Clinical Research Article

Return to Work Following Isolated Opening Wedge High Tibial Osteotomy

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Abstract

Purpose. Patients with isolated medial compartment osteoarthritis and varus deformity may undergo high tibial osteotomy (HTO) to reduce the contact pressure in the medial compartment. The purpose of this investigation is (1) examine the timeline of return to work (RTW) following HTO and (2) evaluate RTW stratified by occupational intensity. *Methods*. Consecutive patients undergoing HTO were reviewed retrospectively at a minimum of 2-years postoperatively. Patients completed a subjective work questionnaire, a visual analogue scale for pain, Single Assessment Numerical Evaluation, and a satisfaction questionnaire. *Results*. Thirty-eight patients were included at an average of 9.0 ± 3.3 years postoperatively. Thirty-seven patients (average age 43.4 ± 7.8 years, 91.9% with a Kellgren-Lawrence grade of III/IV) were employed within 3 years prior to surgery. Eighteen patients (48.6%) underwent subsequent surgery with 14 patients (37.8%) receiving a salvage knee arthroplasty at an average of 6.1 ± 3.5 years following HTO. Thirty-five patients (94.5%) returned to work at an average of 2.9 ± 2.0 months. The rate of RTW for sedentary, light, moderate, and heavy duties were 87.5%, 100%, 100%, and 93.3%, respectively, while the duration until RTW was 1.0 months, 1.1 months, 2.4 months, and 3.3 months, respectively. *Conclusion*. In a young and active population with osteoarthritis or varus deformity, an HTO allows patients to return to work; however, patients with high-intensity occupations may be absent from work longer than those with lesser physically demanding occupations. HTO is not a definitive treatment option as nearly 40% of patients underwent knee arthroplasty by 6.1 years postoperatively. *Level of Evidence*. IV, case series.

Keywords

high tibial osteotomy, return to work, outcome measures, general

Introduction

Treatment of osteoarthritis (OA) initially involves conservative management; however, because of the progressive nature of OA, patients may eventually undergo total knee arthroplasty (TKA). Indications for TKA have expanded to include younger, and more active patients[1,2]; however, these patients expect to perform better in activities of daily living, work, and leisure—often at higher levels of demand.[1] In young patients undergoing total knee arthroplasty, at least 90% of patients were able to return to their previous level of occupation regardless of work intensity level.[3] However, patients younger than 55 years undergoing TKA have nearly a 3-fold higher risk of failure than older patients as defined by incidence of revision surgery.[4]

High tibial osteotomy (HTO) provides an alternative treatment option for young patients with unicompartmental OA and varus deformity. By reducing the contact pressure on the medial aspect of the knee, an HTO can reduce pain, improve function, and slow knee deterioration, thereby reducing the need for joint arthroplasty.[5] Following an HTO, patients demonstrated improved functional outcome scores, as measured by the International Knee Documentation Committee (IKDC) and Lysholm scores as well as high rates of satisfaction and procedural survivorship.[6-10] While patients in this cohort have shown improved functional or clinical outcomes, these metrics may have a ceiling effect and such it is difficult to determine the outcome of higher functioning patients following HTO.

As the age of retirement increases, return to work (RTW) following HTO may be an important determinant of patient outcomes.[11] It has previously been shown that approximately 85% of patients returned to work following HTO;

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Table 1. Categorization of Work by Demand.[a]

Demand Level	Description
Sedentary	Exerting up to 10 pounds of force occasionally or negligible amount of force frequently to lift, carry, push, pull or otherwise move objects. Sedentary work involves sitting most of the time, but may involve walking or standing for brief periods of time. Jobs are considered sedentary if walking and standing are required occasionally and all other sedentary criteria are met.
Light	Exerting up to 20 pounds of force occasionally, up to 10 pounds of force frequently, or a negligible amount of force constantly. If lifted weight is a negligible amount, a job may be rated as light work if (1) requires walking or standing to a significant degree, (2) sitting a significant amount of time but requires constant pushing/pulling of controls, or (3) the job requires working at a production pace, where an individual constantly pushes or pulls negligible weight.
Moderate	Exerting 20-50 pounds of force occasionally, 10-25 pounds of force frequently, or negligible to 10 pounds of force constantly.
Heavy	Exerting 50-100 pounds of force occasionally, 25-50 pounds of force frequently, or 10-20 pounds of force constantly to move objects.

