drainage, medical interventions including analgesia, anticoagulation and antibiotic use. The incidence of 'more pain than was expected' and the ability to identify causes for that pain were also examined, as was the occurrence of 'more swelling than was expected'

and the assessment of that swelling. The investigation of infection, the mobilization programme, and the consideration of manipulation for stiffness were also included.

**iii. Survey definitions**

For the purpose of this study the following definitions of terms used as relating to symptomatology apply:

'Unexpected': implies a subjective assessment of such occurrence beyond the expected in the experience of the observer.

'Unexplained': implies a symptom which cannot be shown to have a demonstrable cause.

**iv. Measurement**

The questionnaire was converted into an Excel-based spreadsheet for email communication and online completion. Each reply was added to a single tabulated spreadsheet for data analysis. The focus of the study was to assess the perceived incidence of pain and swelling reported by South African knee surgeons. As such, the respondents were grouped according to their response to the above-mentioned questions; subsequent comparative analysis of the variation in perioperative parameters in these groups was then performed.

Categorical data was used and the broad categories for possible responses included: never, seldom (1-5%), sometimes (6-20%), mostly (21-80%) and always.

### v. Data Analysis

The chi-squared test of association was performed for analysis of the categorical data. A p-value of $< 0.05$ was considered to indicate statistical significance.

### vi. Ethics

The study protocol adhered to the tenets of the declaration of Helsinki, and was approved by the University of Cape Town Research and Ethics Committees. Informed consent forms were not required as informed voluntary response was required to participate. Anonymity was strictly adhered to.

# III. RESULTS

Of the 280 questionnaires sent out, 61 respondents returned a completed questionnaire (22%). 32 of the respondents were also members of the South African Knee Society. 92% (56/61) of reporting surgeons practice in the private sector. Less-experienced surgeons (<10 years) comprised 34% (21/61) and surgeons with more than 10 years experience made up 66% (40/61).

The number of cases performed each year was also taken as a measure of experience, with 17 (28%) performing less than 20 TKR per year. Only 8 (13%) 'high-volume' surgeons performed more than 100 cases per year. 35% performed 20-50 cases per year, and 23% between 50–100 cases per year.

Surgeons were asked to indicate the implant / technique which they used most frequently. 60% used mobile bearing knees. 20% retained the posterior cruciate ligament. Only 18% routinely resurfaced the patella. Computer-assisted surgery was regularly used by 15% of respondents for their cases. 16% of surgeons perform an average knee replacement in under an hour, with another 16% typically taking longer than 90 minutes. Only 10% of respondents don't use a tourniquet, and 10% don't use drains post-operatively.

All surgeons use prophylactic antibiotics. The majority (95%) choose a first-generation cephalosporin. The duration of use varies: 7% give a second dose at 8 hours, 66% continue for 24 hours and 26% for more than 24 hours post-operatively.

Thrombo-embolic prophylaxis is often performed in a combined synergistic approach. 85% of surgeons use low molecular weight heparin (LMWH), 10% use warfarin and 5% use aspirin as a chemical prophylaxis. Mechanical prophylaxis with foot pumps is used by 72% and graduated compression stockings by 80%. Of those using LMWH, 50% prescribe it for less than the recommended 10 days, and 30% use it for longer than 21 days. One quarter commence it on the day before surgery, 50% on the day of surgery and 25% on the day following surgery.

For post-operative pain and swelling, all surgeons use oral preparations, 80% use NSAIDS, 70% use IM injections and 65% prefer IV opioid / PCA pumps. Only 11% use a systemic steroid. None use intra-articular steroids or intra-articular pumps. Roughly equal numbers use each of the regional anaesthetic techniques; 47% prefer epidurals and 43% employ nerve blocks. 26% use local anaesthetic in the wound, and 19% of surgeons use a local 'cocktail' preparation.

For assessment of patients' pain, 23% used a scoring system such as the Visual Analogue Scale (VAS). The remainder of respondents employed "clinical judgment".

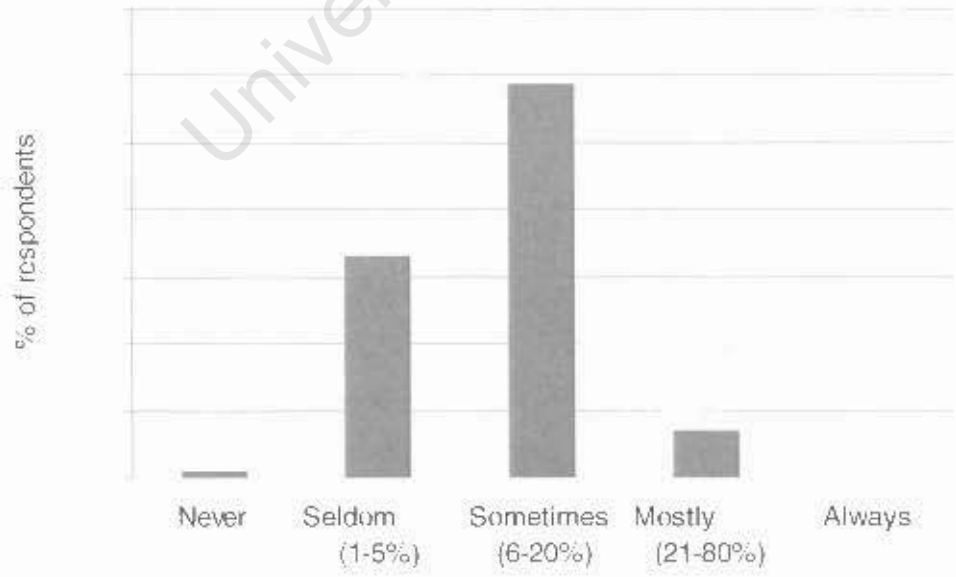
For assessment of swelling, 28% used a tape-measure to assess swelling. The remainder of respondents relied on subjective clinical assessment. No others modalities such as volumetry, ultrasound or MRI were used.

50% of surgeons refer patients for a preoperative physiotherapy programme. Post-operatively, 25% of respondents mobilize their patients on day 1, 50% on day 2 and 25% on day 3. 60% of surgeons will allow their patients home with <90° flexion. With regard to performing an MUA for a stiff knee, 60% will consider an MUA before 6 weeks, 25% only consider an MUA after 3 months and 15% do not consider an MUA to be necessary at all.

Only one respondent claimed never to see more pain than expected in the postoperative phase. 33% seldom (1-5% of cases) saw more pain than they expected, whereas 60 % reported an incidence of 6-20% unexpected postoperative pain. 7% had a high incidence (21-80%) of unexpected pain in their patients (Figure 1).

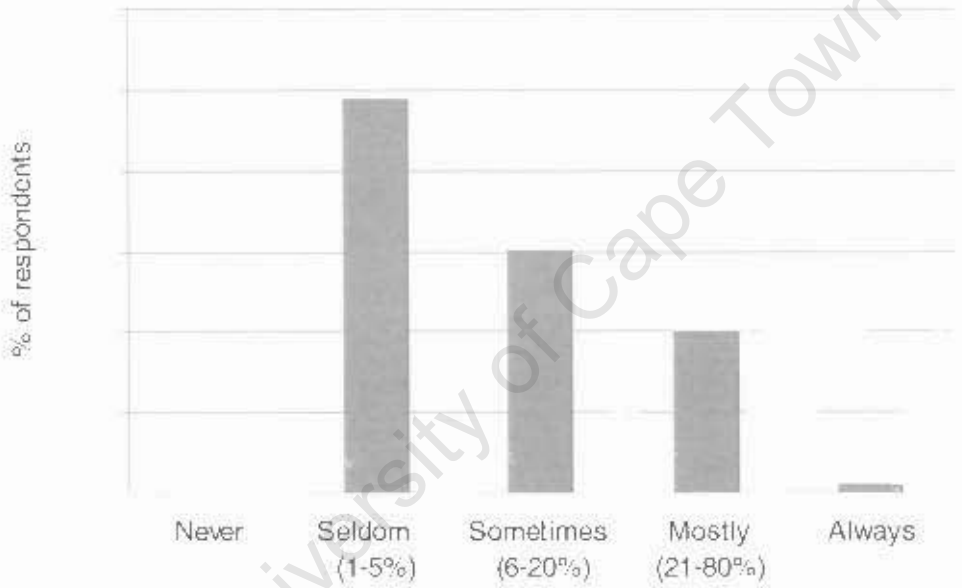


**Figure 1: Occurrence of unexpected pain after TKR**



This unexpected pain is essentially unexplained in the majority of cases, as half the respondents fail to find a cause more than 95% of the time. 33% sometimes find a cause, and only 17% are satisfied that they mostly find a cause for this postoperative pain (Figure 2).

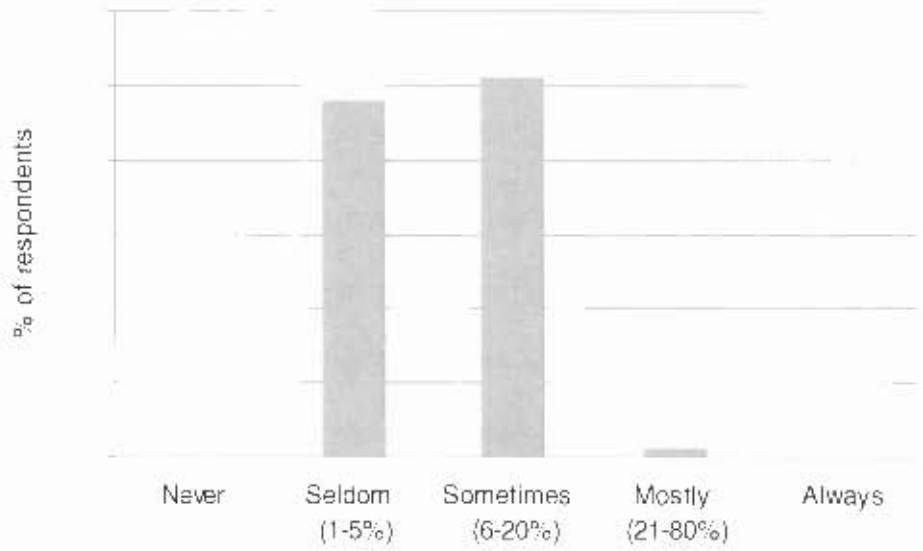
**Figure 2: Cause identified for unexpected pain**






Half the respondents seldom find unexpected postoperative swelling to be a problem, but the other 50% do find swelling to be more than they expected in between 6-20% of their cases (Figure 3).

**Figure 3: Occurence of unexpected swelling post TKR**




Comparative analysis with 2 by 2 tables and the chi-squared test of association were used. A p-value of $< 0.05$ was considered to indicate statistical significance. For the purposes of this study, respondents were divided into two groups: those reporting a low incidence of unexpected pain, and those reporting a relatively high incidence of unexpected pain. A similar segmentation was performed for swelling. Thus of the respondents:

21 (33%) reported a low incidence of unexpected pain in their patients (<5% of cases).

40 (66%) reported a higher incidence of unexpected pain in their patients (>6% of cases).

