# Return to Sports After High Tibial Osteotomy With Concomitant Osteochondral Allograft Transplantation

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**Background:** Young patients with symptomatic chondral defects in the medial compartment with varus malalignment may undergo opening wedge high tibial osteotomy (HTO) with concomitant osteochondral allograft transplantation (OCA). Although patients have demonstrated favorable outcomes after HTO + OCA, there is limited information is available regarding return to sporting activities after combined HTO and OCA.

**Purpose:** To evaluate (1) the timeline to return to sports (RTS), (2) patient satisfaction, and (3) reasons for discontinuing sporting activity after combined HTO and OCA.

**Study Design:** Case series; level of evidence, 4.

**Methods:** Consecutive patients who underwent concomitant HTO + OCA for varus deformity and medial femoral condyle focal chondral defects with a minimum 2-year follow-up were retrospectively reviewed. Patients completed a subjective sports questionnaire, satisfaction questionnaire, visual analog scale for pain, and Single Assessment Numerical Evaluation.

**Results:** Twenty-eight patients with an average age of 36.97 ± 7.52 years were included at average follow-up of 6.63 ± 4.06 years[AQ5]. Fourteen patients (50.0%) required reoperation during the follow-up period with 3 (10.7%) undergoing knee arthroplasty. Twenty-four patients participated in sports within 3 years before surgery, with 19 patients (79.2%) able to return to at least 1 sport at a mean 11.41 ± 6.42 months postoperatively. However, only 41.7% were able to return to their preoperative level. The most common reasons for sports discontinuation were a desire to prevent further damage to the knee (70.0%), persistent pain (55.0%), persistent swelling (30.0%), and fear (25.0%).

**Conclusion:** In young, active patients with varus deformity and focal medial femoral condyle chondral defects, HTO with concomitant OCA allows 79.2% of patients to RTS by 11.41 ± 6.42 months postoperatively. However, only 41.7% of patients were able to return to their preinjury level or better. It is imperative that patients be appropriately educated to manage postoperative expectations regarding sports participation after HTO + OCA.

**Keywords:** high tibial osteotomy; osteochondral allograft transplantation; varus deformity; cartilage restoration; return to sports

Focal chondral defects can be debilitating in a young, athletic population with high activity demands. Without surgical intervention, these lesions are likely to progress to osteoarthritis.[7,25] Total knee arthroplasty produces reliable outcomes; however, concern for implant failure and activity restrictions has led to an increased incidence of biologic treatments in younger patients with symptomatic tibiofemoral joint disease.[14,41,42] Cartilage repair and restoration techniques such as microfracture, osteochondral autograft transfer, autologous chondrocyte implantation, and osteochondral allograft transplantation (OCA) have been shown to be successful joint-preserving treatment options when utilized for the appropriate indications.[16,22,39,40]

Varus deformity of the knee predisposes patients to medial chondral and meniscal pathology and progression to osteoarthritis because of the increased mechanical load through the medial compartment.[4] Opening wedge high tibial osteotomy (HTO) has been shown to be a reliable method of correcting varus malalignment and preserving the medial compartment by restoring an anatomic mechanical alignment and pathologic medial proximal tibial angle by redistributing the mechanical load to preserve the medial compartment.[3,27,44] A synergistic relationship likely exists between knee realignment and cartilage repair[29]; therefore, HTO is increasingly utilized as an adjunctive procedure to optimize the biomechanical microenvironment in the medial compartment for cartilage restoration.[12,15,37] As a result, concomitant HTO and cartilage restoration procedures may optimize patient-reported outcome measures (PROMs) and return to sports (RTS), minimize pain, and decrease the risk of conversion to total knee arthroplasty.[24,26]

Combined cartilage restoration and HTO procedures have previously been shown to provide successful mid- and long-term clinical and radiographic outcomes.[2,12,26,29] After HTO with concomitant OCA, patients experience statistically significant improvements on the International Knee

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Documentation Committee outcome metric and high rates of satisfaction.[26] Furthermore, Agarwalla et al[1] demonstrated that 96% of patients return to their previous level of occupation by 4 months after HTO + OCA. Independently, both HTO and OCA have shown successful rates of RTS after surgery.[31,36,38] However, outcomes such as RTS for patients undergoing concomitant HTO and OCA for varus deformity and focal chondral defects are relatively unknown.

The purpose of this investigation was to evaluate (1) the timeline of RTS, (2) patient satisfaction, and (3) reasons for discontinuing sporting activity after combined HTO and OCA, and identify (4) predictive factors of RTS. The authors hypothesize that a high proportion of patients will be able to RTS after HTO + OCA; however, return to the preoperative activity intensity may be limited.