[a]Occasionally indicates that activity or condition exists for up to one-third of the time. Frequently indicates that activity or condition exists from one-third to two-thirds of the time. Constantly indicates that activity or condition that exists from two-thirds to most of the time. All physical demand requirements are in excess of the previous level.

however, the timing of return to work and stratification based on work intensity was not provided.[12,13] Several recent investigations examined the relationship between work intensity and the ability to return to work following high tibial osteotomy. However, these investigations had conflicting results and were limited by short- to mid-term follow-up, which does not provide insight into a patient's ability to maintain their level of function on returning to work.[14,15] Schroter *et al*.[16] demonstrated a difference in RTW based on level of intensity; however, this investigation contained a single patient with a high-intensity occupation. Therefore, previously reported rates and duration of absenteeism from work may not be truly reflective of patients undergoing HTO.

The purpose of this investigation is to evaluate the ability of a high tibial osteotomy to return patients in the young and active population to work. We hypothesize that patients in higher intensity occupations will demonstrate a lower rate of return to their previous level of work intensity and a higher duration of absenteeism from work in those who do return to work.

Methods

Approval was obtained from the institutional review board prior to the start of this investigation. A retrospective review was performed on a registry of patients who underwent opening wedge HTO from 2004 to 2015 by the senior author. Inclusion criteria for this study were patients who received isolated opening wedge HTO and were available for minimum 2-year follow-up. Patients were excluded if they were 18 years or younger at the time of surgery or underwent bilateral HTO within 3 years of each other. Patients who underwent concomitant osteochondral allograft (OAG), meniscal allograft transplant (MAT), or autologous chondrocyte implantation (ACI) were excluded from the investigation. Patients who underwent previous meniscectomy, microfracture, cartilage procedure (MAT, OAG, or ACI), anterior cruciate ligament (ACL) reconstruction were included in the investigation. At the time of surgery, all patients had at least mild osteoarthritis (Kellgren-Lawrence grade $\geq$2).

Thirty-eight patients (70.4%) were contacted to complete a questionnaire regarding their work status at a minimum of 2 years' follow-up. Patients with a functional telephone number or email address were contacted. Those who were not contacted for follow-up had a disconnected phone number or did not respond to attempts to have the questionnaire mailed to their home. This questionnaire has been used previously to describe work-related outcomes following orthopedic procedures.[11,17,18] Work intensity status was stratified into low-, medium-, and high-intensity occupational demands (**Table 1**).[11] In addition to this questionnaire, pre-operative diagnosis, demographic information, intra-operative variables, complications, and surgical history were collected from patient records. Preoperative radiographs were also assessed for the degree of OA using the Kellgren-Lawrence grading system, while operative reports were reviewed for the degree of varus correction.

Surgical Technique

A longitudinal incision was made along the anteromedial portion of the proximal tibia and the medial collateral ligament was elevated subperiosteally. The knee was flexed to 10° of flexion and under fluoroscopic guidance, 2 osteotomy drill pins were inserted on the medial tibial diaphysis toward the fibular head. An oscillating saw and osteotomes were used to cut the proximal tibia anteriorly, posteriorly, and medially, leaving the lateral cortex intact. A fixed angle

