MENTORS IN ORTHOPEDICS

HIGH TIBIAL OSTEOTOMY: WHY WE CHOOSE A LATERAL CLOSING WEDGETECHNIQUE AND WHAT IS OUR “IDEAL” PATIENT?

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SUMMARY

Background: High tibial osteotomy (HTO) is indicated for medial compartment knee osteoarthritis in young, active patients to delay total knee replacement (TKR), which carries higher failure rates in this demographic. The procedure aims to redistribute mechanical loading from the degenerated medial compartment to the preserved lateral compartment.

Objective: This article describes a specific lateral closing wedge HTO technique and evaluates preoperative predictors of long-term clinical success and survivorship.

Key Points: The described technique utilizes a modified Coventry approach with a Krakow staple for stabilization, facilitating primary bone healing and early mobilization. In cases of medial collateral ligament pseudolaxity, a combined lateral closing and medial opening wedge modification is employed. A prospective 10-year study of 95 patients demonstrated an overall survivorship of 79% at 10 years. Three preoperative variables were significantly associated with superior outcomes: age under 55 years, body mass index (BMI) below 30 kg/m^2, and a Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score exceeding 45. Patients meeting these "ideal" criteria achieved a 97% survivorship rate at 10 years, compared to 69% for those with suboptimal preoperative profiles.

Conclusion: Lateral closing wedge HTO provides durable functional improvement and high patient satisfaction. Precise patient selection based on age, BMI, and preoperative functional scores is essential to optimize long-term survivorship and clinical outcomes.

KEYWORDS

Osteotomy; Tibia; Osteoarthritis, Knee; Genu Varus; Bone Staples

INTRODUCTION

High tibial osteotomy (HTO) is a well-established surgical technique for the management of medial compartment osteoarthritis of the knee in the young, active patient; in this group, partial and total knee replacements are reported to have high failure rates [1]. The purpose of HTO is to shift the lower limb mechanical axis laterally to redistribute weight-bearing forces away from the worn medial compartment and through the preserved lateral compartment (Figure 1). This relieves pain and can encourage fibrocartilagenous regrowth over the eburnated medial femoral condyle. When successful, HTO permits high levels of activity, has excellent long term outcomes, and is readily revised to TKR if required. Furthermore, TKR performed after HTO has similar outcomes to primary TKR [2].

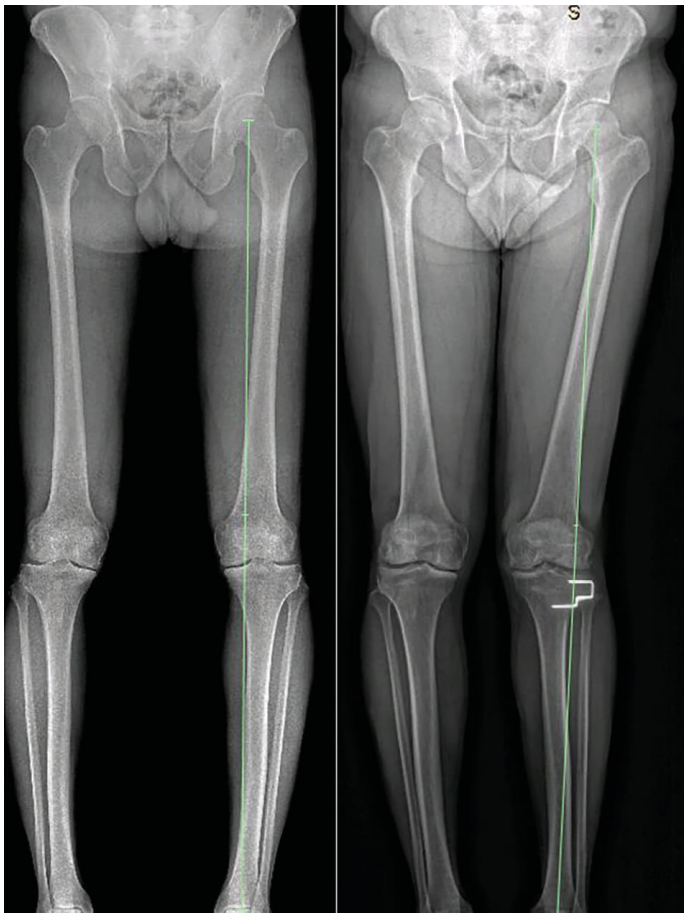

Figure 1: Preoperative (1a) and post-operative (1b) XR after closing wedge HTO.