## METHODS

### Study Cohort

After approval by the institutional review board, a retrospective review of a prospectively collected database was performed. The database was queried for patients undergoing concomitant OCA and HTO by the senior author [AQ1] between 2004 and 2015. Indications for concomitant OCA and HTO included patients younger than 50 years of age with focal chondral defects on the medial femoral condyle and varus deformity greater than 5° as measured on weightbearing, standard bilateral standing long leg length radiographs. Patients were included if they underwent concomitant HTO and OCA and available for follow-up for >2 years. Patients were excluded from this study if they were younger than 18 years of age at the time of surgery or underwent bilateral HTO within 3 years of each other. Patients were not excluded for undergoing other concomitant procedures such as meniscal allograft transplant (n = 13; 46.4%). Patients who underwent previous surgery such as meniscectomy, cartilage procedure, or anterior cruciate ligament reconstruction were also included in this investigation. The senior author's decision to pursue OCA is dependent on the depth and Outerbridge grade of the lesion.[43] Osteochondral allograft [AQ6] is typically performed when there are femoral lesions greater than 5 mm and Outerbridge grade ≥III with subchondral bone involvement as shown on magnetic resonance imaging or failed previous surgery. Those with varus malalignment were also indicated for HTO to offload the medial compartment.

TABLE 1
Categorization of Sport by Intensity

| Demand Level | Sport |
|---|---|
| Low | Golf, swimming, bowling, nature sports, fitness sports, yoga |
| Medium | Rowing, cycling, cross-country skiing, downhill skiing, softball, baseball |
| High | Running, basketball, football, tennis, volleyball, soccer |

### Data Collection

A total of 39 patients who underwent concomitant OCA and HTO were identified from our institution's electronic medical record via Current Procedural Terminology codes (HTO, 27457; OCA, 27415). Of these, 11 patients were lost to follow-up, leaving 28 patients (71.8%) with a minimum of 2 years of follow-up available at an average [AQ7] 6.63 ± 4.06 years postoperatively. Patients were contacted via telephone, email, and standard mail to complete a sports questionnaire regarding their pre- and postsurgical sports participation and satisfaction. Patients with a functional telephone number or email address were contacted. This questionnaire has previously been used to evaluate RTS outcomes after orthopaedic procedures.[17-21,34,35] Patients also completed a Single Assessment Numerical Evaluation (SANE), Marx Activity Scale, and visual analog scale (VAS) for pain.[32,33] Patient-reported activities were stratified into low-, medium-, and high-intensity lower extremity demands as defined by previous RTS investigations after HTO (Table 1).[32,33] Patient records were reviewed for patient information, preoperative Kellgren-Lawrence

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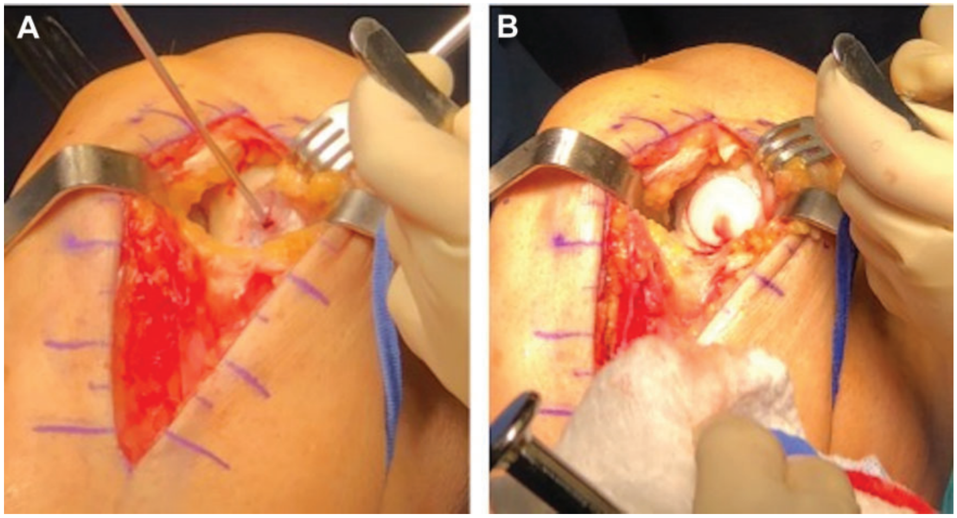


**Figure 1.** Osteochondral allograft transplantation of the medial femoral condyle. (A) A guide pin is placed perpendicular to the center of the chondral defect for accurate reaming perpendicular to the articular surface. (B) Osteochondral allograft plug press-fit into the medial femoral condyle to restore the articular surface.

grade, intraoperative degrees of osteotomy correction, surgical history, and postoperative complications.