HTO wedge plate (Conventional Puddu plate, Arthrex, Inc., Naples, FL) was inserted along the anteroposterior plane. The degree of correction is based on the preoperative long leg alignment films.[19] Patients had the mechanical axis shifted through the axis of the lateral tibial eminence.[20,21] Two 6.5-mm cancellous screws were inserted proximally and two 4.5-mm cancellous screws were inserted distally. Cancellous bone chips, iliac crest allograft, or harvested bone autograft (distal femur, proximal tibia) was then packed into the osteotomy site. Harvested bone autograft was used if a sufficient amount of tissue was obtained during the procedure. In cases where an insufficient amount of autograft was available, cancellous bone chips or iliac crest allograft was used—depending on its availability on the day of surgery. In these cases, harvested autograft was mixed with the cancellous bone chips or iliac crest allograft.

Rehabilitation Protocol

For the first 6 weeks postoperatively, patients are nonweightbearing/heel-touch only and are allowed to progress to full weightbearing after the 6-week time-point. Patients are advised to use a brace at all time for the first 2 weeks following surgery, after which, the brace can be removed at night until 6 weeks postoperatively. After 6 weeks, a brace is no longer used. Patients may advance range of motion as tolerated, but an emphasis on maintaining full extension during the first 2 weeks is encouraged by sleeping in a locked brace at 0°.

Statistical Analysis

Statistical analysis was conducted using Microsoft Excel (Microsoft, Seattle, WA) and Rstudio software version 1.0.143 (R Foundation for Statistical Computing, Vienna, Austria). Descriptive analysis of continuous variables included means and standard deviations, whereas frequencies and percentages were used to report discrete variables. A post hoc analysis of variance power analysis was performed to determine if there was sufficient size to detect a statistical difference on the rate and duration of RTW. A binomial logistic regression was performed to assess the effect of demographic and surgical variables on patient likelihood of returning to work. All tests for statistical significance were performed using 2-tailed hypothesis testing with statistical significance set at $P \leq 0.05$.

Results

A total of 121 patients who underwent an HTO were screened from 2004 to 2015; of whom, 54 patients underwent isolated HTO without concomitant procedures. Sixteen patients were lost to follow-up; thus, 38 patients (70.4%) were available for follow-up at an average of 9.0 ± 3.3 years. Thirty-seven patients (97.4%) were employed within 3 years of surgery, leaving 37 patients for final analysis. Average age at the time of surgery was 43.4 ± 7.8 years (range: 27-62 years). Thirty-one patients (83.7%) were male and the average body mass index BMI was 27.3 ± 3.7 kg/m^2 (range: 23.4-38.9 kg/m^2). Twenty patients (54.1%) had their dominant leg operated upon. The average intraoperative degree of correction was from 9.9° ± 2.4° of varus to the tibial eminence (range: 3°-15°). The most frequently reported indications to pursue an HTO were pain relief (32 patients, 86.5%), a desire to remain active (22 patients, 68.5%), and to improve motion (16 patients, 44.4%). Thirty-four patients (91.9%) had a Kellgren-Lawrence grade of III or IV at the time of surgery. Thirty-four patients (89.1%) previously underwent at least 1 surgery on the ipsilateral leg prior to their HTO, with a single patient (2.7%) receiving an HTO prior to presentation to the senior author. Twenty-three patients (62.2%) previously underwent a meniscectomy, 9 patients (24.3%) previously received an ACL reconstruction, and 4 patients (10.8%) underwent a previous microfracture.

Postoperative Complaints and Complications

The average postoperative visual analogue scale (VAS) score was 2.8 ± 2.5 while the average postoperative Single Assessment Numerical Evaluation (SANE) score was 67.2 ± 23.7. Twenty-five patients (67.6%) were at least somewhat satisfied with their surgery, and 25 patients (64.9%) would still have underwent the operation again if presented the opportunity to alter their decision.