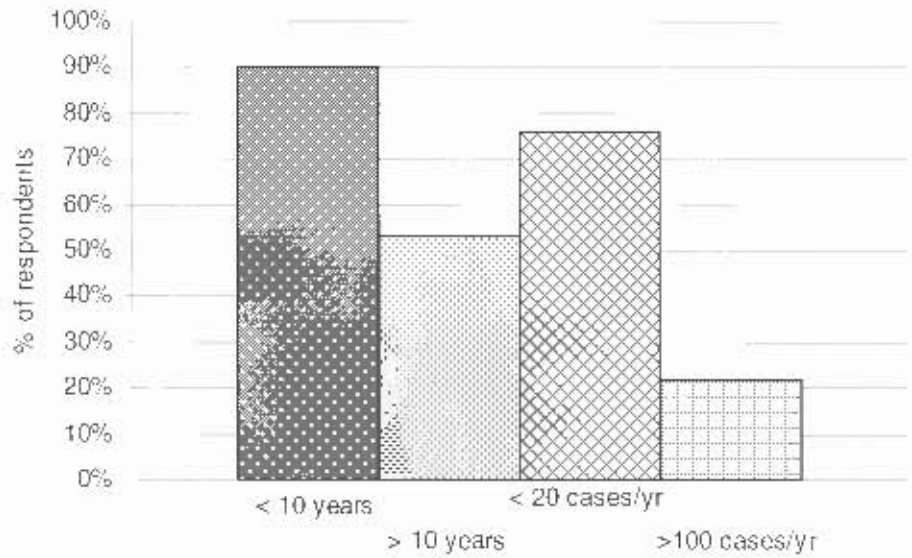
32 (52%) reported a low incidence of unexpected swelling (<5% of cases).

29 (48%) reported a higher incidence of unexpected swelling (>6% of cases).

The data was analysed for trends or significant differences between the groups with respect to demographics, surgical techniques and other perioperative variables. For each intervention the difference from these mean values was evaluated and any variations were subjected to statistical analysis.

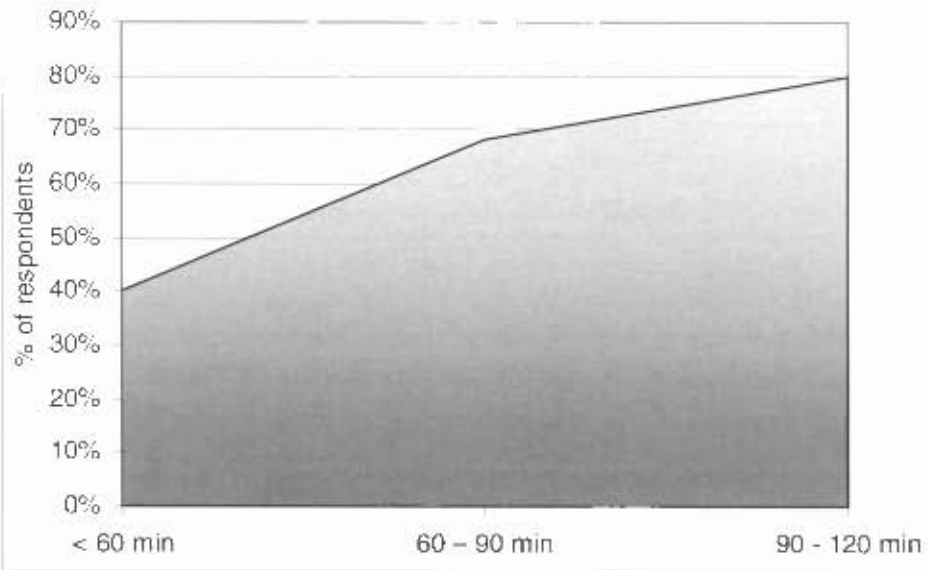
Less experienced surgeons reported a higher incidence of unexpected pain: those who performed <20 cases per year (76%) vs those who performed more than 100 cases per year (22%) ($p<0,05$). Similarly, of those who had <10 years experience, 90% reported unexpected pain vs 53% of those who had >10 years experience ($p<0,05$) (Figure 4). This association was statistically significant.

**Figure 4: Reported occurrence of higher frequency of unexpected pain relating to surgeon experience**

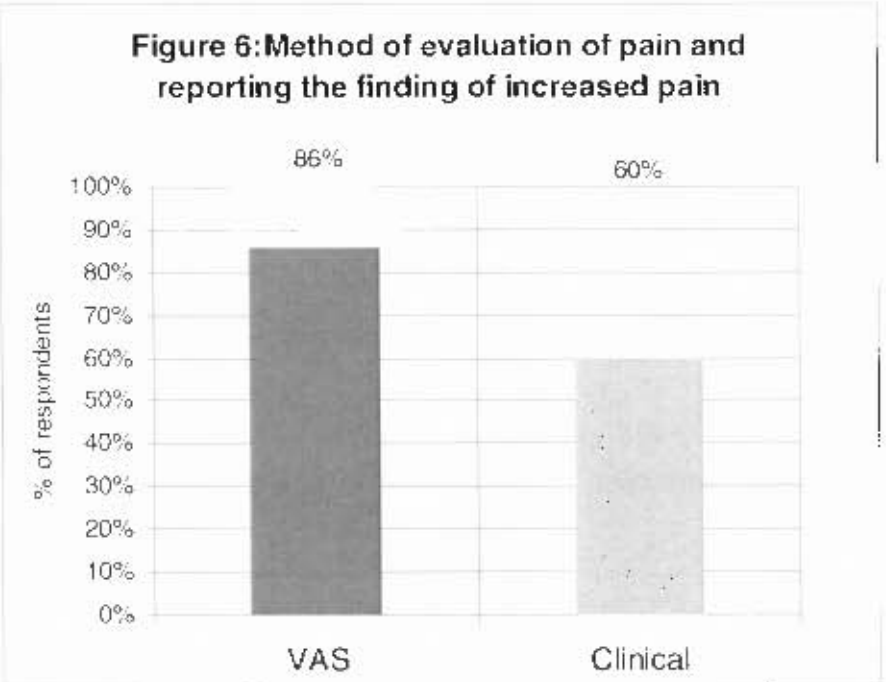


The surgeons who took longer to complete a TKR also reported a higher incidence of unexpected pain: 80% of surgeons who took longer than 90 mins were in the group with a higher incidence of unexpected pain (p>0,05) (Figure 5).

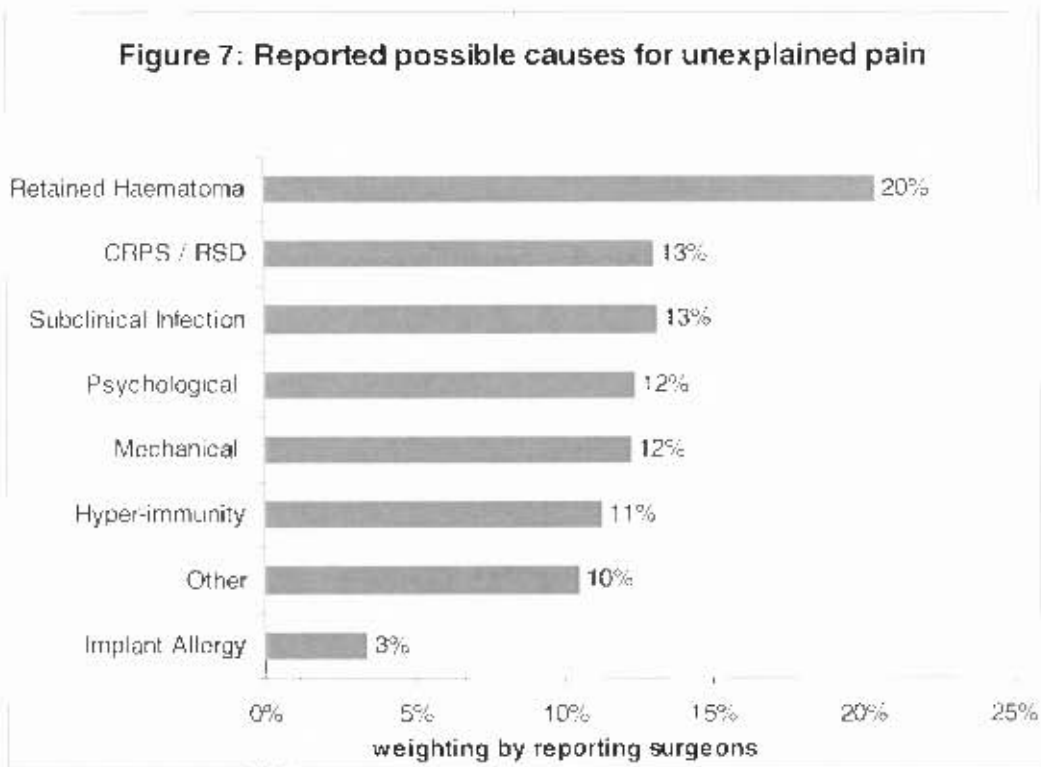
**Figure 5: Surgical time related to higher frequency of unexpected post-operative pain**




The surgeons who used a VAS scoring system for pain assessment reported a higher incidence of unexpected pain from their patients: 86% vs 60% of those only using clinical estimates (p>0,05) (Figure 6).

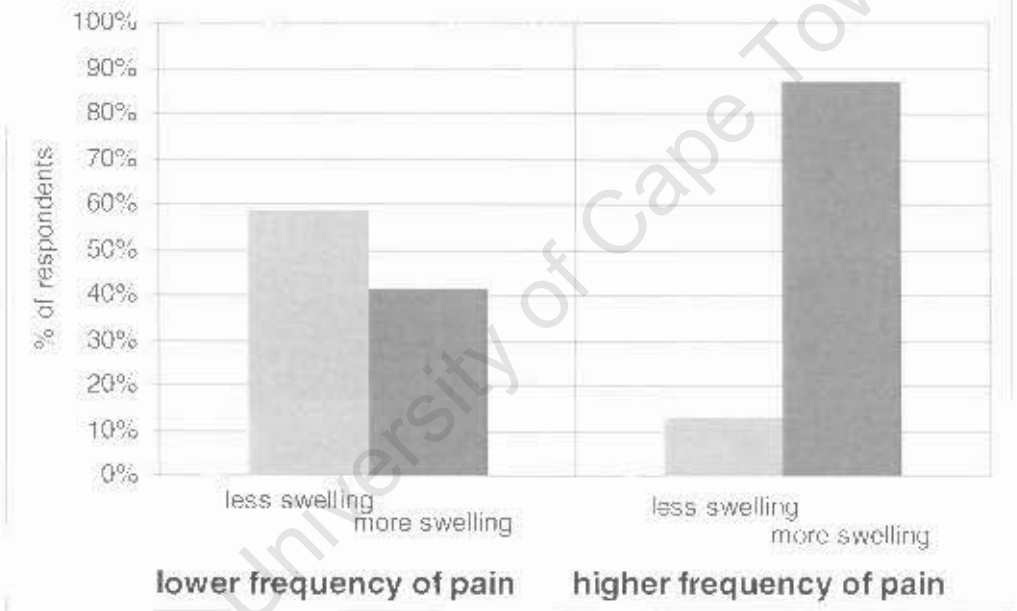



Suggested causes for unexplained pain are recorded in Figure 7.



The surgeons whose patients had a relatively high incidence of unexpected pain also reported a higher incidence of unexpected swelling (87%), ie. more often than not a higher incidence of unexpected pain is associated with more (unsuspected) swelling. 59% of those who reported a low incidence of pain also had a low incidence of swelling ($p<0.05$) (Figure 8).

