Survivorship of High Tibial Osteotomy in the treatment of osteoarthritis of the knee – a retrospective cohort study with 14 years' follow-up

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Abstract:

Introduction

This study was to evaluate the survivorship of HTO for the treatment of medial compartment osteoarthritis (OA) in young and active patients from two teaching hospitals in a single city.

Methods

A retrospective cohort multicenter study looking at HTO for treatment of medial compartment OA. We analyzed a case series of HTO's performed by four surgeons in two centres over a 14-year period. Failure was defined as conversion to Total Knee Replacement (TKR). All cases where additional procedures for instability of the knee were performed at the time of the index surgery were excluded. Time to failure was recorded and a Kaplan Meir (KM) analysis was performed to evaluate survivorship. Univariate binary regression analysis was undertaken to identify associations between risk factors and failure.

Results

A total of 96 patients were included in the study with a median age was 45 years. The survivorship at 5-years post-op was 90.3% and at 10 years post-op it was 82%. Patients that were 14 years after surgery had a survivorship of 65%. 18.8% of patients required the removal of their metalwork. The overall complication rate was 6.3%. The univariate regression analysis showed that higher age (p=0.02) and larger corrections requiring the use of bone graft increased the risk of failure (p=0.02). There was no statistically significant correlation between laterality, gender, complication rate and pre-operative alignment to survivorship.

Conclusion

This is one of the largest reported case series of HTO's with comparable survivorship at 5 and 10-year follow-up compared to the reported literature. There was an association found between increasing age and larger corrections requiring bone graft at index procedure to increasing failure rate.

Keywords: High Tibial Osteotomy; HTO; survivorship; medial compartment osteoarthritis.

Declarations

-**Ethical Approval**: This study was registered and approved by the local Caldicott Guardian. It was registered in the research registry with an ID number 8003.

-**Consent to Participate**: Not applicable

-**Consent to Publish**: Not applicable

-**Authors Contributions**

Mr Rahul Bhattacharyya: Primary author, written and edited manuscript, study plan, data analysis.

Mr Almothenna Alloush: Co-author Data collection, data analysis, first draft and writing manuscript.

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Dr James Doonan: Co-author, Data analysis, statistical analysis, editing

Mr Brian Rooney: Co-author, performed the operations, editing manuscript

Mr Colin Walker: Co-author, performed the operations, editing manuscript

Mr Angus Maclean: Co-author, performed the operations, editing manuscript

Mr Mark Blyth: Senior author, designed the study, performed the operations, editing manuscript

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-**Availability of data and materials**: The datasets generated during and/or analysed during the current study are not publicly available

1. Introduction

Medial compartment Osteoarthritis (OA) is a common disease affecting patients of different ages[1]. The treatment options vary according to the nature of the condition, patient age and activity levels. A systematic review[2] of the literature has shown that Unicompartmental Knee Replacement (UKR) is superior in the older and lower demand patients compared to High Tibial Osteotomy (HTO) which is considered more appropriate in the young and active patient. The ideal indications for HTO are; (1) young and active patients (age <65 years), (2) normal-range body mass index (BMI), (3) mild articular destruction (no more than grade 2 Ahlbäck classification), (4) no patellofemoral arthrosis, and (5) good range of motion (ROM) and a stable joint[2]. Further studies have reported benefits of HTO in the young and active patient group with medial compartment OA[3–8].

The majority of the evidence on the survivorship of HTO are single centre case series showing good early to mid-term survivorship[6]. The largest series available was from the Finnish registry of 3195 patients[9]. They reported a 5-year survivorship of 89% and a 10-year survivorship of 73% when Total Knee Replacement (TKR) was taken as the endpoint.

The primary aim of our study was to evaluate the survivorship of HTO for the treatment of medial compartment OA in young and active patients from two teaching hospitals in a single city. The secondary aim was to identify if any factors were associated with a higher risk of failure of the procedure.

2. Materials and Methods

2.1 Registration an ethical approval

This study was registered and approved by the local Caldicott Guardian.. It was registered in the research registry with an ID number 8003.

2.2 Study design

This study was a retrospective cohort study of patients receiving HTOs performed by four surgeons in two centres (major teaching hospitals) from 2002 to 2019.