Thirty-three patients (89.2%) reported postoperative problems with their knee at some point during the postoperative follow-up period. The most common complaint was occasional pain (45.9%), stiffness (37.8%), chronic pain (37.8%), frequent swelling (18.9%), and instability (13.5%). Eighteen patients (48.6%) returned to the operating room following the index HTO, with four patients (10.8%) undergoing hardware removal and a single patient (2.7%) undergoing revision HTO due to nonunion. Notably, 14 patients (37.8%) underwent knee arthroplasty (10 TKA, 4 unicompartmental knee arthroplasty) by 6.1 ± 3.5 years following their HTO. The average age of patients undergoing subsequent arthroplasty at the time of surgery was 42.3 ± 7.9 years. The reason for arthroplasty included progressive medial compartment osteoarthritis (28.6%), continued pain (21.4%), or unknown reasons due to the arthroplasty being performed elsewhere (50.0%).

Work Outcomes

Thirty-five patients (94.6%) who were employed at the time of surgery returned to the same level of work intensity at an average 2.1 ± 2.0 months postoperatively. Five patients

Table 2. Rate and Duration to Return to Work Based on Work Intensity Status.

	Working Before HTO (*n*)	Working After HTO (*n*)	Rate of RTW (%)	Average Time to RTW (Months)
Sedentary	8	7	87.5	1.0 ± 0.7
Light	7	7	100	1.1 ± 0.8
Moderate	7	7	100	2.4 ± 2.0
Heavy	15	14	93.3	3.3 ± 2.5
Total	37	35	94.5	2.9 ± 2.0

HTO = high tibial osteotomy; RTW = return to work.

Table 3. Occupations of Patients Working Postoperatively.

Job Intensity	Occupation
Sedentary	Underwriter, chief executive officer, sales, accountant, administrator, attorney, information technology (*n* = 2)
Light	Engineer (*n* = 3), actuary, nurse, financial adviser, attorney
Medium	Physical therapist, surgeon, salesman, architect, physician assistant, business owner
High	Maintenance (*n* = 2), carpenter, construction (*n* = 2), truck driver, electrician, general manager, plumber, police officer (*n* = 2), warehouse worker, iron worker, business owner

(13.5%) were covered by Workers' Compensation; of whom, 4 patients (80.0%) returned to the occupation they held prior to surgery. The single patient who did not return to the same occupation returned to work at a similar level of intensity 24 months postoperatively. The single patient who underwent a revision HTO was able to return to work in their same capacity by 4 months postoperatively.

When stratified by level of intensity, patients who held sedentary, light-, moderate-, or heavy-intensity occupations were able to return to their previous level of occupational intensity at a rate of 87.5%, 100%, 100%, and 93.3%, respectively (**Table 2**). There was no statistical difference between the level of occupational intensity and the rate of return to the previous level of occupation ($P = 0.9$); however, there was a statistical difference between the level of occupational intensity and the duration of return to work ($P = 0.03$). Occupations that patients returned to postoperatively are provided in **Table 3**.

There was no correlation between age at the time of surgery ($P = 0.3$), BMI ($P = 0.6$), gender ($P = 0.4$), surgery on the dominant extremity ($P = 0.3$), Workers' Compensation status ($P = 0.8$), Kellgren-Lawrence grade III or IV ($P = 0.8$), patient satisfaction ($P = 0.7$), degree of correction ($P = 0.6$), and a patient's ability to RTW following HTO. With reference to the heavy intensity occupational level, moderate, low, or sedentary occupational intensity levels were not predictive of RTW ($P = 0.2$, $P = 0.9$, $P = 0.9$, respectively). Additionally, there was no correlation between age at the time of surgery ($P = 0.5$), BMI ($P = 0.5$), gender ($P = 0.2$), surgery on the dominant extremity ($P = 0.5$), Workers' Compensation status ($P = 0.1$), Kellgren-Lawrence grade III or IV ($P = 0.5$), degree of correction ($P = 0.4$), and patient's undergoing subsequent knee arthroplasty. With reference to the heavy intensity occupational level, moderate, low, or sedentary occupational intensity levels were not predictive of subsequent knee arthroplasty ($P = 0.1$, $P = 0.9$, $P = 0.8$, respectively). However, lower patient satisfaction was predictive of subsequent knee arthroplasty ($P = 0.04$).