## Surgical Technique

*Osteochondral Allograft Transplantation.* OCA was typically performed before the osteotomy. A technique for OCA of the femoral condyle has previously been described.[16] Under general anesthesia, patients are placed supine on the operating table and diagnostic arthroscopy is performed to visually confirm the osteochondral lesion and evaluate for concomitant pathology. When treating defects in the medial compartment, a medial parapatellar mini-arthrotomy is utilized. A Z-retractor (Arthrex) is used to retract the patella, allowing direct visualization of the defect and determination of an appropriately sized allograft. The fresh (within 15-28 days after harvest) osteochondral allograft (JRF Ortho) is then placed in room temperature sterile saline on the back table. Cylindrical, cannulated sizing guides are used to determine the optimal allograft diameter, and a guide pin is drilled perpendicular to the femoral condyle in the appropriate position. The sizing guide is removed and a cannulated reamer (Arthrex) of the measured diameter is placed over the guide pin to ream to a depth of 6 to 8 mm. Once reaming is completed and the reamed bone is collected for use as bone graft during the osteotomy, a ruler is used to measure the reamed defect at the 12-, 3-, 6-, and 9-o'clock positions. The donor allograft is then prepared on the back table. A bushing (Arthrex) is firmly held by an assistant over the desired location. A circular donor harvester (Arthrex) is used to create a cylindrical osteochondral plug of the diameter to match the reamed recipient site. The plug is then cut using a sagittal saw to the measured depth of the reamed defect. Pulsatile lavage with bacitracin-mixed saline is used to copiously irrigate both the donor allograft and the recipient site. The allograft plug is initially press-fit by hand and gently tamped into place (Figure 1). This technique has previously been described by the senior author with concomitant procedures.[8,9]

*High Tibial Osteotomy.* A longitudinal incision was extended from the medial parapatellar arthrotomy along the anteromedial portion of the proximal tibia, and the medial collateral ligament was elevated from the subperiosteal bone. With the knee flexed to 10° of flexion, 2 osteotomy drill pins were inserted on the medial tibial diaphysis toward the fibular head with the knee under fluoroscopic guidance. With the use of an oscillating saw and osteotomes, the proximal tibia was cut on the anterior, posterior, and medial borders, leaving the lateral cortex intact. An HTO wedge plate (Arthrex opening wedge osteotomy system) was inserted along the anteroposterior plane. The degree of correction is based on the preoperative weightbearing leg length radiographs. Each patient had the mechanical axis shifted to the lateral tibial eminence. Two 6.5-mm cancellous screws were inserted proximally and two 4.5-mm cancellous screws were inserted distally.[AQ8] Bone graft obtained at the time of osteochondral allograft reaming was harvested and used for bone graft at the osteotomy site. This was also augmented with cancellous bone chips or iliac crest allograft when necessary (Figure 2).

## Rehabilitation Protocol

All patients were instructed to maintain heel-touch weightbearing for 6 weeks postoperatively. For the first 2 weeks, patients wore a hinged knee brace locked in extension that was only removed for hygiene and home exercises. Patients utilized a continuous passive motion (CPM) machine for 6 hours per day beginning on postoperative day 1 at 0° to 40° and advanced 5° to 10° daily as tolerated. After 2 weeks, the brace was then locked at 0° to 90° of motion and