In this article we will outline our favoured surgical technique for HTO, including a rationale for our choice, and then provide a detailed description. We will also emphasise our patient selection criteria and present the supporting research.

LATERAL CLOSING WEDGE HIGH TIBIAL OSTEOTOMY

1.Why we choose the lateral closing wedge HTO

A lateral closing wedge high tibial osteotomy is our preferred surgical option - it is an inherently stable osteotomy. There is a large surface area of metaphyseal bone under compression, and this keeps the endosteal bone gap to less than 0.5mm, which allows for primary healing and bone healing by 3-4 weeks. A single metallic Krakow staple avoids the risk of prominent hardware, and bone grafting is not required. A closing wedge HTO is readily converted to TKR, and has outcomes similar to a primary TKR. Finally, it has been shown that closing wedge HTO decreases posterior tibial slope, and produces excellent long term results in the ACL deficient knee [3].

The compared advantages of lateral-closing and medial-opening wedge HTO techniques are presented in Table 1.

Lateral closing wedge	Medial opening wedge
■ inherently stable - compression at osteotomy site with weight bearing and quadriceps/hamstring contraction	■ ability to modify/revise correction angle intra-operatively
■ large contact surface area of metaphyseal cancellous bone, rapid bony healing	■ avoidance of proximal tibiofibular joint disruption or fibular osteotomy
■ small hardware constructs	■ restoration of anatomy with addition of bone to the diseased medial side
■ no need for grafting	■ no muscular dissection
■ tends to decrease posterior slope - good outcomes for those ACL deficient patients	■ single osteotomy
	■ possibility of combination with other procedures
	■ less risk to common peroneal nerve

Table 1: Comparison of advantages of medial opening and lateral closing wedge HTO.

2. How we perform a lateral closing HTO

The technique utilised is a modification of Coventry's original technique [4], which adds bony stabilisation with a metallic Krakow staple and encourages early ROM and mobilisation in a valgising ROM knee brace.

Planning

In the clinic we ensure the patient is suitable - typically the younger, more active patient with medial compartment OA, who experiences pain with medial compartment loading, and has radiographic evidence of >50% medial joint space loss (Figure 2). We exclude patients with symptomatic OA of the lateral compartment, those with inflammatory arthritis, and those with a fixed flexion deformity of >10° or flexion range <90°. Age, weight and WOMAC score are important factors that will be discussed further. It is important to pre-operatively demonstrate the pain experienced with varus loading through the medial (diseased) compartment, and the relief of pain on valgus loading through the lateral compartment; this confirms the suitability of the patient for HTO, and is instructive to the patient. Finally, we assess integrity of the MCL, making note of patients with more than 3mm of laxity to valgus stress.

Figure 2: Typical young patient with isolated medial compartment osteoarthritis and varus malalignment.

Pre-operative planning is undertaken with a long leg weight-bearing alignment film. The width of the plateau is calculated and the current mechanical axis assessed - this is typically medialised in the patient with varus osteoarthritis. Using a transverse axis across the surface of the tibial plateau, and ignoring osteophytes, we calculate the point 40% across the plateau from the lateral margin, and mark this as our intended weight bearing point. Two lines are drawn to this point – first from the femoral head centre, and the second from the middle of the talar dome. The angle thus subtended will be the osteotomy angle, or the angle of the resected bony wedge. The goal is to produce a post-operative weight bearing line that falls through the intended weight bearing point, at 40% laterally on the tibial plateau.

Operative technique

The patient is administered a general anaesthetic, and a foot bolster and side support setup to support the knee at 90° in a supine position. A single dose of prophylactic antibiotics is administered. A thigh tourniquet is applied and the limb exsanguinated.

A posterolateral hockey-stick incision is made adjacent to the fibular head to follow the course of the common peroneal nerve. The initial step is to isolate the nerve, and it is carefully protected throughout the case. The proximal tibiofibular joint is excised, but the soft tissue attachments to the fibula styloid are preserved. To protect the neurovascular structures and soft tissues during the osteotomy, we undertake sub-periosteal dissection of the anterior and posterior aspects of the tibia and place Hohman's retractors around the entire tibia. The first osteotomy is made at the level of the tibiofibular joint, usually 15mm distal to the level of the plateau, and parallel to the joint line. The oscillating saw is stopped short of the far medial cortex is so as to leave an intact "hinge" of cortex and periosteum. An angular jig is set to the planned osteotomy angle and the second (distal) osteotomy completed using the first osteotomy as a reference (Figure 3).