2.3 Inclusion and exclusion criteria

The inclusion criteria were: young and active patients who underwent an HTO for Kellgren and Lawrence grade 3 or 4 medial compartment OA on radiological assessment; with no anterior cruciate ligament deficiency and who had varus malalignment (deemed suitable for a HTO by the responsible consultant surgeon) as assessed radiologically on a standing hip to ankle anterior-posterior radiograph. Patients who required surgery for instability together with the HTO at the time of the index procedure were excluded. 95 patients were identified as eligible for inclusion to this study. Two patients died and were therefore excluded. Three patients had bilateral HTO surgery and therefore, 93 patients with 96 HTO procedures were included in the final analysis.

2.4 Surgical technique

The surgery was carried out by one of the 4 senior authors who are all fellowship trained knee surgeons. An opening wedge technique was employed throughout, aiming to correct the deformity to allow the weight-bearing access to pass through Fujisawas point following deformity correction[10]. Ipsilateral iliac crest bone graft or bone graft substitute was used to in larger corrections, particularly over 10mm.

In 65 patients the osteotomy was fixed with a Puddu plate (Arthrex, Naples, Florida) with standard non-locking screws, and in the remainder 31 patients, a Tomofix locking plate (De Puy Synthes) was employed.

Patients were routinely managed partial weight-bearing with crutches for the first 6 weeks following surgery.

2.5 Data collection

Patient demographics and clinical data were collected, including pre-operative alignment and post-operative correction (using Fujisawa's point[10] as a reference); surgical technique; degree of correction achieved; use of bone graft; complications following surgery; whether removal of metalwork was required; length of follow-up; HTO failure rate (conversion to TKR and time to conversion to TKR). The Oxford Knee Score (OKS) at 1 year post TKR was analysed and compared to data for routine TKR in our unit. The complications following TKR after HTO surgery were also evaluated.

2.6 Statistical analysis

Kaplan Meier (KM) survivorship analysis was produced using GraphPad Prism (Version 6) and linear regression analysis performed using IBM SPSS Statistics (Version 27). Univariate binary regression analysis was undertaken to identify associations between risk factors and failure. Statistical significance was set at the 5% level ($p < 0.05$). The degree of correction achieved for the patients who required a bone graft intra-operatively was compared with the group without the bone graft. These were independent groups and the data was non-parametric so the Mann Whitney U test was used to assess statistical significance.

3. Results

Patient demographics are reported in **Table 1**. Overall survivorship for the whole cohort of patients was 81.3% (78/96 patients did not require a TKR). The mean length of FU was 8.95 years (range 1-14 years). Using KM analysis **(Figure 1)**, five-year survivorship was 90.3%, and 10-year survivorship was 82%. 18 (18.8%) patients required removal of their metalwork. Overall complication rate was 6.3% (6/96); two patients had an intra-operative fracture, two patients had a non-union and two patients had a superficial wound infection requiring antibiotic treatment only.

18 patients in this cohort required conversion to a TKR (18.8%). The median time to conversion was five years (range 1-13) and the median age at conversion was 53 years (range 44-66). Of the 18 patients converted to TKR, 13 of them had radiological progression of OA, four had ongoing pain with the decision taken to convert to a TKR, and one patient had non-union and metalwork failure which was revised to a TKR. Standard primary cruciate retaining or posterior stabilized implants were used in 11 of the 18 patients with seven patients required more constrained implants (varus-valgus constrained or hinged). At one year following conversion to TKR the median post-operative OKS was 33 (Range = 25-42; SD = 9.4) which is 5 points lower than the median one year post-operative OKS for primary TKRs in our unit over the same 7-year period that the HTO data was collected (Median OKS = 38, Range = 32-43; SD = 8; n=843). Of the patients that were converted to TKR, two (11.1%) had complications, one patient had superficial wound infection not requiring further surgery, while another patient had ongoing pain and required arthroscopic removal of scar tissue.

Data was analysed by univariate regression analysis which showed that higher age (p=0.02) and larger corrections requiring the use of bone graft [12.5 mm (7.5-21.5) v10 mm (6-15)] increased the risk of failure (p=0.02). There was no statistically significant correlation between laterality, gender, complication rate and pre/post-operative alignment to survivorship (Table 2).