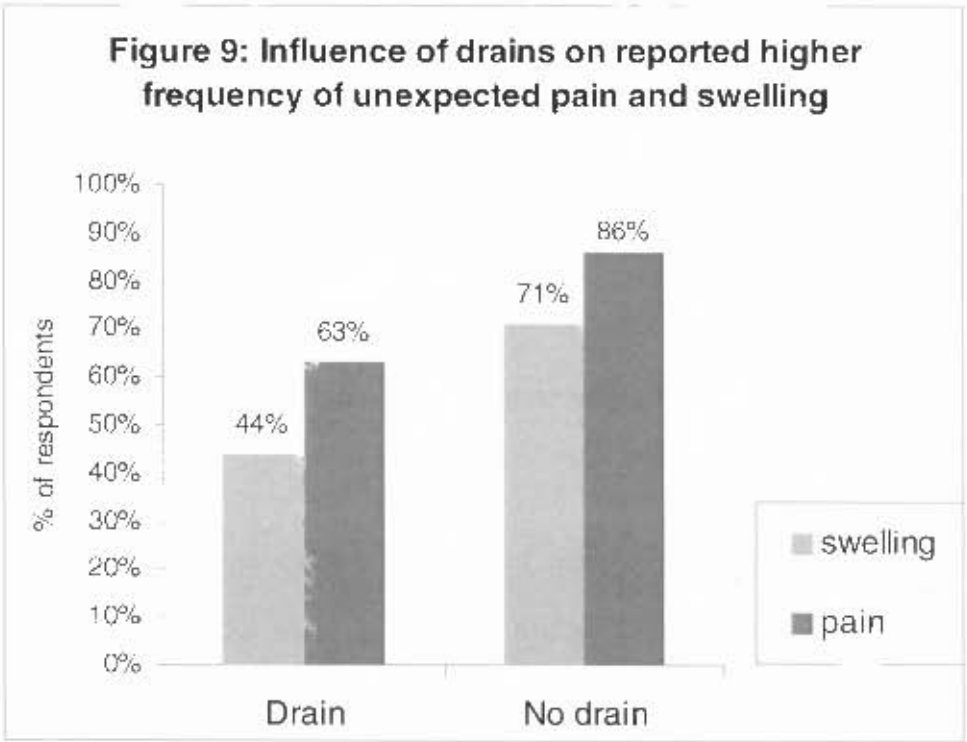
**Figure 8: Incidence of both pain and swelling**





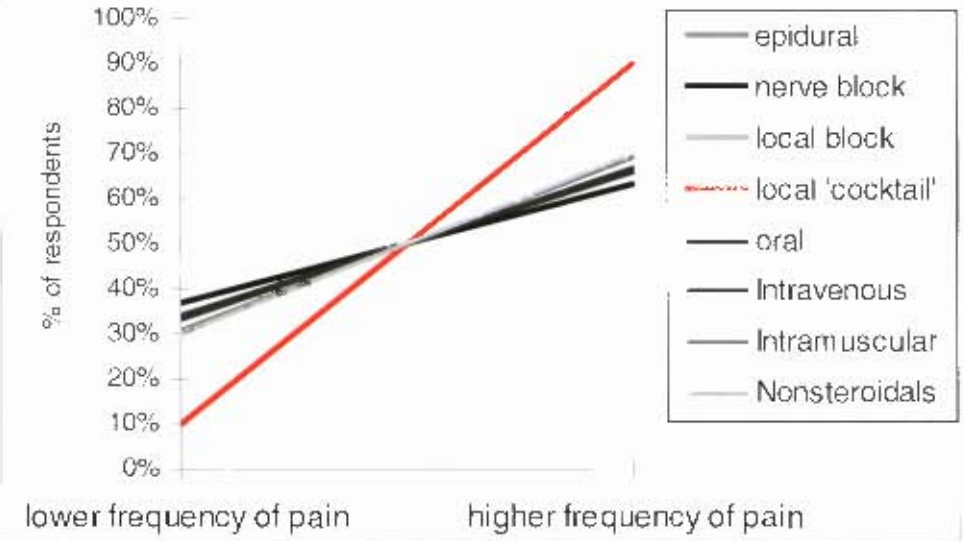

A result which is somewhat counter-intuitive is the fact that swelling was not seen to be as much of a problem for the inexperienced surgeons as for the experienced surgeons. Only 29% of surgeons doing <20 cases/year were in the group reporting a higher incidence of swelling, but 78% of those doing >100 cases/year were in that group ($p<0.05$).

The surgeons who did not use drains also reported a higher incidence of pain: 86% vs 63% were in high incidence group (p>0.2). This group of surgeons also report more swelling (71% vs 44%) (Figure9).




90% of those who used local peri-articular injections with a 'cocktail' of agents were in the higher incidence group of reported unexpected pain. This is a notable deviation, but not statistically significant, as no other analgesic regimens differed from the average response of 33% (low pain incidence) vs 66% (higher pain incidence) (Figure10).

**Figure 10: Analgesic use with respect to reported frequency of unexpected pain**




For all the other parameters investigated there were no marked positive or negative deviations from the mean to warrant further evaluation or discussion. Multivariate logistic regression analysis could not be performed due to the relatively small sample size.

# IV. DISCUSSION

As this survey shows, total knee replacement surgery is not without unexplained problems. Whilst the assessment of symptoms is mostly subjective, all surgeons, to a greater or lesser degree, were surprised by the amount of pain or swelling after the procedure.

Less-experienced surgeons, both in terms of age and number of cases per year, report a higher incidence of unexpected pain when compared to more experienced surgeons. In essence there are a few options to explain this.

Firstly, their relative inexperience makes it possible that they have not yet recognized how much pain the procedure evokes. If this were so, by implication, it may suggest that surgical procedures on the knee evoke more discomfort and swelling than do similar procedures elsewhere.

Secondly, the question of technical competence may also play a role. Whilst it is intuitive that more- experienced surgeons would be more technically competent, and that the surgical time taken for the procedure may be a 'surrogate' for competence, the study did not show a statistical difference for surgical time between the less- or more-experienced surgeons.

Conversely, the more-experienced surgeons report a higher incidence of unexpected swelling when compared to the less-experienced surgeons. This may reflect the fact that senior surgeons more actively evaluated and assessed the swelling postoperatively, indicating a greater awareness of excessive swelling which is not often predictable and may be a problem.

Only 28% of reporting surgeons objectively measure postoperative swelling with a tape-measure – the remainder being subjective assessments. A more accurate, reliable, reproducible method for evaluating postoperative swelling is required. One of the reasons for this survey was to ascertain whether a reliable and readily available measurement tool was being employed elsewhere that could be used in our Department, but no suggestions were forthcoming from responding surgeons.

Post-operative swelling is a natural occurrence due to the inflammatory response to surgical trauma, but mediators have been shown to return to baseline levels by day 7. Reduction in swelling does not always follow. This is probably due to generalized tissue oedema, impaired lymphatic and venous drainage, but it may also be due to the ongoing inflammatory stimulus of the retained haematoma or haemarthrosis. Apart from the expected inflammatory response, mechanical and infective causes need to be excluded as possible causes of the swelling as these may be treated accordingly.

The range of suggested causes for unexpected pain supports our hypothesis that few surgeons actually know why some patients have more pain than others. There is still

potential to investigate the ill-defined causes such as 'hyperimmunity', 'subclinical infection', chronic regional pain syndrome, or the role that psychological overlay may play.

From this, it is clear that future prospective studies should include the assay of innate and humoral components that are involved in the inflammatory response to gauge individual and on-going responses. Other measurement possibilities would include a reproducible tape-measure method of obtaining circumferential measurements at levels above, at, and below the patella, or an adjustable sealed volumetric device. MRI scanning in the acute setting is a possibility, and will differentiate haematoma and soft tissue oedema, but it is expensive to perform, and may be more useful in the sub-acute stage to identify correctable soft-tissue causes of knee pain and stiffness. Ultrasonography is also a modality which may be of use in evaluating these patients.

The prevention of wound haematoma by wound drainage is very popular despite several studies showing no difference in clinical outcomes whether drains are used or not.[76-80] This current study suggests that those who use drains have a lower perceived incidence of pain and swelling in their patients. Tourniquets have also not been shown to have a proven beneficial outcome, [81-83] and yet 90% of respondents use them routinely.

Excessive postoperative pain, due to both sensori-neural pathways and inflammatory mechanisms, if uncontrolled, may lead to a cycle of sensitization and an ongoing inflammatory cascade. The lack of motion at the painful joint results in intra-articular and

peri-articular adhesions which in turn lead to an inflammatory reaction and more pain. Heuleu and Neyret[84] reported that, with proper pain control, the incidence of manipulation after TKR decreased from 9% to 1%, supporting the close link between the experience of pain and the occurrence of joint stiffness.

Local 'cocktail' injections are gaining in popularity and are being used to good effect in New York by Ranawat et al.[23] and in other centres.[22] This current survey showed that surgeons who identified pain as a post-operative problem more frequently employed this modality. Although not interrogated by the questionnaire, it is likely that these surgeons employ this technique because of their increased awareness for the need to obtain better pain and inflammation control in the post-operative period.

As shown in the literature review, the surveys of patients' experience of postoperative pain and swelling have a much higher incidence than the reported incidences in many surgical papers. Perhaps such varied reporting is due in part to the lack of a standardized scoring or assessment of patient's pain, swelling and function. In our survey less than a quarter of surgeons currently attempt to assess pain using a validated system, such as the Visual Analogue Scale (VAS). When the VAS was used, these surgeons reported a higher level of unexpected pain in their patients compared to those that use subjective measures, perhaps demonstrating that the more one measures an outcome, the higher the reported incidence of that outcome - the classic 'Hawthorn effect'!

The definition of stiffness varies. An acceptable flexion range may be 75° for one report, yet 95° for another. Flexion to 90° seems to be the most commonly recognized limit of acceptability.[1-6] Due to limitations in the questionnaire design, the correlation between swelling and stiffness could not be made from the data obtained from this study.

Many other perioperative variables were included in the questionnaire. For example: the type of implant used, the use of patella resurfacing, limitations of surgery based on the patients 'body mass index', the use of laminar flow theatres and exhaust suits, varying medications such as tranexamic acid, antibiotics, anti-thrombotic agents, investigations for excluding postoperative infection, and commencement of weight-bearing and mobilization programmes. After analysis, there were no marked trends or differences in these parameters when related to the question of pain swelling and stiffness, and thus further discussion is not warranted here, and dilutes the focus of the principle question.

The results of this survey show a marked variation in perioperative management options amongst surgeons demonstrated by the differing responses with respect to analgesic regimens, thrombo-embolic schedules, and rehabilitation programmes. These are not always based on evidence, and often surgeon experience and training, hospital limitations with respect to drug availability and post-operative monitoring, anaesthetic preferences, and community nursing and physiotherapy services, affect the care given. Although not an objective of this study, finding such variation prompts the thought that there is a need to develop an evidence-based management protocol for TKR. However, there is

definitely no single way to deal with all the perioperative issues pertaining to knee arthroplasty, and most surgeons will continue to do what 'works' for them.

**Survey limitations**

The low rate of returned questionnaires (22%) weakens the power of this study, and multivariate analysis could not be performed. Follow-up enquiries cited reluctance to the completion of forms, difficulties with the online Excel familiarity and 'too many questions' as reasons for non-compliance.

While the investigators were not 'blind' to respondents' names – leading to possible concerns around prejudice / bias – this information was not used for comparison of individual surgeons, and did not alter the analysis of results.

With the benefit of hindsight some additional questions, in particular relating to stiffness and its relationship with pain, would have been added, and perhaps fewer, more focused questions would have been asked. A more thorough pilot study would have been beneficial.