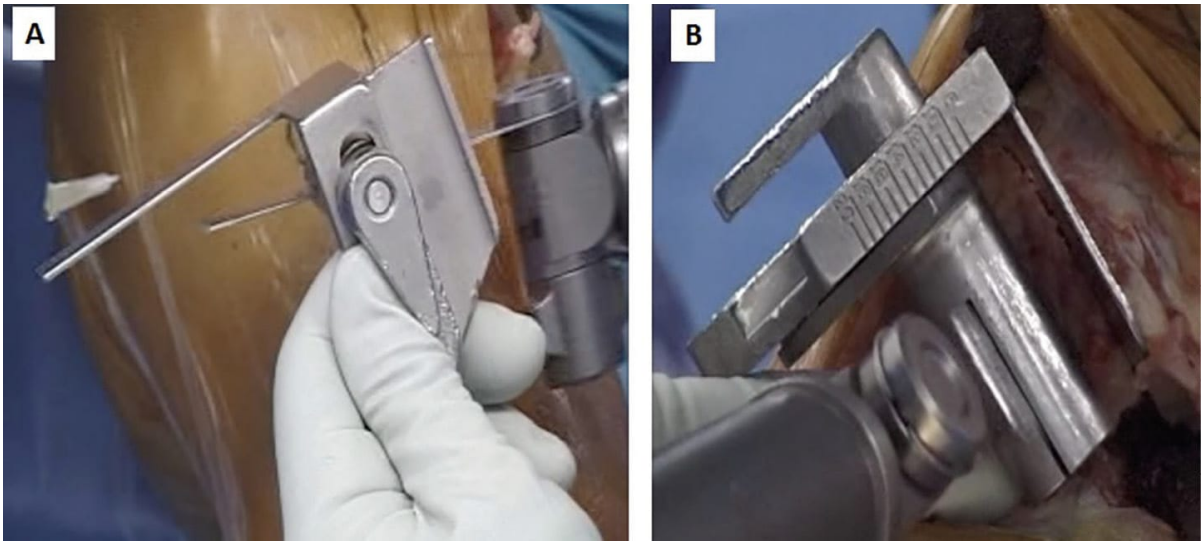

Figure 3: A. The angular jig with sagittal saw is passed through the cutting slot. B. The angular jig is loaded into the first (proximal) osteotomy and guides the second osteotomy.

The wedge is removed and the metaphysis is allowed to close with gentle valgus force (Figure 4). A single metallic Krakow staple (Smith & Nephew, Memphis, Tennessee) applied (Figure 5).