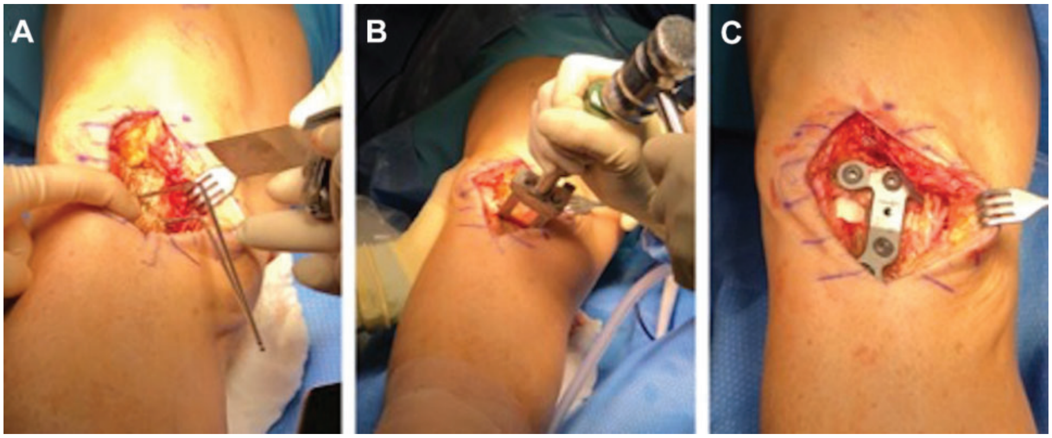


**Figure 2.** High tibial osteotomy for varus deformity correction. (A) Two osteotomy drill pins are placed in the medial tibia directed toward the fibular head using fluoroscopy guidance. (B) An osteotome wedge is used to correct the deformity by the appropriate amount based on preoperative imaging. (C) An osteotomy wedge plate is placed along the anteromedial tibia and iliac crest allograft is used to fill the osteotomy site.

patients advanced hip, core, and quadriceps strengthening. CPM is continued 6 hours per day up to 90° of motion as tolerated. At 6 weeks postoperatively, patients advanced weightbearing status by 25% weekly until full weightbearing status was achieved. Additionally, the brace was discontinued and patients progressively advanced exercises to include heel raises, closed chain exercises, eccentric quadriceps and hamstring strengthening, gait normalization, and core and hip strengthening. After 8 weeks postoperatively, patients advanced to full range of motion and full weightbearing while continuing to advance home strengthening exercises and began to use a stationary bike. After 6 months postoperatively, patients were able to advance to all activity as tolerated.

TABLE 2
Patient Characteristics for Patients Undergoing HTO + OCA[a]

| | Value |
|---|---|
| Age, y | 36.97 ± 7.52 (27-49) |
| Body mass index, kg/m$^2$ | 27.92 ± 3.87 (21-34) |
| Male sex | 22 (78.6) |
| Operation on dominant leg | 17 (58.6) [AQ2] |
| Average degree of correction | 8.48 ± 2.24 (5.0-15.0) |
| Kellgren-Lawrence grade (I/II) | 25 (89.3) |
| Concomitant meniscal allograft transplantation | 13 (46.4) |

[a]Data are presented as n (%) or mean ± SD (range). HTO, high tibial osteotomy; OCA, osteochondral allograft transplantation.

## Statistical Analysis

Statistical analysis was performed using Excel (Microsoft Corp) and Stata version 13.0 (StataCorp). Descriptive analysis of continuous variables included means and standard deviations, whereas frequencies and percentages were reported for discrete variables. A simple $t$ test was used to compare the number of days patients participated in physical activity pre- and postoperatively. Finally, a binary logistic regression was performed to assess for patient characteristics and surgical variables predictive of RTS. Statistical significance was set at $P < .05$.

# RESULTS

## Patient Characteristics

Patient characteristics are provided in Table 2. A total of 26 patients (92.9%) had undergone previous surgery on that same knee. Previous surgical procedures included microfracture (n = 7; 25.0%), meniscectomy (n = 11; 39.3%), anterior cruciate ligament reconstruction (n = 1; 3.6%), autologous chondrocyte implantation (n = 1; 3.6%), osteochondral autograft transfer (n = 1, 3.6%), and previous HTO (n = 2; 7.1%). Those who had a previous HTO underwent a second procedure because of continued pain secondary to inadequate correction. Patients indicated that the most common reasons for pursuing concomitant HTO and OCA were to relieve pain (n = 23; 82.1%), the desire to stay physically active (n = 18; 64.3%), to improve motion (n = 14; 50.0%), and to prevent arthritis (n = 6; 21.4%).

## Sports and Activity Outcomes

Of the patients, 24 (85.7%) reported participating in sports within the 3 years leading up to their concomitant HTO and OCA, and 19 patients (79.2%) resumed playing at least 1 sport postoperatively at a mean 11.41 ± 6.42 months. However, only 10 patients (41.7%) reported returning to their preoperative level. Twenty patients (83.3%) reported discontinuing at least 1 sport they had participated in before surgery. Patients reported that their number of days participating in sporting activities per week decreased from 4.29 ± 1.81 days preoperatively to 2.88 ± 2.25 days