Some potential problems with question clarity arose, for example, the temporal relationship of the complications was not adequately delineated. Acute postoperative pain swelling and stiffness does not necessarily result in or equate to chronic pain swelling and stiffness.

Also, possible numerical data (% of cases) was specifically divided into categorical data groups (1-5%, 6-20% etc.) in the questionnaire before data collection, which changed the way the data could be analyzed, and perhaps influenced the range of possible responses.

**Implications and Recommendations**

Many questions, including the following, are raised by the findings of this study. In the uncomplicated TKR how much pain and swelling and stiffness should one expect? When does pain and swelling subside? At what rate should the range of motion return? How frequently can a cause simply not be found despite rigorous and exhaustive investigation? When we can't explain it, what *is* causing it?

The most obvious finding is that the frequency of post operative pain, swelling and stiffness is not negligible, and that less experienced surgeons report to have a higher incidence of unexpected pain after TKR. Also, from the review of the literature, there is a high rate of patient dissatisfaction with the short- to medium-term outcome of this procedure, and thus future patients need to be made aware of the high possibility of these occurrences.

As a result of this study it is highly recommended that future research, guided by findings arising from this survey, should be undertaken.

# V. CONCLUSIONS

From this survey of South African surgeons, of varying degrees of experience, perspectives around the prevalence and potential causes of unexpected pain, swelling and stiffness after routine total knee replacement procedures, it seems evident that:

1. Unexpected pain, with corresponding swelling and stiffness is indeed a problem, and is not uncommon irrespective of surgeon experience. More often than not such pain and swelling cannot readily be explained.

2. Less experienced surgeons - whether in years or number of TKR operations performed each year - report a higher incidence of unexpected pain. However, more experienced surgeons had a greater awareness of unexpected swelling.

3. Reduced levels of unexpected pain and swelling are reported by surgeons who use drains, and by those that have shorter surgical procedure times.

4. Surgeons employing the 'local cocktail injection' technique and objective quantitative evaluation methods (such as the VAS or a measuring-tape) report a higher incidence of unexpected pain than those that do not.

5. The reported operative and treatment practices vary widely between surgeons.

# VII. ACKNOWLEDGEMENTS

I am indebted to the surgeons who gave of their time to complete the questionnaire and participate in this survey. Thank you.

# VIII. REFERENCES

The following are additional references to those used in the literature review:

76. Adalberth G, Bystrom S, Kolstad K, Mallmin H, Milbrink J. Postoperative drainage of knee arthroplasty is not necessary. *Acta Orthop Scand* 1998;**69**(5):475-478.

77. Reilly TJ, Gradisar IA, Pakan W, Reilly M. The use of postoperative suction drainage in total knee arthroplasty. *Clin Orthop* 1986;**208**:23842.

78. Cobb JP. Why use drains? *J Bone Joint Surg Br*.1990;**72**(6):993-5.

79. Beer KJ, Lombardi AVJ, Mallory TH, Vaugan BK. The efficacy of suction drains after routine total joint arthroplasty. *J Bone and Joint Surg Am*1991;**73**(4):58&7.

80. Ritter MA, Keating E M, Fais P M. Closed wound drainage in total hip or total knee replacement. A prospective, randomized study. *J Bone Joint Surg Am*1994;**76**(I):35-8.

81. Wakankar HM, Nicholl JE, Koka R, D'Arcy JC. The tourniquet in total knee arthroplasty. *J Bone Joint Surg Br*1999;**81-B**:30-3.

82. Klenerman L. Is a tourniquet really essential for knee replacement? *J Bone Joint Surg Br*1995;**77-B**:174-5.

83. Abdel-Salam A, Eyres KS. Effects of tourniquet during total knee arthroplasty: a prospective randomised study. *J Bone Joint Surg Br*1995;**77-B**:250-3.

84. Heuleu JN, Neyret P. Conduite a tenir devant les raiders post-operatoires du genou. *Rev Chir Orthop Repar Appar Mot* 2002;**88**(suppl.5):1S27-51.

# Part D: Appendices

A. **Accompanying letter**

B. **Questionnaire**

C. **Departmental Research Committee approval letter**

D. **Ethics Committee approval letter**

E. **Future TKR research proforma**

F. **Published article**

# UNIVERSITY OF CAPE TOWN

**Division of Orthopaedic Surgery**
H49 OMB
Groote Schuur Hospital
Observatory 7925
Cape Town - South Africa
Telephone: (-27-21) 406 6157/ 8
Telefax: (-27-21) 4472709
e-mail: johan.walters@uct.ac.za

Dear Dr.

**Re: Questionnaire on Pain, Swelling and Stiffness post Knee Replacement.**

Professor Walters and I, as part of a multi-tiered investigation have formulated a brief questionnaire regarding the problem of 'unexpected and unexplained' pain, swelling and stiffness after an uncomplicated TKR. We hope to gauge the scope of the problem in our specialist field and which treatment or interventions may play a role.

I realise that time is precious, but I would like to request approx. 6 minutes of your time to complete a straight-forward questionnaire, which is in excel format for ease of completion. Please save to your computer with your name as file name, complete your name on the first line, and then save again before returning as an attachment via email.

Your co-operation in completing this by return of email would be greatly appreciated.

My thanks in advance
Yours Sincerely

Ben Garrett

# KNEE PAIN / SWELLING / STIFFNESS Questionnaire

Prof. J. Walters, Dr B. Garrett

Knee Swelling and Pain, for reasons other than Haematoma, Infection and DVT, is common, but variable, after Knee Replacement Surgery, and on occasion this is **more than what one would like to see** or expect after this surgery.

In a small number of these, the accompanying **inflammatory response affects the outcome** of the procedure with *stiffness* or *loss of range of motion*, well below what is considered acceptable.

The purpose of this Survey is to assess the **perceived incidence** of significant and worrisome Knee Pain, Swelling and Stiffness after an **'uncomplicated and straightforward'** TKR. In addition, an attempt will be made to assess any relationships between pain, swelling and stiffness, and whether or not various interventions appear to play a role in limiting or aggravating this complication.

Your co-operation in completing this simple questionnaire will be greatly appreciated.
Please include those patients you have treated primarily and those referred to you.
Please indicate one option per question.

## Question 1: *Demographics*

| | |
|---|---|
| **1a)Do you practise mostly in Private?** | 1 |
| ***In State?*** | 2 |
| **1b)Number of years experience?** | |
| <5 | 1 |
| <10 | 2 |
| >10 | 3 |
| **1c)Number of cases per year?** | |
| <20 | 1 |
| 20-50 | 2 |
| 50-100 | 3 |
| >100 | 4 |

## Question 2

Indicate the implant / **technique used most frequently** for standard TKR. (If you use more than one option frequently, restrict reporting to one specific implant or operation technique)

| | |
|---|---|
| **2a) Bearing** | |
| Fixed | 1 |
| Mobile | 2 |
| **2b) PCL** | |
| Retaining | 1 |
| Substituting | 2 |
| **2c) 'Mobility'/Flexion design** | |
| 'Standard' | 1 |
| 'High mobility'/flexion | 2 |
| **2d) Fixation** | |
| Cemented | 1 |
| Uncemented | 2 |
| **2e) Procedure** | |
| Standard | 1 |
| MIS | 2 |
| CAOS | 3 |
| **2f) Patellar resurfacing** | |
| Yes | 1 |
| No | 2 |

## Question 3: *Pre-op Management*

| | | |
|---|---|---|
| **3a) Do you have a weight threshold for surgery?** | No | 1 |
| | <110 kg | 2 |
| | <130 kg | 3 |
| **3b) Do you have a BMI threshold for surgery?** | | |
| | No | 1 |
| | <40 | 3 |
| | <45 | 4 |
| | <50 | 5 |

## Question 4: *Operation technique*

| | | |
|---|---|---|
| **4a)Do you use laminar flow (L/F)** | **Yes** | 1 |
| | **No** | 2 |
| **4b) L/F with body or head exhaust suit** | **Yes** | 1 |
| | **No** | 2 |
| **4c) L/F with 'enclosure'** | **Yes** | 1 |
| | **No** | 2 |
| **4d)Do you Use a tourniquet** | **Yes** | 1 |
| | **No** | 2 |
| **4e)If Yes: Average Tourniquet time: ( mins)** | | |
| | <60 | 1 |
| | 60 - 90 | 2 |
| | 90 - 120 | 3 |
| | > 120 | 4 |
| **4f)Tourniquet application** | Esmarch | 1 |
| | Elevation of leg | 2 |
| **4g)Exsanguination** | Before skin prep | 1 |
| | After skin prep | 2 |
| **4h)Haemostasis** | | |
| Do you Cauterise vessels? | **Yes** | 1 |
| | **No** | 2 |
| 4i)If Yes: | On the way in | 1 |
| | On the way out | 2 |
| **4j)Use of drains ?** | **Yes** | 1 |
| | **No** | 2 |
| 4k)If Yes : | Size ¼ | 1 |
| | Size ⅛ | 2 |
| **4l)Surgical time** (skin to skin)minutes | | |
| | < 60 | 1 |
| | 60 – 90 | 2 |
| | 90 - 120 | 3 |
| | >120 | 4 |
| **4m)Do you do bilateral TKR** | | |
| | Same day sequential | 1 |
| | Simultaneous | 2 |
| | Interval | 3 |
| **4n)Post op management** | | |
| | Compression Dressing | 1 |
| | Immobilise in Extension | 2 |
| | Flexion | 3 |
| | Ice packs | 4 |
| **4o)Do you use CPM?** | **Yes** | 1 |
| | **No** | 2 |

## Question 5: *Medical Interventions*

| | Yes | No |
|---|---|---|
| **5a)Postoperative Analgesia** | | |
| 1)Epidural Catheter | 1 | 2 |
| 2)Peripheral nerve block | 1 | 2 |
| 3)Wound Infiltration using: | 1 | 2 |
| LA | 1 | 2 |
| NSAI | 1 | 2 |
| Cocktail | 1 | 2 |
| 4)Intra Articular LA Pump | 1 | 2 |
| 5)PCA / IV | 1 | 2 |
| 6)Intra Muscular | 1 | 2 |
| 7)Oral Analgesia | 1 | 2 |
| **5b)Cyclocapron (tranexamic acid)** | 2 | 2 |
| **5c)Anti-inflammatory:** | | |
| 1)NSAI | 1 | 2 |
| 2)Steroid: systemic | 1 | 2 |
| 3)Steroid: Intra articular | 1 | 2 |
| **5d)Anticoagulation** | | |
| 1)LMWH | | |
| Day before surgery | 1 | |
| Day of surgery | 2 | |
| Day of surgery | 3 | |
| 2)Duration | | |
| 7 – 10 days | 1 | |
| 10 – 20 days | 2 | |
| > 20 days | 3 | |
| 3)Aspirin | 1 | 2 |
| 4)Warfarin | 1 | 2 |
| 5)Foot Pumps | 1 | 2 |
| 6)TED stockings | 1 | 2 |
| **5e)Antibiotics**: 1)Duration | | |
| 8hrs | 1 | |
| Up till 24hrs | 2 | |
| More than 24hrs | 3 | |
| 2)Antibiotic of choice | | |
| Cephalosporin | 1 | |
| Cloxacillin | 2 | |
| Other | 3 | |

## Question 6: *THIS SECTION DEALS WITH PAIN*

6a) To what extent is knee ***Pain*** after TKR more than you would expect?

| | |
|---|---|
| Never | 1 |
| Seldom | 2 |
| Sometimes | 3 |
| Mostly | 4 |
| Always | 5 |