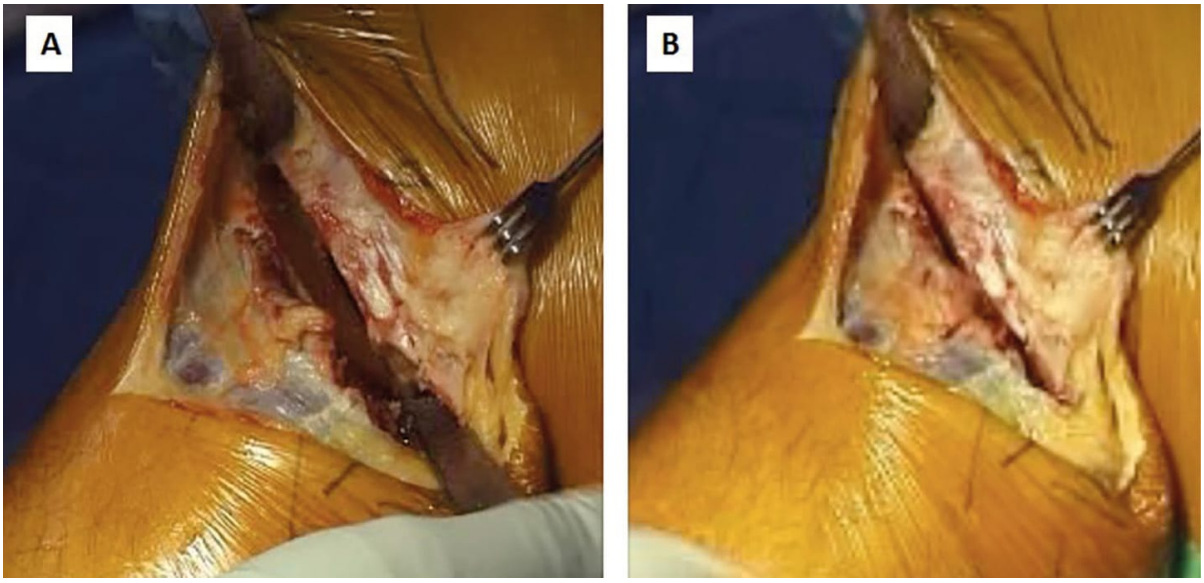

Figure 4: A. The bony wedge is removed and a potential space is created. B. With gentle valgus pressure the osteotomy is compressed and the lateral shift of the mechanical axis is completed.

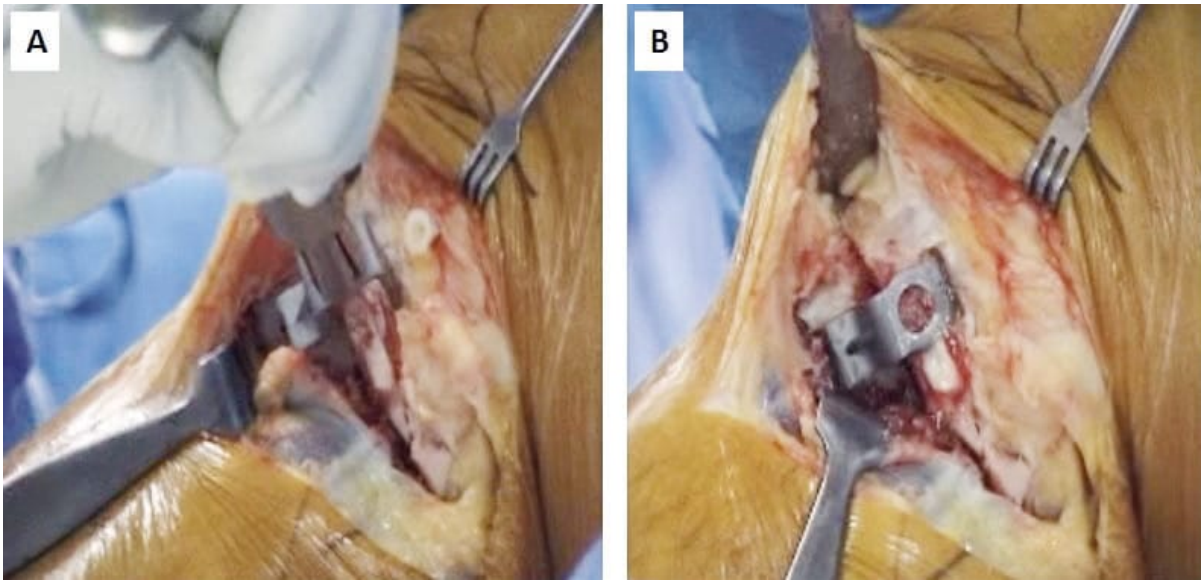

Figure 5: A. Demonstrated positioning of the Krakow staple as valgus pressure is applied. B. Final appearance of the secured osteotomy.

In patients who have more than 3mm of MCL laxity with valgus stress (pseudolaxity), we make two modifications to the technique to restore tension to the MCL (Figure 6). Firstly, the initial osteotomy is completed through the medial cortex, releasing cortical and periosteal constraints but leaving the MCL intact. Secondly, the apex of the second, distal osteotomy is aimed short of the medial cortex (only two-thirds of the transverse width across the tibia). When the leg is now forced into valgus, the effect is a simultaneous closing wedge lateral osteotomy, and an opening wedge medial osteotomy. The mechanical axis is still shifted laterally, and the tension in the medial collateral ligament is restored. No graft is necessary as the medial wedge is small (Figure 7).