Discussion

In this investigation, we demonstrate that 94.6% of patients returned to their previous occupation following their high tibial osteotomy at an average of 2.9 ± 2.0 months. There was no significant difference in the rate of RTW based on level of occupational intensity; however, patients in higher intensity occupations took approximately 2 months longer to RTW than those who were employed by less strenuous occupations. Additionally, patients with lower levels of satisfaction had a higher incidence of undergoing knee arthroplasty after their HTO. Since an HTO is commonly performed in patients that are currently active in the workforce,[22,23] it is an important issue for patients to know whether they will be able to return to work and how long they will be absent from work. The results of this study are helpful for counseling patients and managing postoperative expectations.

The rate of RTW in this investigation is higher to what has been reported previously (95% vs. 85%)[12]; however, the duration until return to work is sooner than prior studies.[14-16] There was also a significant relationship between work intensity and duration to return to work. Patients with higher intensity occupations, such as construction workers, electricians, or plumbers, which require constant exertion of at least 10 to 20 pounds of force, take

longer to RTW than those with less physically demanding occupations. Despite the increased duration of RTW, patients with heavy-intensity occupations were not hindered in their ability to return to their previous occupation than those with less physically demanding occupations. In a series of 40 patients, Bode *et al*.[14] demonstrated that patients in higher intensity occupations were absent from work for a longer duration than those in lower intensity occupations. Similarly, Faschingbauer *et al*.[15] reviewed 43 patients 22 months postoperatively and reported a direct relationship between work intensity and duration of RTW. However, these investigations only provide short- to mid-term follow-up, which does not provide adequate information to describe a patient's performance and ability to maintain their level of function on reintegration to the workforce. Last, Schroter et al.[16] found that patients in higher intensity occupations were absent from work for a longer duration than those in lower intensity occupations. However, the findings of this investigation are subject to type II error as it only contained a single patient in a heavy-intensity occupation.

Although there was no relationship between occupational intensity and the rate of RTW, there was a statistical difference in the duration of absence from work based on occupational intensity. Since only a small proportion of the study patients (12.5%) were covered by workers compensation at the time of surgery, many of the included patients may have been more motivated to return to work. Additionally, the senior author implements a nonweight-bearing/heel-touch protocol until 6 to 8 weeks postoperatively. This protocol is conducive to allowing patients who work in sedentary or light occupations to return to work sooner than those who require a significant amount of physical exertion as a part of their livelihood. Preoperative education regarding the surgery and postoperative care are critical for appropriately managing expectations, which have been shown to impact subjective clinical outcomes.[24,25] Motivation to return to work is multifactorial as it is influenced by economic need, disability coverage, social situation, comorbid conditions, as well as health care and benefits. Based on the results of the present investigation, surgeons can counsel patients that a high proportion of patients return to their previous level of occupation regardless of work intensity; however, patients in higher intensity occupations may take longer to return to their previous level of functioning. Proper preoperative patient education can be used to manage expectations regarding patient's ability to RTW.