6b) How do you routinely quantify ***Pain***?

| | |
|---|---|
| Reproducible objective tool (eg Visual analogue scale) | 1 |
| Clinical experience/judgement | 2 |

6d) How frequently can you find 'adequate' reason for the pain?

| | |
|---|---|
| Never | 1 |
| Seldom | 2 |
| Sometimes | 3 |
| Mostly | 4 |
| Always | 5 |

---

## **Question 7:** *THIS SECTION DEALS WITH SWELLING*

7a) When is ***Swelling*** of the knee after TKR more than you would expect?

| | | |
|---|---|---|
| Never | 0% | 1 |
| Seldom | 1-5% | 2 |
| Sometimes | 5-20% | 3 |
| Mostly | 20-80% | 4 |
| Always | 100% | 5 |

7b) Subsidence of (uncomplicated TKR) Perioperative Swelling usually occurs by:

| | |
|---|---|
| Week 1 | 1 |
| Week 2 | 2 |
| Week 6 | 3 |
| Month 3 | 4 |
| > Month 3 | 5 |

7c) How do you quantify or measure Swelling?

| | Yes | No |
|---|---|---|
| 1)Clinical estimation | 1 | 2 |
| 2)Tape-measure | 1 | 2 |
| 3)Figure-of-eight taping | 1 | 2 |
| 4)Displacement Volumetry | 1 | 2 |
| 5)Ultrasound | 1 | 2 |
| 6)MRI | 1 | 2 |

7d) In a swollen painful knee, with no other signs of Infection, what percentage would you attribute the following causes?

| | |
|---|---|
| 1)Subclinical Infection | % |
| 2)Nickel Allergy | % |
| 3)Plastic Allergy | % |
| 4)Hyper-immune Response | % |
| 5)Retained Haematoma | % |
| 6)Chronic Regional Pain Syndrome | % |
| 7)Mechanical mismatch | % |
| 8)Psychological profile | % |
| 9)Other | |
| | |
| | |

7e) How do you exclude Infection as a possible cause of excessive swelling?

| | Yes | No |
|---|---|---|
| 1)Routine Examination and XR | 1 | 2 |
| 2)Blood parameters (CRP, ESR, WBC) | 1 | 2 |
| 3)Joint Aspirate | 1 | 2 |
| 4)Bone Scan | 1 | 2 |
| 5)Re-operation, Washout and Culture | 1 | 2 |

## Question 8: *THIS SECTION DEALS WITH STIFFNESS*

***Post op 'mobilisation'***

| **8a) Do you have a pre-op physio programme ?** | |
|---|---|
| Yes | 1 |
| No | 2 |
| **8b)Commence flexion/extension** on (post-op) day | |
| Day 1 | 1 |
| Day 2 | 2 |
| Day 3 | 3 |
| **8c)Standing** | |
| Day 1 | 1 |
| Day 2 | 2 |
| Day 3 | 3 |
| **8d)Weight bearing** (partial) starts on | |
| Day 1 | 1 |
| Day 2 | 2 |
| Day 3 | 3 |
| **8e)Discharge day after surgery** | |
| < 5 days | 1 |
| 5 -7 days | 2 |
| 7 – 9 days | 3 |
| > 9 days | 4 |
| **8f)Acceptable ROM** at discharge | |
| < 70 ° | 1 |
| 70° - 90° | 2 |
| 90° or more | 3 |
| **8g)At what stage would you consider an MUA?** | |
| Before 7 days | 1 |
| Before 14 days | 2 |
| Before 6 weeks | 3 |
| After 3 months | 4 |
| MUA not considered necessary | 5 |

8j) What factors inhibit the return of the **Expected ROM** after TKR?

| |
|---|
| |
| |
| |
| |
| |
| |
| |

UNIVERSITY OF CAPE TOWN

Health Sciences Faculty
Research Ethics Committee
Room E52-24 Groote Schuur Hospital Old Main Building
Observatory 7925
Telephone [021] 406 6338 • Facsimile [021] 406 6431
e-mail: [redacted]

17 August 2009

REC REF: 343/2009

Dr BR Garrett
Division of Orthopaedics
Groote Schuur Hospital

Dear Dr Garrett

**PROTOCOL TITLE: KNEE PAIN, SWELLING AND STIFFNESS AFTER TOTAL KNEE REPLACEMENT**

Thank you for submitting your study to the Research Ethics Committee for review.

It is a pleasure to inform you that the Ethics Committee has **formally approved** the above-mentioned study.

**Approval is granted for one year until 16 August 2010.**

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Yours sincerely

Signed by candidate

**PROFESSOR M BLOCKMAN**
**CHAIRPERSON, HSF HUMAN ETHICS**

This serves to confirm that the Faculty of Cape Town Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC, SA), Food and Drug Administration (FDA, USA), International Conversion on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

The Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines For Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50 and 312.

Federal Wide Assurance Number: [redacted]
Institutional Review Board (IRB) number: [redacted]

## TKR PERIOPERATIVE MANAGEMENT PROFORMA

| **Demographics** | | **Study no.** | | | |
|---|---|---|---|---|---|
| Name | | | | | |
| Folder number | | | | | |
| Contact details | | | | | |
| Date of birth | | Age | | | |
| Date on waiting list | | | | | |
| Date of surgery | | | | | |
| Date of follow-up visits | | | | | |

| **Background** | |
|---|---|
| Diagnosis | |
| Previous surgery / Injury | |
| Occupation | |
| Co-morbidities | |
| Medication | |
| Fitness for surgery | |
| Consent form | |

| **Pre-operative** | | | | | |
|---|---|---|---|---|---|
| Ligament laxity | AP | | | ML | |
| Swelling measurement | 1 | 2 | 3 | 4 | 5 |
| Stiffness | flexion | | | extension | |
| Mental state | anxiety | | | depression | |
| Function | stick | | | ADL's | |
| KSS score | | | | | |
| Oxford knee score | | | | | |
| SF-36 score | | | | | |
| Pain Score (VAS) | | | | | |
| Leg legth discrepancy | | | | | |
| Quadriceps strength | | | | | |
| Neurology | | | | | |
| Vascular | | | | | |
| Back motion | | | | | |
| Weight / BMI | | | | | |
| Status of other knee | | | | | |

| **Pre-operarative plan** | |
|---|---|
| Radiographic findings | |
| Deformity | |
| Alignment | |
| Bone stock | |
| Patella height | |
| Templating | |

| **Perioperative** | |
|---|---|
| Antibiotics | |
| Antithrombosis (mechanical) | |
| Antithrombosis (chemical) | |
| Preemptive Analgesia | |
| GA / Regional | |
| Spinal / epidural | |
| Nerve blocks | |
| Laminar flow | |

| **Intraoperative** | |
|---|---|
| Surgeon | |
| Assistant | |
| Approach | |
| Deformity | |
| Bone loss | |
| Osteophytes | |
| Balancing | |
| PCL | |
| Prosthesis | |
| Patella | |
| Tourniquet | |
| Tranexamic acid | |
| Drain | |
| Blood loss | |
| Local anaesthetic | |
| 'Cocktail' injection | |
| Closure | |
| Dressing | |
| Range of motion | |
| Difficulty | |

| **Postoperative** | **Dose, duration** | | | |
|---|---|---|---|---|
| Analgesia | IV | | Epidural | |
| | IM | | N block | |
| | Oral | | NSAID | |
| Compression | | | | |
| Splinting | extension | | flexion | |
| Ice packs | | | | |
| Antibiotics | | | | |
| Antithrombotics | | | | |

| **Rehabilitation in ward** | **Day 1** | **Day 2** | **Day 3** | **Day 4** | **Day 5** |
|---|---|---|---|---|---|
| Mobilisation | | | | | |
| Weight-bearing | | | | | |
| ROM | | | | | |
| Swelling | | | | | |
| Pain (VAS) | | | | | |

| **Follow-up measurements** | **Week 2** | **Week 6** | **Month 3** | **Month 6** | **Year 1** |
|---|---|---|---|---|---|
| Functional Scoring (KSS) | | | | | |
| Radiographic scoring (KSS) | | | | | |
| Pain score (VAS) | | | | | |
| Swelling measurement | | | | | |
| ROM (F/E) | | | | | |
| Inflammatory markers | | | | | |
| X Ray | | | | | |

| **Complications** | **Date and details** |
|---|---|
| Wound dehiscence | |
| Wound drainage | |
| Deep Infection | |
| Prolonged Swelling | |
| Prolonged Pain | |
| Stiffness | |
| MUA required | |
| Nerve palsy | |
| Loosening | |
| Fracture | |
| Other Systemic | |

CLINICAL ARTICLE

# Knee pain, swelling and stiffness after total knee replacement: a survey of South African knee surgeons

BR Garrett, MBBCh (Wits)
Registrar, Department of Orthopaedics

J Walters, FC(Orth) SA
Professor and Head of Orthopaedics
Groote Schuur Hospital, Department of Orthopaedic Surgery, University of Cape Town, Cape Town, South Africa

Reprint requests:
Dr B Garrett
Department of Orthopaedic Surgery
H49 OMB
Groote Schuur Hospital
7925 Observatory
Cape Town

## Abstract

Knee pain, swelling and stiffness after total knee replacement (TKR) surgery are well-recognised complications. However, in some cases, despite investigation, the cause may be unexplained. This study, using a questionnaire sent to South African orthopaedic surgeons, examined the perceived incidence of unexpected knee pain and swelling after a straightforward TKR, aiming to identify possible associated or contributory factors. Of the 61 respondents, two-thirds had more than 10 years' experience and close to three-quarters performed 20 or more TKRs per annum. Less-experienced surgeons report a greater frequency of unexpected pain than more-experienced surgeons (90% vs 53%) ($p<0.05$). Similarly, surgeons using the visual analogue scale (VAS) to assess a patient's pain also have a greater awareness of unexpected pain. Two-thirds of surgeons reported finding more pain than had been anticipated in between 6% and 20% of their cases. Unexpected swelling is also an issue. Approximately one half of surgeons could identify the cause for pain in less than 5% of their cases. Surgeons who use drains and have shorter surgical times reported a reduced incidence of unexpected pain and swelling, although this did not reach statistical significance. No suggestive relationships were found for other peri-operative parameters such as analgesic regimens, thrombo-embolic prophylaxis or mobilisation protocols.

## Introduction

Total knee replacement (TKR) surgery has revolutionised the care of patients suffering from degenerative or inflammatory arthritis of the knee. The goal of treatment is a pain-free, stable knee joint which allows good function for activities of daily living.

There are a myriad causes for a poor outcome. Often the clinical picture is a spectrum of both pain and stiffness, but many authors report one or the other as the predominant symptom. The prevalence of postoperative pain and stiffness varies in the literature. Studies quote figures from 1.1% to 10.8%[1-5] (*Table I*). The overlap between pain and stiffness varies between papers, and there is an inconsistent definition of stiffness which varies from 70° to 95° of flexion.[1-5] Swelling may be associated with both of these groups but it was not reported as an outcome in our literature search.

In the Orthopaedic Department at the University of Cape Town it has been recognised that some patients – for whom the results were anticipated to be excellent after a nominally 'simple and straightforward' TKR – had much more pain and swelling than was expected. This delayed their rehabilitation, decreased their range of motion, prolonged their hospital stay, and correlated with a poor medium-term outcome. For many of them a specific cause for their pain and swelling could not be identified.