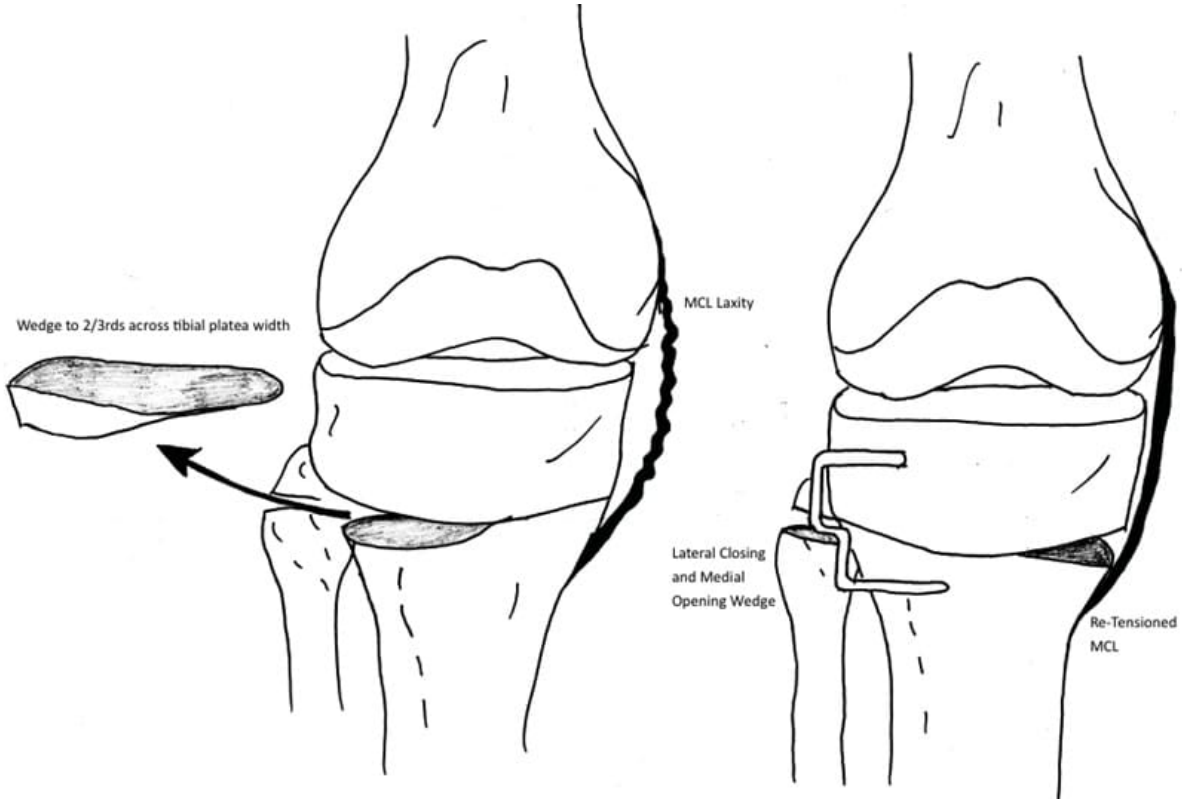

Figure 6: For patients with more than 3mm of MCL laxity, the MCL can be re-tensioned by limiting the osteotomy wedge to the lateral two-thirds of the tibia, hence producing a lateral closing wedge and a medial opening wedge.

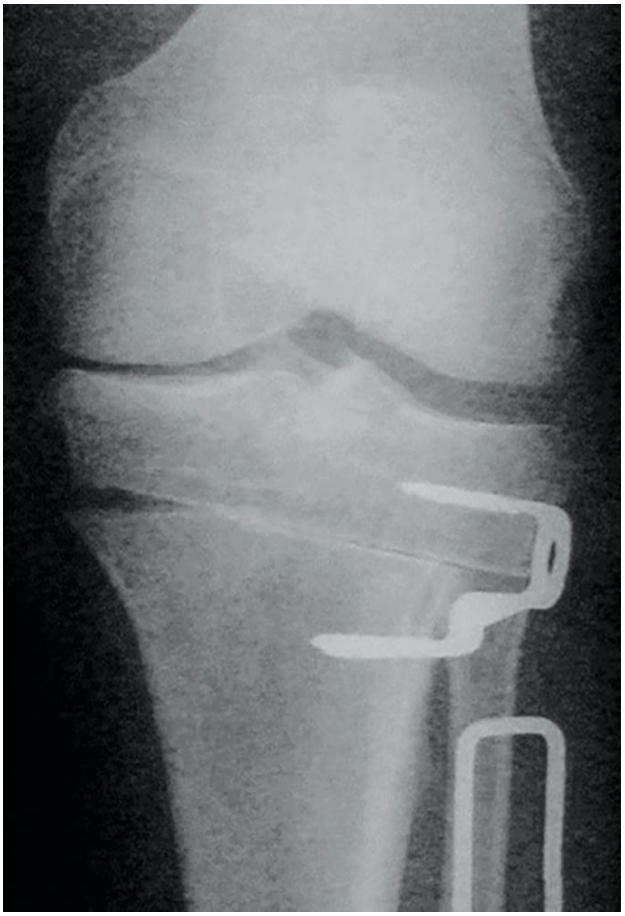

Figure 7: Post-operative XR of a modified HTO designed to re-tension the MCL.

