Results of High Tibial Osteotomy
A Review of Literature

Myles Coolican

Sydney Orthopaedic Research Institute
Introduction

- High tibial osteotomy widely performed procedure treating medial compartment osteoarthritis
- Multiple techniques
  - Closing wedge
  - Opening wedge
  - Dome
  - Chevron
Introduction

Many debated issues

* Choice between opening or closing wedge
* Graft selection in opening wedge osteotomies
* Fixation-plates-locked-tooth-frame
* Additional surgery - MACI - Micro-fracture
* Post operative care-WB status-brace

* Measurement tools
  - KOOS
  - WOMAC
  - Lysholm
  - Activity scales
  - Gait analysis
  - Survivorship
Introduction

* Vast array of different HTO options
* Difficult to compare
* Older literature – older techniques
* Registries-limited follow up
  - not much use
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Questions for Literature

* Who should have an osteotomy
* What is the most reliable technique
* What are the outcomes after HTO
* Survivorship of HTO
* Are patients more satisfied with HTO or UKR
* Survivorship of UKR V HTO
* Survivorship of patients
* What are outcomes of post HTO TKR
* What are outcomes of post UKR TKR
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### Older literature - HTO Survivorship

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<thead>
<tr>
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<td>Flecher et al</td>
<td>2006</td>
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<td>54.1 (18y)</td>
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<td>Akizuki et al</td>
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Recent Literature-Outcome

European Journal of Orthopaedic Surgery & Traumatology
https://doi.org/10.1007/s00590-017-2112-8

**General Review - Knee - Osteotomy**

Functional results following high tibial osteotomy: a review of the literature

Mark Webb¹, Varun Dewan², David Elson³

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- Systematic review-23 manuscripts appraised
- Different follow up periods
- Varied approach to the use of PROMs
- In all of the 14 studies that compared pre-operative to postop PROMs - significant improvements
Recent Literature-Outcome

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Functional results following high tibial osteotomy: a review of the literature

Mark Webb1© · Varun Dewan2© · David Elson3

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- Return to sport reviewed in 11 articles with 87.2% patients achieving this
- The published evidence confirms improved outcomes in symptoms function and return to activity
- PROMs are reliable to measure outcomes following HTO
Satisfactory functional and radiological outcomes can be expected in young patients under 45 years old after open wedge high tibial osteotomy in a long-term follow-up

- 20 patients, 12.3yr average f/u
- Medial OWHTO –no bone graft-locked plate
- 1 conversion to TKR during study period
- Survivorship 95% average 12 years
Recent Literature-Outcome

Knee Surgery, Sports Traumatology, Arthroscopy
https://doi.org/10.1007/s00167-017-4816-z

Satisfactory functional and radiological outcomes can be expected in young patients under 45 years old after open wedge high tibial osteotomy in a long-term follow-up

Michael E. Hantes1 · Prodromos Natsaridis1 · Antonios A. Koutalos1 · Yohei Ono2 · Nikolaos Doxariotis1 · Konstantinos N. Malizos1

Received: 3 September 2017 / Accepted: 21 November 2017
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- All clinical outcome scores IKDC, KOOS, OKS, and SF-12 significantly improved postoperatively
- No deterioration over time
- No significant radiographic progression of was observed.
Return to sports and quality of life after high tibial osteotomy in patients under 60 years of age. Bastard et al (2017)

- 30 patients, 1-1.5yrs
- All returned to sports at 1 year:
  - 73.3% at their pre-surgery level
  - 23.3% at a higher level
- Quality of life (SF-36) was significantly improved 65.3% pre-operatively to 72.5%
Recent Literature-Open vs Closed

* Lateral closing wedge HTO has been for a long time as the gold standard

* Requires fibular osteotomy or proximal tibiofibular joint disruption, lateral muscle detachment, bone stock removal & subsequent TKR more difficult

* Opening wedge HTO gained popularity and became a widely used alternative option- incremental change & navigate

Recent Literature-Open vs Closed

* Opening wedge not free from drawbacks defect to fill possible loss of correction

* Brouwer- 2006-randomized controlled trial comparing the two techniques. At the one-year follow-up, both groups showed improvement in knee function and pain, without significant differences