**Table I: Prevalence of pain and stiffness reported by surgeons**

| Author | Year | Knees | Outcome: Pain/Stiffness (definition) | % P/S |
|---|---|---|---|---|
| Kim *et al.*[1] | 2004 | 1 000 | Stiffness (<75°) | 1.3% |
| Parvisi *et al.*[2] | 2006 | 10 000 | Stiffness (<90°) | 1.1% |
| Gandhi *et al.*[3] | 2006 | 1 216 | Stiffness (<90°) | 3.7% |
| Scranton[4] | 2001 | 250 | Pain and stiffness (<90°) | 10.8% |
| Yercan *et al.*[5] | 2006 | 1 188 | Pain and stiffness (<95°) | 5.3% |
| Fischer *et al.*[6] | 2007 | 1 024 | Pain and stiffness (<90°) | 6.9% |
| Elson *et al.*[7] | 2007 | 622 | Unexplained pain at 6/12 | 4% |

Whether this is inherent to the patient's response to the surgical assault, or as a result of a preventable cause, are two possible options to explain this phenomenon.

The aim of this study was to assess the perceived incidence of these problems among knee surgeons in South Africa and to see whether any surgical or other peri-operative intervention or variable appeared to play a role in the presence of postoperative pain, swelling and stiffness.

This study was conducted via a survey dealing with peri-operative management practices of South African Orthopaedic Surgeons performing TKRs. A comprehensive questionnaire was sent to members of the South African Orthopaedic Association (SAOA), focusing on the surgeon's perception of unexpected and unexplained postoperative pain and swelling.

Following this, the intention is to perform a prospective study guided by recommendations arising from this survey.

## Materials and methods

A survey of South African knee surgeons was performed using the database for the South African Orthopaedic Association (SAOA). Of the 550 members, 150 were still in training or no longer actively performed knee arthroplasty. One hundred-and-twenty surgeons on the database had incomplete or inaccurate contact email addresses. Thus 280 questionnaires were sent to generalist and specialist surgeons who perform total knee replacements.

### Questionnaire

Following a pilot study assistance for the design and data content was obtained from a biostatistician. The questions covered multiple aspects of peri-operative assessment and care of a patient after a total knee replacement (TKR), including the following: surgeon demographics, implant variations, operative techniques including use of tourniquets, haemostasis and drainage, medical interventions including analgesia, anticoagulation and antibiotic use. The incidence of 'more pain than was expected' and the ability to identify causes for that pain were also examined, as was the occurrence of 'more swelling than was expected' and the assessment of that swelling. The investigation of infection, the mobilisation programme, and the consideration of manipulation for stiffness were also included.

### Survey definitions

For the purpose of this study the following definitions of terms used as relating to symptomatology apply.

'Unexpected' implies a subjective assessment of such occurrence in the experience of the observer.

'Unexplained' implies a symptom which cannot be shown to have a demonstrable cause.

### Measurement

The questionnaire was converted into an Excel-based spreadsheet for email communication and online completion. The respondents were grouped according to their response to the questions on pain and swelling. Subsequent comparative analysis of the variations in peri-operative parameters in these groups was then performed.

## Results

Of the 280 questionnaires sent out, 61 respondents returned a completed questionnaire (22%). Thirty-two per cent of the respondents were also members of the South African Knee Society. Ninety-two per cent (56/61) of reporting surgeons practise in the private sector. Less-experienced surgeons (<10 years) comprised 34% (21/61) and surgeons with more than 10 years' experience made up 66% (40/61).

The number of cases performed each year was also taken as a measure of experience, with 17 (28%) performing fewer than 20 TKRs per year. Only eight (13%) 'high-volume' surgeons performed more than 100 cases per year. Thirty-five per cent performed 20–50 cases per year, and 23% between 50 and 100 cases per year.

Surgeons were asked to indicate the technique/implant which they used most frequently. Sixty per cent used mobile bearing knees. Twenty per cent retained the posterior cruciate ligament. Only 18% routinely resurfaced the patella. Computer-assisted surgery was regularly used by 15% of respondents for their cases. Sixteen per cent of surgeons perform an average knee replacement in under an hour, with only another 16% typically taking longer than 90 minutes. Only 10% of respondents do not use a tourniquet, and 10% do not use drains postoperatively.

All surgeons use prophylactic antibiotics. The majority (95%) choose a first-generation cephalosporin.

The duration of use varies; 7% give a second dose at 8 hours, 66% continue for 24 hours and 26% for more than 24 hours postoperatively.

Thrombo-embolic prophylaxis is often performed in a combined synergistic approach. Eighty-five per cent of surgeons use low molecular weight heparin (LMWH), 10% use Warfarin and 5% use aspirin as chemical prophylaxis. Mechanical prophylaxis with foot pumps is used by 72% and graduated compression stockings by 80%. Of those using LMWH, 50% prescribe it for less than the recommended 10 days, and 30% use it for longer than 21 days. Twenty-five per cent commence it on the day before surgery, 50% on the day of surgery and 25% on the day following surgery.

For postoperative pain and swelling, all surgeons use oral preparations, 80% use NSAIDs, 70% use IM injections and 65% prefer IV opioid/PCA pumps. Only 11% use a systemic steroid. None use intra-articular steroids or intra-articular pumps. Roughly equal numbers use each of the regional anaesthetic techniques; 47% prefer epidurals and 43% employ nerve blocks. Twenty-six per cent use local anaesthetic in the wound, and 19% of surgeons use a local 'cocktail' preparation.

For assessment of patients' pain, 23% used a scoring system such as the Visual Analogue Scale (VAS). The remainder employs clinical judgment. For assessment of swelling, 28% used a tape-measure to assess swelling. No other modalities such as volumetry, ultrasound or MRI were used.

With the benefit of hindsight, a more detailed interrogation should have been undertaken with regard to stiffness. However, 50% of surgeons refer patients for a pre-operative physiotherapy programme, presumably to maximise their pre-operative range of knee motion. Postoperatively, 25% of respondents mobilise their patients on day 1, 50% on day 2 and 25% on day 3. Sixty per cent of surgeons will allow their patients home with <90° flexion.

With regard to performing a manipulation under anaesthesia (MUA) for a stiff knee, 60% will consider an MUA before 6 weeks, 25% only consider an MUA after 3 months and 15% do not consider an MUA to be necessary at all.

Only one respondent claimed never to see more pain than expected in the postoperative phase; 33% seldom (1-5% of cases) saw more pain than they expected, whereas 60 % reported an incidence of 6-20% unexpected postoperative pain. Seven per cent had a high incidence (21-80%) of unexpected pain in their patients (*Figure 1*).

This unexpected pain is essentially unexplained in the majority of cases, as half the respondents fail to find a cause more than 95% of the time. Thirty-three per cent sometimes find a cause, and only 17% are satisfied that they mostly find a cause for this postoperative pain (*Figure 2*).

Half the respondents seldom find unexpected postoperative swelling to be a problem, but the other 50% do find swelling to be more than they expected in between 6% and 20% of their cases (*Figure 3*).

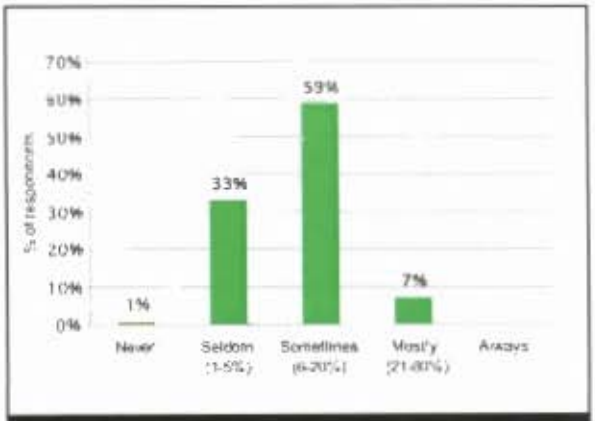



**Figure 1: Occurrence of unexpected pain after TKR**

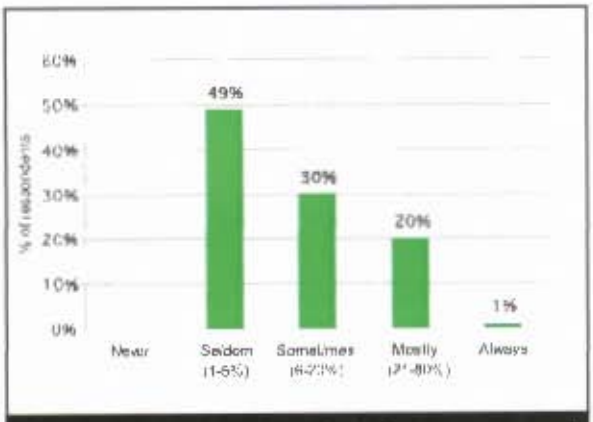



**Figure 2: Cause identified for unexpected pain**

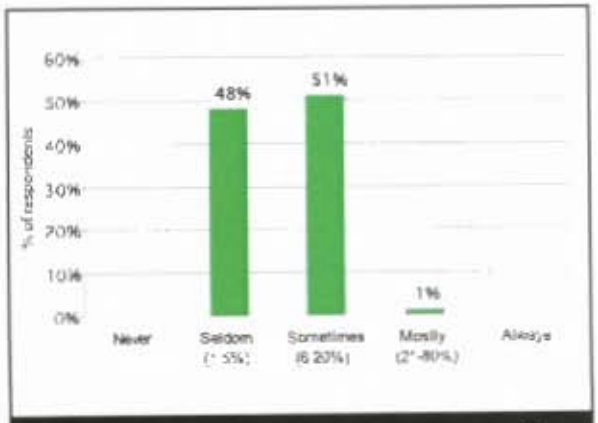



**Figure 3: Occurrence of unexpected swelling post TKR**

For postoperative pain and swelling, all surgeons use oral preparations, 80% use NSAIDs, 70% use IM injections and 65% prefer IV opioid/PCA pumps

## Analysis of results

Comparative analysis with 2 x 2 tables and the Chi-squared test of association were used. A p-value of <0.05 was considered to indicate statistical significance. For the purposes of this study, respondents were divided into two groups: those reporting a low incidence of unexpected pain, and those reporting a relatively high incidence of unexpected pain. A similar segmentation was performed for swelling. Thus of the respondents:

- 21 (33%) reported a low incidence of unexpected pain in their patients (<5% of cases)
- 40 (66%) reported a higher incidence of unexpected pain in their patients (>6% of cases)
- 32 (52%) reported a low incidence of unexpected swelling (<5% of cases)
- 29 (48%) reported a higher incidence of unexpected swelling (>6% of cases).

The data was analysed for trends or significant differences between the groups with respect to demographics, surgical techniques and other peri-operative variables.

Less experienced surgeons reported a higher incidence of unexpected pain: those who performed fewer than 20 cases per year (76%) vs those who performed more than 100 cases per year (22%) ($p<0.05$). Similarly, of those who had <10 years experience, 90% reported unexpected pain vs 53% of those who had >10 years experience ($p<0.05$) (*Figure 4*). This association was statistically significant.

The surgeons who took longer to complete a TKR also reported a higher incidence of unexpected pain: 80% of surgeons who took longer than 90 minutes were in the group with a higher incidence of unexpected pain ($p>0.05$) (*Figure 5*).

The surgeons who used a VAS scoring system for pain assessment reported a higher incidence of unexpected pain from their patients: 86% vs 60% of those only using clinical estimates ($p>0.05$) (*Figure 6*).