Post Operative Care

The wound is closed in layers and a four-part valgising brace applied for the first 6 weeks, with the range set to 0-90°. The patient is allowed touch-weight bearing for the first two weeks in the brace, and progresses to full weight bearing thereafter. Anti-inflammatory medications are avoided for the first 6 weeks to optimise bony healing.

If the need for revision to TKR arises, staple removal is rarely required, and a single stage procedure with primary components is usually possible.

THE "IDEAL" PATIENT FOR HTO

Good long term outcomes can be achieved with HTO but are highly dependent on careful patient selection. To clarify the pre-operative factors that favour long survivorship, we prospectively assessed outcomes in 100 patients over
10 years following lateral closing wedge HTO, and looked for preoperative predictors of survivorship and functional outcome. Here we outline the study that guided our decision making, and emphasise the key findings [5].

Patient Enrolment

We prospectively enrolled 100 patients who underwent HTO for medial compartment osteoarthritis between 2000 and 2002. Of the 100 subjects, 95 were reviewed at 10 years; 3 were lost to follow up and 2 had deceased. Of the 95 patients included in this analysis, the mean age at surgery was 50 years [range 26-66yrs], the mean BMI was 28 kg/m2 [range 21-39] and the mean preoperative biomechanical axis alignment was 6.0 degrees varus. The median review period was 124 months [range 107-147 months]. Patients were assessed preoperatively, and at 5 and 10 years after surgery: we used patient demographics, surgical details, long-leg alignment films, Western Ontario and MacMaster University osteoarthritis index (WOMAC) score, and Knee Society Scores (KSS).

Predictorsof survivorshipand functional outcome (Table 2)

At the 10 year review, we identified three pre-operative variables that were strongly associated with long term outcome. When compared to those who required no further surgeries over the 10 year period, those who required revision surgery had significantly lower preoperative WOMAC scores (47 vs 65, p=0.0001), a higher mean age (54 vs 49, p=0.006) and a higher mean BMI (30.2 vs 27.9, p=0.005). Furthermore, for those with no further surgery, the overall WOMAC score (maximum 100) improved from a mean of 61 preoperatively to 88 at 5 years (p=0.001) and 84 at 10 years after HTO (p=0.001). Although younger patients had better long term HTO survival, patient reported outcomes at 10 years (WOMAC and KSS) were better in patients >55yrs than the younger cohort <55yrs. Overall, 72 of the 74 patients (97%) were satisfied or enthusiastic with the outcome of their surgery at 10 years and 66 of the 74 (89%) would undergo the procedure again under the same circumstances.

Variables		N	5yr survival (%)	10yr survival (%)	Hazard ratio	95% CI	P value
Age	< 55 yrs	63	97	87	6.5	2.4-17.7	0.001
	≥ 55 yrs	32	69	63			
Preop WOMAC score	≤ 45	19	63	42	10.7	4-28.6	0.001
	> 45	74	93	88			
BMI	< 30	34	90	84	3	1.2-7.6	0.017
	≥ 30	34	82	71			
"Ideal' Candidate	<55yrs + BMI <30 + WOMAC > 45	34	97	97	13.6	1.8-101.8	0.011
	All others	61	80	69			

Table 2: 10 year results of the prospective study of 95 patients after HTO, with subgroup analysis of the three significant pre-operative variables, namely age, WOMAC score and BMI.

Survivorship analysis

When all subjects were pooled, survival of the HTO was 87% at 5 years and 79% at 10 years. At 10 years 74 of 95 patients had no further surgery and 21 subjects had undergone a total knee replacement (at a mean of 5 years). Importantly, the survival rate for the "ideal" candidate (<55yrs + BMI<30 + Preop WOMAC>45) was 97%. In distinction, for patients with unfavourable results in these three variables pre-operatively (>55yrs + BMI >30 + Preop WOMAC < 45) the survival rate was only 69% (Figure 8). There was a significant difference between the groups (P=0.01).