Recent Literature-Open vs Closed

Comparison of clinical and radiological outcomes between opening-wedge and closing-wedge high tibial osteotomy: A comprehensive meta-analysis

Lingfeng Wu¹, Jun Lin², Zhicheng Jin³, Xiaobin Cai¹, Weiyang Gao⁴*

¹ Department of Orthopedics, the Fifth Affiliated Hospital & Central Hospital of Lishui City of Wenzhou Medical University, Lishui, China, ² Department of Orthopedics, Qingyuan Country People's Hospital, Lishui, China, ³ Department of Surgery, Second Clinical Medical College, Wenzhou Medical University, Wenzhou, China, ⁴ Department of Orthopedics, the Second Affiliated Hospital & Yuying Children's Hospital of Wenzhou Medical University, Wenzhou, China

- No significant difference regarding surgery time, duration of hospitalization, knee pain VAS, Lysholm score and HSS knee score
- Opening-wedge HTO group showed greater range of motion
- Opening-wedge HTO group showed greater posterior tibial slope angle and less patellar height
Multiple options

* Autologous bone graft most successful - osteoconductive, osteoinductive and osteogenic properties\(^9,10\)

* Tibial wedge & shaped femoral head –less donor morbidity fear of disease transmission

* Bone substitutes reduce operative time & donor site morbidity, but concerns about resistance to loads and biological degradability.\(^11\)

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* The use of bone cement is not recommend \(^{11}\)

* Dallari-encouraging results with the use of PRP, bone marrow stromal cells and growth factors added to both bone graft and bone substitute\(^ {12}\)

* Use still remains experimental and their efficacy compared to autologous iliac crest graft has not been demonstrated \(^ {11}\)

Recent Literature-Fixation

* Conventional plates-long or short
* Locking plates
* With or without tooth/spacer
* Staples
* External fixateurs
Recent Literature-Fixation

* Stoffel et al. compared the biomechanical properties of the modified Puddu plate and the TomoFix plate.

* Both plates create sufficient immediate stability.

* Lateral hinge fracture - the TomoFix plate showed enough residual stability, while the Puddu plate required additional lateral fixation.

* Agneskirchner et al. compared four different plates and stated that a rigid long plate fixator with fixed angle locking screws yields the best results.
Unicompartmental Knee Arthroplasty vs High Tibial Osteotomy for Knee Osteoarthritis: A Systematic Review and Meta-Analysis

ZhenWu Cao, MM a, XiJun Mai, MM b, Jun Wang, MM a, EnHui Feng, MM b, YongMing Huang, MD b,*

* Department of Orthopedic Surgery, Guangzhou University of Traditional Chinese Medicine, Guangzhou City, Guangdong Province, People’s Republic of China
b Department of Orthopedic Surgery, The Second Affiliated Hospital of Guangzhou University of Traditional Chinese Medicine, Guangzhou, Guangdong Province, People’s Republic of China

- 10 comparative studies
- f/u range 2-7.5 years
- UKA lower revision rates, complications and post-op pain
- HTO patients achieved superior ROM
Recent Literature-TKR after HTO

* All data published fail to demonstrate statistically significant differences between the patients treated with a primary TKR or with a TKR following an HTO

* Amendola et al. in their retrospective study compared primary TKR with TKR following HTO and concluded that previous osteotomy does not affect the outcome of TKR

* Karabatsos et al. in their retrospective cohort study stated that TKR after HTO was technically more challenging than primary TKR but there were no significant differences between the two groups at the five-year follow-up. Similar results were described by Van Rajii et al. and Kazakos et al.
Recent Literature- UKR converted to TKR

Pearse et al NZ Registry

- Uni to TKR compared to Primary
- Revision rate 4 times that of Primary TKR
- Poorer outcome scores Oxford 30 V 37
- Uni converted to Uni-13 times revision

Chou et al

- 69% survival at 5 years
- Revisions more difficult
- Outcomes inferior
Overall HTO Survivorship

Survivorship (%)

Years after surgery

Overall HTO Survivorship 79%
Figure KP12: Cumulative Percent Revision of Primary Unicompartmental Knee Replacement by Age (Primary Diagnosis OA)