Suggested causes for unexplained pain are recorded in *Figure 7*, with retained haematoma considered the most likely.

The surgeons whose patients had a relatively high incidence of unexpected pain also reported a higher incidence of unexpected swelling (87%), i.e. more often than not a higher incidence of unexpected pain is associated with more (unsuspected) swelling. Fifty-nine per cent of those who reported a low incidence of pain also had a low incidence of swelling ($p<0.05$) (*Figure 8*).

A result which is somewhat counter-intuitive is the fact that swelling was not seen to be as much of a problem for the inexperienced surgeons as for the experienced surgeons. Only 29% of surgeons doing <20 cases/year were in the group reporting a higher incidence of swelling, but 78% of those doing >100 cases/year were in that group ($p<0.05$).

The surgeons who did not use drains also reported a higher incidence of pain: 86% vs 63% were in the high incidence group ($p>0.2$). This group of surgeons also reported more swelling (71% vs 44%) (*Figure 9*).

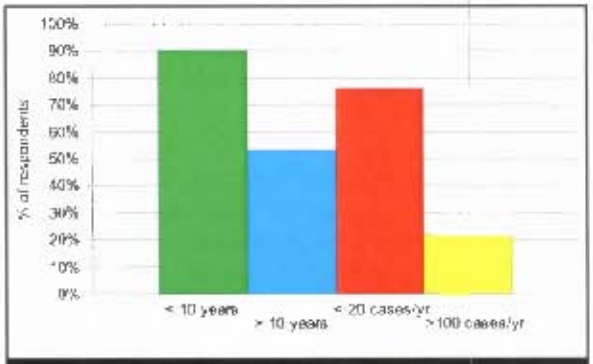



**Figure 4: Reported occurrence of higher frequency of unexpected pain relating to surgeon experience**

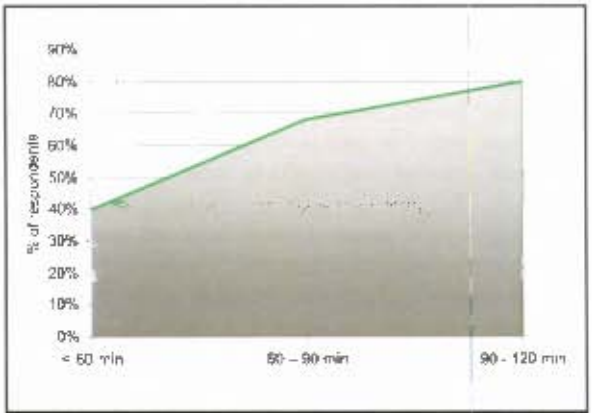



**Figure 5: Surgical time related to higher frequency of unexpected postoperative pain**

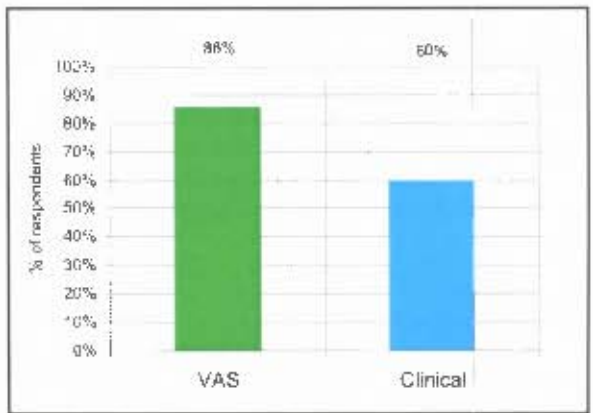



**Figure 6: Incidence of higher frequency of pain related to evaluation of pain**

Less experienced surgeons reported a higher incidence of unexpected pain and surgeons who took longer to complete a TKR also reported a higher incidence of unexpected pain

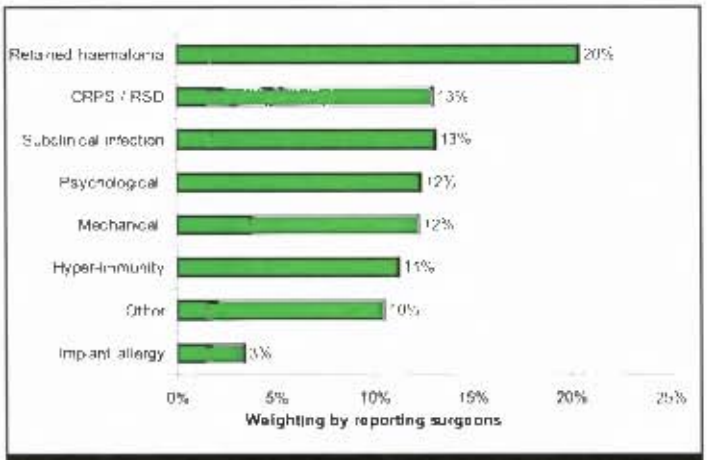



**Figure 7: Reported possible causes for unexplained pain**

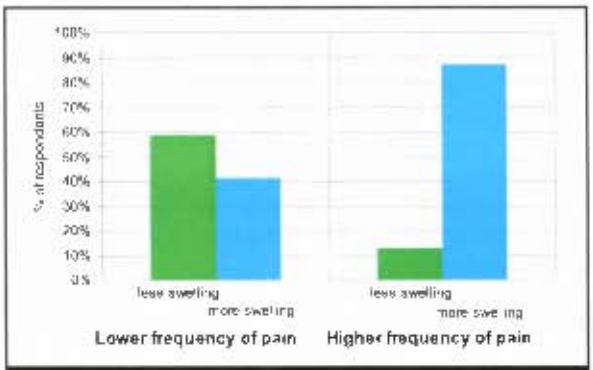



**Figure 8: Incidence of both pain and swelling**

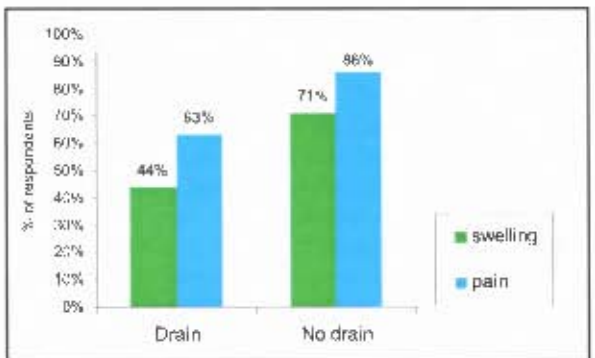



**Figure 9: Influence of drains on reported higher frequency of unexpected pain and swelling**

Ninety per cent of those who used local peri-articular injections with a 'cocktail' of agents were in the higher incidence group of reported unexpected pain. This is a notable deviation, although not statistically significant, as no other analgesic regimens differed from the average response of 33% (low pain incidence) vs 66% (higher pain incidence) (*Figure 10*).

For all the other parameters investigated there were no marked positive or negative deviations from the mean to warrant further evaluation or discussion.

## Discussion

As this survey shows, TKR surgery is not without unexplained problems. While the assessment of symptoms is mostly subjective, all surgeons, to a greater or lesser degree, were surprised by the amount of pain or swelling which they did not expect to encounter after the procedure.

Less experienced surgeons report a higher incidence of unexpected pain when compared to more experienced surgeons. While this is most likely due to the fact that they have not yet recognised that this procedure evokes more pain than they expect, it is possible that their surgical experience may play a role, although there was no difference in lengths of theatre time between the two groups.

The more-experienced surgeons report a higher incidence of unexpected swelling when compared to the inexperienced surgeons. This may reflect a greater awareness for excessive postoperative swelling, or it may represent a difference in the level of expectation between these two groups of surgeons.

In general, the local tissue response is proportional to the degree of tissue trauma and is initiated by the clotting cascade resulting in the migration of inflammatory cells to the site of injury. Cytokines are the major mediators and maintainers of the inflammatory response.[4] Interleukin-1 (IL-1) and tumour necrosis factor-α (TNF-α) are released by activated macrophages and monocytes which stimulate release of IL-6 which is the main cytokine responsible for the systemic changes known as the acute-phase response. Cytokine levels are maximal at 24 hrs and remain elevated for 48–72 hrs.[5,7]

Postoperative swelling is a 'normal' occurrence due to the inflammatory response to surgical trauma, but mediators should return to baseline levels by day 7. Swelling does not always follow. This is probably due to generalised tissue oedema, and impaired lymphatic and venous drainage, but it may also be due to retained haematoma.

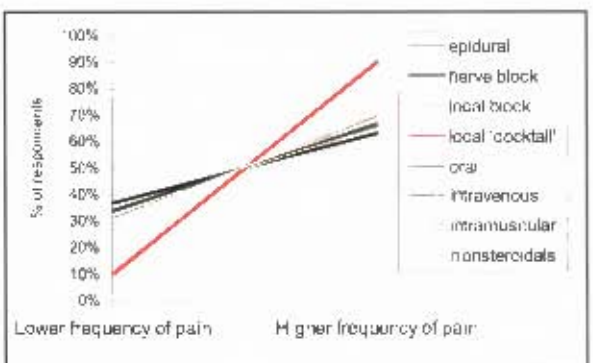



**Figure 10: Analgesic use with respect to reported frequency of unexplained pain**

Wound drainage is very popular despite several studies showing no difference in outcomes whether or not drains are used.[11-14] This current study suggests that those who use drains have a lower perceived incidence of pain and swelling in their patients. Tourniquets have also not been shown to have a proven beneficial outcome,[15-17] and yet 90% of respondents use them routinely.

Excessive postoperative pain inhibits motion leading to intra-articular and periarticular adhesions which in turn lead to an inflammatory reaction and more pain. Heuleu and Neyret[18] reported that, with proper pain control, the incidence of manipulation after TKR decreased from 9% to 1%.

Acute pain results from mechanically-, chemically- and thermally-induced damage to tissue integrity. Skin, capsule, synovium and bone nociceptors are all activated in response to noxious stimuli, and lead to neurotransmitter release in dorsal horn nuclei of the spinal cord, and relay information via the thalamus to the cerebral cortex.[19,20]

The understanding of the mechanisms of pain is becoming clearer, and more emphasis is being placed upon pre-emptive and multimodal analgesia with the focus on local and regional techniques. Multimodal analgesia addresses multiple mechanisms of pain, and has been shown to decrease requirements and side effects of individual agents.[21,22]

Local 'cocktail' injections are gaining in popularity and are being used to good effect in New York by Ranawat *et al.*[23] This current study showed that surgeons who identified pain as a postoperative problem more frequently employed this modality. Although not interrogated by the questionnaire, it is likely that these surgeons employ this technique because of their increased awareness for the need to obtain better pain control in the postoperative period.

It has been shown in reports that unexplained pain varies from 4% to 18% at 6 months. Elson and Brenkel[7] evaluated their series of 622 TKRs and found an incidence of 4% unexplained pain at 6 months. They report that half of these patients recovered over the subsequent 5 years, and that surgery for unexplained pain had a poor outcome.

Brander *et al.*[24] show that of the patients with significant pre-operative pain (72%), almost one-quarter (22.6%) still had excessive pain by 3 months, which reduced to 18.4% at six months postoperatively. However at 12 months, one in eight patients (13%) still has unexplained pain. After 5 years, while nearly all of these patients were satisfied; 5% still had unexplained pain.[25]

Perhaps such discrepant reporting, from the incidences reported in *Table I*, is due to the lack of a standardised scoring system or inadequate assessment of patients' pain, swelling and function. In our survey less than a quarter of surgeons currently attempt to assess pain using a validated system, such as the VAS. When the VAS was used, these surgeons reported a higher level of unexpected pain in their patients compared to the subjective group, perhaps demonstrating that the more one measures an outcome, the higher the reported incidence of that outcome – the classic 'Hawthorn effect'!