In the present investigation, there were no cases of revision HTO; however, 47.4% of patients returned to the operating room following the index HTO, with 31.6% of patients undergoing a knee arthroplasty at the time of final follow-up. Additionally, 89.5% of patients reported postoperative problems with their knee. The most common complaints were pain, stiffness, or swelling, which may be due to progression of arthritis; however, the cause of these symptoms was unable to be verified. These symptoms were managed nonoperatively through activity modification, physical therapy, or pain management. In previous studies that investigated RTW following HTO, the rate of complications ranged from 3% to 19%, the rate of revision HTOs were 10%, and hardware removal was performed in 82.9% of patients.[14-16] The high incidence of postoperative problems in this population may be due to elevated expectations in this cohort, who wish to participate in more strenuous activities that places greater stress on the knee. Participation in strenuous activities may subsequently lead to an increase rate of reported pain, swelling, or stiffness. While an HTO may reduce symptomatology, and enable patients to return work and leisure activity, it may not completely reduce the need for further intervention as nearly 32% of patients progressed to knee arthroplasty. It has been previously reported that the survivorship of HTO ranges from 73% to 92% at 7 to 10 years postoperatively.[10,26-30] The difference in rate of conversion arthroplasty in this series versus previous investigations may be multifactorial. The patients in this investigation were younger and had higher grade of osteoarthritis preoperatively. Previous investigations regarding the survivorship of high tibial osteotomy had an older patient population[26-29] and a lower grade of preoperative osteoarthritis.[27] Ultimately, this investigation represents a more modern series of patients undergoing HTO as the proportion of patients younger than 55 years receiving a TKA increased by 40% from 2002 to 2007.[31] Since the outcomes for TKA are superior when surgery is performed prior to the development of advanced OA,[32,33] the decision to pursue knee arthroplasty may be discussed earlier in patients who have progression of osteoarthritis or continued symptomatology following HTO. For patients included in this investigation, the reason for arthroplasty included progression of medial compartment disease, continued symptomology, or an unknown reason. The findings of this investigation corroborate those of previous studies that HTO may only be a temporizing and incomplete solution to those with symptoms due to medial compartment disease as many patients undergo subsequent knee arthroplasty. Although 31.6% of patients undergo subsequent arthroplasty, an HTO provides sufficient pain relief to allow patients to return to their previous level of occupation.

Despite the merits of this investigation, there are some limitations of this study because of its retrospective nature. In this investigation, the included patient population was heterogeneous as evidenced by the wide age range as well as the male predominance in this group. The demographics of the included patient population may inhibit the external validity of these findings. However, we attempted to minimize

heterogeneity by performing multivariate statistical analyses that can account for confounding variables. Concomitant procedures, such as meniscectomy or microfracture, were not controlled in this investigation, which may have impacted the results of this investigation. Additionally, the use of a retrospective survey creates the potential for recall bias, which may influence the results of this investigation, such as the duration of return to work and patient satisfaction. Faschingbauer *et al*.[15] and Bode *et al*.[14] similarly used postoperative surveys to determine the duration of incapacity of work, while Schroter *et al*.[16] reviewed patient charts to establish RTW following HTO. However, the design of this investigation was similar to previous studies reporting return to work following orthopedic procedures.[11,17,18] This investigation is also subject to nonresponse bias as 29.6% of patients were lost to follow-up. The patients who were lost to follow-up may represent a population of patients who were more active and mobile and were able to move elsewhere in the labor market. Patients with less successful outcomes may have been unable to pursue additional opportunities and may have been disproportionately available for follow-up in this investigation. Long leg radiographs were obtained as standard protocol for preoperative planning; however, these images were unavailable for retrospective analysis. It should be noted that the senior author performs an extra-articular correction below the level of the tibial tubercle to correct for an intra-articular deformity. Radiographic analysis was not performed at final follow-up to evaluate if continued participation in work may have led to progression of osteoarthritis. Last, *post hoc* power analysis demonstrated that this investigation was underpowered to accurately perform statistical comparisons with stratifying patients by level of occupational intensity.

Conclusion

In a young and active population with OA or varus deformity, an HTO is a treatment option that allows patients to RTW; however, patients with high-intensity occupations may be absent from work longer than those with lesser physically demanding occupations. HTO is not a definitive treatment option as nearly 40% of patients underwent knee arthroplasty by 6.1 years postoperatively.

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Declaration of Conflicting Interests

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Ethical Approval

Approval was obtained from the institutional review board prior to the start of this investigation.

Informed Consent

Informed consent was not sought for the present study because this was a retrospective study.

Trial Registration

Not applicable.

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