- **<55 vs ≥75**
  - 0 - 9Mth: HR = 1.69 (1.30, 2.18), p < 0.001
  - 9Mth - 1.5Yr: HR = 2.64 (2.13, 3.27), p < 0.001
  - 1.5Yr+: HR = 2.99 (2.54, 3.52), p < 0.001

- **55-64 vs ≥75**
  - 0 - 6Mth: HR = 1.19 (0.89, 1.59), p = 0.236
  - 6Mth - 2Yr: HR = 1.54 (1.32, 1.81), p < 0.001
  - 2Yr+: HR = 2.19 (1.87, 2.57), p < 0.001

- **65-74 vs ≥75**
  - 0 - 1.5Yr: HR = 1.12 (0.94, 1.33), p = 0.217
  - 1.5Yr+: HR = 1.63 (1.40, 1.91), p < 0.001
Swedish Registry collecting data since 2013
- No outcome data in 2017 other than to state that 30 reported cases of re-operation since 2013 - nonunions
- Australian Registry collecting data since 2016
- The United Kingdom Knee Osteotomy Register (UKKOR) has been recently established to collect PROMs data
Good to excellent results have been reported for both opening and closing wedge HTO.

In open wedge osteotomy, the most reliable fixation and graft techniques are still controversial.

Gold standard locked plates and autologous bone graft

UKA achieves slightly better PROMS compared to HTO

UKR lower survivorship

Osteotomy is still the treatment of choice for the younger and more active patient with medial knee arthrosis.

Different patient groups

Revision of prior HTO to TKR is technically more demanding than a primary implant- there is no difference in the long-term outcomes

Revision UKR to TKR yields inferior results than HTO to TKR
What we do now at SORI

* Choose patients wisely
* Navigated opening wedge
* 2.5 - 3 degrees valgus
* Allograft-tibial wedge or FH
* Locked plate –Tomofix
* Limited ROM brace
* Early weight bear-first steps
* Fully WB by 6 weeks
* Avoid Osteotomy in conditions associated with poorer results

Advanced arthritis
Older patients-no absolute cut off
Patellofemoral arthritis
Markedly decreased range of motion
Inflammatory arthritis
* Avoid Osteotomy in conditions associated with poorer results

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* Routinely obtain MRI to confirm lateral compartment satisfactory
* Happy to combine with ACL reconstruction
* Plan & assess with long films
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Our Results
Methods

* 210 opening-wedge high tibial osteotomies
* November 2002 to October 2013
  * All procedures performed by 3 consultant surgeons

* Osteotomy for osteoarthritis or chondral defects with concomitant varus deformity
* From 2007 - all navigated
Osteotomy Technique

* Opening wedge
* Freehand guidewires
* Osteotomes
* Retractors
* Stable lateral hinge
* Gradual correction
* Monitor with navigation
  & fluoroscopy
Failure defined as conversion to Total Knee Replacement

19 lost to follow up

National Joint Registry data was used to confirm any missed conversions

Kaplan-Meier survivorship analysis
ICRS Lateral Compartment

ICRS LFC N=143

ICRS LTP N=143

Number of patients

N
1a
1b
2
3b
4

Number of patients

N
1a
1b
2
3b
* Age 51
* Gender 86% male
* BMI 28 (26-32)
* Smoking-13% history
* Contra-lateral HTO 10%

**KOOS Pre-op**

![KOOS Pain - Pre-operative](chart.png)
Results

* Post-op alignment
  3.5 (1.7-5.2)
* Converted to TKR
  14 - 6.8%
Procedure Survivorship

Overall HTO Survivorship

Survivorship (%)

Years after surgery

79%
KOOS

* Average surgery to follow-up 2.1 years

Paradowski et al 2006
Males, 35-55yrs; N = 78
Regression

**Increased pain relief**
- Increased postop valgus
- Increased BMI
- Worse pre-op pain

**Decreased pain relief**
- Male gender
- Increased surgery-follow-up time
Conclusion

* HTO is a safe and effective procedure for relieving pain and improving function in “younger” patients with medial compartment OA
* Survival of 80% at 10.5 years
* Ongoing study will better direct indications and techniques
* Ongoing improvements in patient selection and surgical technique should further improve outcomes

→ HTO should become an increasingly important option in surgical management of younger patients with OA
Thank You