Similarly, only 28% of reporting surgeons objectively measure postoperative swelling with a tape-measure – the remainder being subjective assessments. A more accurate, reliable, reproducible method for evaluating postop swelling is required, but no suggestions were forthcoming from this questionnaire. Tape measures are often inaccurate and operator-dependent. Water volumetry is the gold standard, although its use is impractical in the postoperative setting.[26] An opto-electric device, the 'peropter' has been shown to be comparable, and laser scanning and bio-electrical impedance meters have been used but are not readily available.[27]

The definition of stiffness varies. An acceptable flexion range may be 75° for one report, yet 95° for another. Flexion to 90° seems to be the most commonly recognised limit of acceptability.[1-6] Unfortunately, due to limitations in the questionnaire design, the correlation between swelling and stiffness could not be made from the data obtained from this study.

Stiffness may be due to a mechanical restraint resulting from imperfect surgical techniques, component malpositioning, or soft tissue constraint. It may be due to muscle tightness from prolonged disuse, or muscle inhibition from painful stimuli. It may be due to intra-capsular adhesions and fibrous band formation (*Table II*).[3-5,29-32]

Manipulation is an effective form of management for the stiff TKR, although care needs to be taken not to rupture the patella tendon or cause a fracture. Both Daluga *et al.*[33] and Yercan *et al.*[5] have shown that an earlier manipulation under anaesthesia (MUA), less than 3 weeks postoperatively, yields better results in the long-term than those done between 3 weeks and 3 months. Sixty per cent of respondents reported performing an MUA before 6 weeks. Twenty-five per cent preferred to wait 3 months. There was no difference between these groups with respect to the reported occurrence of pain and swelling.

The results of this survey show a marked variation in peri-operative management options among surgeons, as is demonstrated by the differing responses with respect to analgesic regimens, thrombo-embolic schedules, and rehabilitation programmes.

Many questions, including the following, are raised by the findings of this study. In the uncomplicated TKR how much pain and swelling and stiffness should one expect? When does pain and swelling subside? At what rate should the range of motion return? How frequently can a cause simply not be found despite rigorous and exhaustive investigation? When we can't explain it, what *is* causing it?

**Manipulation is an effective form of management for the stiff TKR, although care needs to be taken not to rupture the patella tendon or cause a fracture**

**Table II: Possible causes of pain and stiffness after knee replacement surgery**

| Common articular causes of pain | Causes of stiffness |
|---|---|
| Infection | Pre-operative stiffness |
| Prosthetic loosening | History of previous surgery |
| Instability | Excessive pain |
| Component failure | Poor patient motivation |
| Patello-femoral disorders | Reflex sympathetic dystrophy |
| Peri-prosthetic osteolysis | Heterotopic ossification |
| | PCL tightness |
| **Common non-articular causes of pain** | Instability |
| Hip disease | Peripheral obesity |
| Spine disease | Technical error |
| Vascular disease | Anteriorly shaped femoral cuts |
| Tendonitis/bursitis | Improper component position |
| Reflex sympathetic dystrophy | Oversized components |
| Psychological illness | |
| | Patello-femoral dysfunction |
| **Less common causes of pain** | Patella baja |
| Patella clunk syndrome | Joint line mismatch |
| Lateral patella facet syndrome | Overstuffing |
| Soft tissue impingement syndromes | Osteophytes |
| Fabellar impingement | |
| Popliteus tendon dysfunction | |
| Tibial component overhang | |
| Heterotopic ossification | |
| Recurrent haemarthrosis | |
| Particulate-induced synovitis | |
| Cutaneous neuroma | |

### Survey limitations

The low rate of returned questionnaires (22%) weakens the power of this study; however, one third of the Knee Society members approached did complete questionnaires. The reluctance to complete forms, difficulties with the online Excel familiarity and 'too many questions' are possible reasons for this occurrence.

While the investigators were not 'blind' to respondents' names – leading to possible concerns around prejudice/bias – this information was not used for comparison of individual surgeons, and did not alter the interpretation of results.

With the benefit of hindsight some additional questions, in particular relating to stiffness and its relationship with pain, would have been added. Also, the temporal occurrence of these complications was not adequately delineated, with perhaps an overlap in interpretation of questions.

## Conclusions

From this survey of South African surgeons of varying degrees of experience, perspectives around the prevalence and potential causes of unexpected pain, swelling and stiffness after total knee replacement procedures, it seems evident that:

- Unexpected pain and corresponding swelling and stiffness are indeed a problem, and not uncommon. More often than not such pain and swelling cannot readily be explained.
- Less experienced surgeons – whether in years or number of TKR operations performed each year – report higher incidences of unexpected pain. However, more experienced surgeons had greater awareness of unexpected swelling.
- Reduced levels of unexpected pain and swelling are reported by surgeons who use drains, and have shorter surgical procedure times.
- Surgeons employing the 'local cocktail injection' technique report a higher incidence of unexpected pain than those who do not.
- Among those employing objective quantitative evaluation methods (such as the VAS or a measuring tape) a higher incidence of unexpected pain and swelling are reported.
- Current reported operation and peri-operative interventions vary widely making interpretation difficult.

## Acknowledgements

I am indebted to the surgeons who gave of their time to complete the questionnaire and participate in this survey. Thank you.

*Approval for the study was obtained from the Surgical Departmental Research Committee and the Ethics Committee.*

*The content and preparation of this paper is the sole work of the authors. No benefit of any form was or will be received from a commercial party related directly or indirectly to the subject of this article.*

## References

1. Kim J, Nelson CL, Lotke PA. Stiffness after total knee arthroplasty: prevalence of the complications and outcomes of revision. *J Bone Joint Surg* 2004;**86A**:1479.
2. Parvizi J, Tarity TD, Steinbeck MJ, Politi RG, Joshi A, Purtill JJ and Peter F. Management of stiffness following total knee arthroplasty. *J Bone Joint Surg Am* 2006;**88**:175-81.
3. Gandhi R, de Beer J, Leone J, Petruccelli D, Winemaker M, Adili A. Predictive risk factors for stiff knees in total knee arthroplasty. *J Arthroplasty* 2006;**21**:46-52.
4. Scranton PE Jr. Management of knee pain and stiffness after total knee arthroplasty. *J Arthroplasty* 2001;**16**:428-35.
5. Yercan HS, Sugun TS, Bussiere C, *et al.* Stiffness after total knee arthroplasty: prevalence, management and outcomes. *Knee* 2006;**13**:111-17.
6. Fisher DA, Dierckman B, Watts MR, Davis K. Looks good but feels bad: Factors that contribute to poor results after total knee arthroplasty. *J Arthroplasty* 2007; **22**(6) Suppl.2:39-42.
7. Elson DW, Brenkel IJ. A conservative approach is feasible in unexplained pain after knee replacement: a selected cohort study. *J Bone Joint Surg [Br]* 2007;**89-B**:1042-5.
8. Choileain NN, Redmond HP. Cell response to surgery. *Arch Surg* 2006;**141**:1132-40.
9. Desborough JP. The stress response to trauma and surgery. *Br J Anaesth* 2000;**85**:109-17.
10. Kohl BA, Deutschman CS. The inflammatory response to surgery and trauma. *Curr Opin Crit Care* 2006;**12**:325-32.
11. Adalberth G, Bystrom S, Kolstad K, Mallmin H, Milbrink J. Postoperative drainage of knee arthroplasty is not necessary. *Acta Orthop Scand* 1998;**69**(5):475-8.
12. Cobb JP. Why use drains? *J Bone Joint Surg (Br)* 1990;**72**(6):993-5.
13. Beer KJ, Lombardi AVJ, Mallory TH, Vaugan BK. The efficacy of suction drains after routine total joint arthroplasty. *J Bone and Joint Surg (Am)* 1991;**73**(4):584-7.
14. Ritter MA, Keating EM, Fais PM. Closed wound drainage in total hip or total knee replacement. A prospective, randomized study. *J Bone Joint Surg (Am)* 1994;**76**(I):35-8.
15. Wakankar HM, Nicholl JE, Koka R, D'Arcy JC. The tourniquet in total knee arthroplasty. *J Bone Joint Surg [Br]* 1999;**81-B**:30-3.
16. Klenerman L. Is a tourniquet really essential for knee replacement? *J Bone Joint Surg [Br]* 1995;**77-B**:174-5.
17. Abdel-Salam A, Eyres KS. Effects of tourniquet during total knee arthroplasty: a prospective randomised study. *J Bone Joint Surg [Br]* 1995;**77-B**:250-3.
18. Heuleu JN, Neyret P. Conduite a tenir devant les raiders postoperatoires du genou. *Rev Chir Orthop Repar Appar Mot* 2002;**88**(suppl.5):1S27-51.
19. Ekman EF, Koman LA. Acute pain following musculoskeletal injuries and orthopaedic surgery. Mechanisms and management. *J Bone Joint Surg Am* 2004;**86**:1316-27.
20. Reuben SS, Buvanendran A. Preventing chronic pain after orthopaedic surgery. *J Bone Joint Surg Am* 2007;**89**:1343-58.
21. Skinner HB. Multimodal acute pain management. *Am J Orthop* 2004;**33**(5 Suppl):5.
22. Peters CL, Shirley B, Erickson J. The effect of a new multimodal peri-operative anesthetic regimen on postoperative pain, side effects, rehabilitation, and length of hospital stay after total joint arthroplasty. *J Arthroplasty* 2006;**21**(6Suppl2):132.
23. Ranawat AS, Ranawat CS. Pain management and accelerated rehabilitation for total hip and total knee arthroplasty. *J Arthroplasty* 2007;**22**(7)Suppl.3:12-5.
24. Brander VA, Stulberg SD, Adams AD, *et al.* Predicting total knee replacement pain: a prospective, observational study. Clin Orthop 2003;**416**:27-36.
25. Brander V, Gondek S, Martin E, Stulberg SD. Pain and depression influence outcome 5 years after knee replacement surgery. *Clin Orthop* 2007;**464**:21-6.
26. Perrin.M, Guex J. Edema and leg volume: Methods of assessment. *Angiology* 2000 Jan;**51**:1,9-12.
27. Manetal I. Validity and reliability of the perometer. *Clin Physiol Funct Imaging* 2004:**24**:352-8.
28. McKinnon J. Measurement of limb volume: Laser scanning versus volume displacement. *Journal of Surgical Oncology* 2007;**96**:381-8.
29. Dennis DA. Evaluation of painful total knee arthroplasty. *J Arthroplasty* 2004:**19**(4)Suppl.1:35-40.
30. Mandalia V, Eyres K, Schranz P, Toms AD. Evaluation of patients with a painful total knee replacement. *J Bone Joint Surg [Br]* 2008;**90-B**:265-71.
31. Toms AD, Mandalia V, Haigh R, Hopwood B. The management of patients with a painful total knee replacement. *J Bone Joint Surg [Br]* 2009;**91-B**:143-50.
32. Laskin RS, Beksac B. Stiffness After Total Knee Arthroplasty. *J Arthroplasty* 2004;**19**(4).Suppl.1:41-6.
33. Daluga D, Lombardi Jr AV, Mallory TH, *et al.* Knee manipulation following total knee arthroplasty. Analysis of prognostic variables. *J Arthroplasty* 1991;**6**:119.