4. Discussion:

This is a large cohort study of HTO patients which have reported excellent 5 and 10-year survivorship which is higher than the series published by the Finnish registry[9]. We found an association between increasing age and

higher risk of failure which has been reported previously in various studies[9, 11]. There has been conflicting evidence regarding an association between female gender and higher failure[9, 12]. However, in our study there was no association between gender and failure using univariate regression analysis. A novel finding from our study showed that patients who had larger corrections requiring the use of bone graft had a statistically significant increased association with failure. This was not previously reported. We believe that this was more likely to be related to larger corrections which tended to require a bone graft which increased risk of subsequent failure rather than the use of bone graft itself. We had no association between laterality, pre and post-operative alignment, complications following HTO or removal of metalwork with failure.

The patients who required TKR following an HTO in our series had a 1 year post-operative OKS of 33 compared to 38 for patients undergoing primary TKR for OA. There was a 5-point difference between these 2 groups which does meet the minimally important clinical difference (MICD) for this scoring system[13]. One patient in this group had a superficial wound infection which was treated with oral antibiotics and one patient had ongoing pain with no obvious cause. The majority of patients in this group had primary implants but 7/18 required higher constrained implants (varus/valgus constrained/hinged). Although the number of patients in this group are small our results do suggest the clinical results of TKR after HTO are inferior. This has been shown in other studies and although there is not complete agreement in the literature[14–17] we believe that patients should be advised that the results of a subsequent arthroplasty may be compromised by the HTO procedure. Nonetheless, we believe that the study does provide evidence that in the well selected patient, HTO is a good option for isolated medial compartment OA which buys time for the younger patient and the possibility of a later TKR in cases where the HTO eventually fails.

4.1 Strengths and limitations

The main strength of this study is it is a large cohort study with a good range of follow-up. We have reported survivorship of a relatively uncommon procedure using the well accepted Kaplan Meir analysis for survivorship and have evaluated the associations between risk factors and failure using regression analysis.

A limitation of our study was its retrospective design. However, most survivorship studies reported thus far has been retrospective case series[9]. Another limitation is that we did not have patient reported outcome measures

for our HTO patients. This was because these were not routinely collected as part of the follow-up assessment and we felt that undertaking this now would significantly affect the results due to recall bias.

5. Conclusions:

This is a large cohort study of HTO's which showed greater survivorship at five and 10-year follow-up compared to the reported literature. There was an association found between increasing age, and larger corrections requiring bone graft at index procedure to increasing failure rate. Overall, our study supports previous evidence that HTO is a good treatment option for young patients with isolated medial compartment OA.

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Figures and Tables:

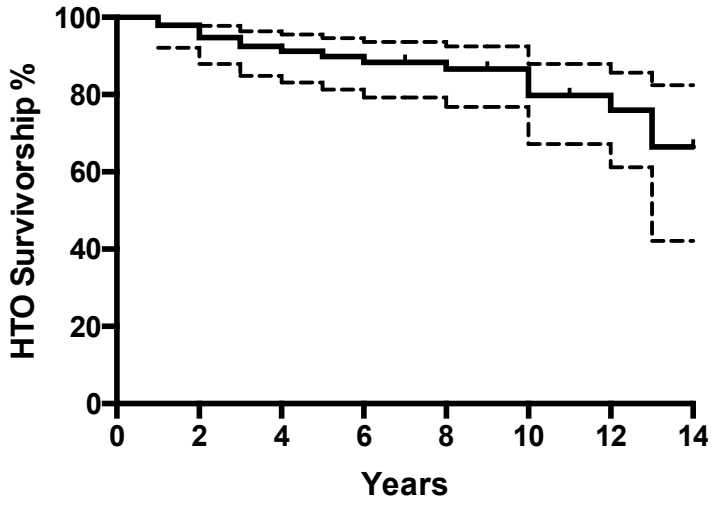

Figure 1: Kaplan Meir survival curve with 95% confidence intervals for High Tibial Osteotomy survivorship

Demographic	**n**
Age, median (range), years	65 (15 - 45)
Gender, Female / Male	22 / 71
Side, Left / Right	50 / 43
Pre-op alignment (Fujisawa point pre-op), median	20% (0%-55%)
Post-op alignment (Fujisawa point post-op), median	59% (15.6%-86.3%)

Table 1: Patient Demographics

Factors	**Univariate binary regression analysis for failure**
Laterality	p = 0.1
Alignment pre-op	p = 0.3
Alignment post-op	p = 0.4
Complication of HTO	p = 0.7
Removal of metal	p = 0.4

Table 2: Factors which show no association with failure of HTO

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