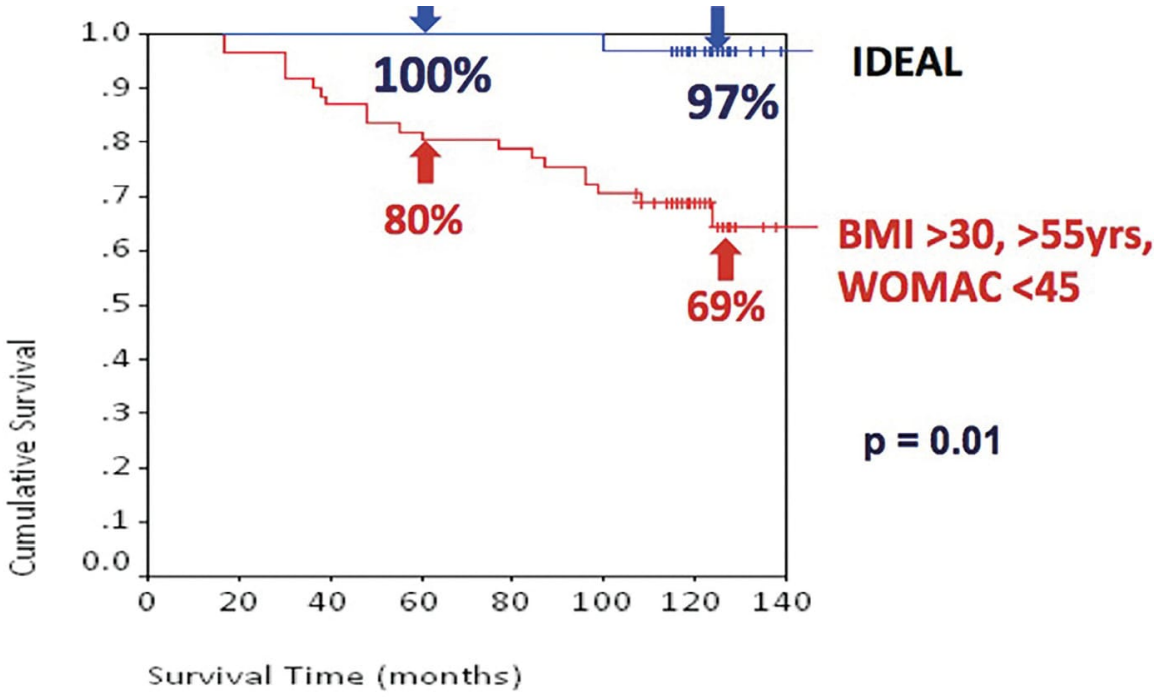

Figure 8: Survivorship analysis comparing the "ideal" group to a sub-optimal group. In blue: the "ideal" candidates: <55yrs + BMI <30 + Preop WOMAC > 45. In red: candidates with non-ideal values for all three variables.In red: candidates with non-ideal values for all three variables.

CONCLUSION

Overall survivorship of HTO in this series was found to be 87% at 5 years and 79% at 10 years. This is comparable to previous results from the wider published literature. Functional outcome following surgery was also demonstrated to be good, with WOMAC and Knee Society Scores improving significantly from preoperatively and being maintained over 10 years. Favourable longevity of HTO was associated with 3 key factors: higher preoperative patient reported outcome scores (WOMAC > 45), age < 55 and a BMI <30, and in this "ideal patient" cohort 10 year survivorship was 97%. In patients over 55 years of age with adequate preoperative functional scores, survivorship can be good and reported functional outcomes can be significantly better than their younger counterparts. We recommend the routine use of preoperative functional, outcome scores to guide decision-making when considering patient suitability for HTO (Table 3).

Our Indications for HTO	Exclusion criteria
■ Younger, active patient ■ Medial compartment osteoarthritis ■ Asymptomatic lateral compartment ■ **"Ideal" patient:** Age < 55yrs BMI < 30 WOMAC > 45	■ Inflammatory disease ■ FFD of 10° ■ Unable to flex past 90° ■ Previous HTO ■ Morbid obesity

Table 3: Our indication and exclusion criteria for HTO, highlighting the "ideal patient".

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