TABLE 3
Patient Satisfaction After HTO + OCA[a]

| Level of Satisfaction | Overall Satisfaction | Satisfaction With Return to Sport |
|---|---|---|
| Extremely satisfied | 8 (28.57) | 6 (21.43) |
| Satisfied | 8 (28.57) | 5 (17.86) |
| Somewhat satisfied | 5 (17.86) | 5 (17.86) |
| Somewhat dissatisfied | 4 (14.29) | 8 (28.57) |
| Dissatisfied | 3 (10.71) | 4 (14.29) |

[a]Data are presented as n (%). HTO, high tibial osteotomy, OCA, osteochondral allograft transplantation.

postoperatively ($P = .004$). When asked about their postoperative level of physical fitness, 17 patients (58.3%) [AQ3] reported being the same or better than their preoperative level. Preoperatively, 17 patients (70.8%) were recreational athletes, 3 (12.5%) were competitive athletes, 3 (12.5%) were collegiate athletes, and 1 (4.2%) patient played at the Minor League level with potential for professional play. Postoperatively, 18 patients (75.0%) were recreational athletes and 1 patient (4.2%) returned at the collegiate level. Ten patients (41.7%) reported being able to return to their preoperative level of sports intensity.

Fifteen patients (62.5%) [AQ4] reported being at least somewhat satisfied with their ability to play sports after their concomitant HTO and OCA (Table 3). Among the 20 patients who stopped participating in at least 1 sport after surgery, 14 patients (70.0%) cited a desire to prevent further damage to the knee, 11 patients (55.0%) cited persistent pain, 6 patients (30.0%) reported persistent swelling, 5 patients (25.0%) cited fear, 2 patients (10.0%) cited a decision to pursue other activities, and 1 patient (5%) cited a loss of interest in the activity.

The direct rate of RTS for the most commonly reported sports was 100% (5/5) for yoga, 100% (5/5) for light weight lifting, 85.7% (6/7) for heavy weight lifting, 75.0% (6/8) for cycling, 70.0% (7/10) for golf, 66.7% (4/6) for cross-fit/high-intensity interval training, 50.0% (5/10) for swimming, 33.3% (3/9) for running, 0.0% (0/6) for soccer, and 20.0% (1/5) for basketball (Figure 3).

Preoperative variables including age, sex, body mass index, reoperation, preoperative Kellgren-Lawrence $\geq$3, and preoperative status as a competitive or noncompetitive athlete were not associated with RTS ($P > .05$).

## Outcomes

Preoperative outcome scores were not available for patients included in this investigation. The mean postoperative SANE score was 71.18 ± 21.88 (range 20-100), the mean VAS pain score was 3.21 ± 2.56 (range 0-8), and the mean Marx Activity Scale score was 2.52 ± 3.47 (range 1-8). A total of 21 patients (75.0%) stated that in retrospect they would decide to have surgery if given the opportunity to revisit their decision, and 21 patients (75.0%) reported being at least somewhat satisfied with the overall outcome of their procedure (Table 3). Twenty-four patients (85.7%) reported experiencing at least 1 symptom in their knee since their surgery: 14 patients (50.0%) reported occasional pain, 11 patients (39.3%) reported stiffness, 9 patients (32.1%) reported swelling, 8 patients (28.6%) reported frequent pain, 4 patients (14.3%) reported catching/locking, and 4 (14.3%) patients reported instability.

## Complications

At final follow-up, 14 patients (50.0%) had returned to the operating room for further treatment after concomitant HTO and OCA. Four patients (14.3%) underwent hardware removal for painful hardware, 4 patients (14.3%) underwent arthroscopic debridement, 3 patients (10.7%) underwent arthroplasty for persistent symptoms (1 unicompartmental knee arthroplasty, 2 total knee arthroplasty), 2 patients (7.1%) underwent arthroscopic lysis of adhesions, and 1 patient (3.6%) underwent irrigation and debridement for postoperative infection.

## DISCUSSION

This investigation demonstrated that 79.2% of patients were able to resume participation in at least 1 sporting activity at a mean 11.41 ± 6.42 months after concomitant HTO and OCA. However, only 41.7% of patients reported they were able to return to the same or greater level of intensity of their chosen sports after concomitant HTO and OCA. Additionally, this study reports the sport-specific rates of return after concomitant HTO and OCA. In young, active patients, adequate patient-reported outcome scores or survivorship may not truly recapitulate treatment success after HTO + OCA. Therefore, the results of this investigation are essential when educating and counseling young, active patients with varus deformity and medial femoral condyle focal chondral defects about postoperative expectations after HTO + OCA.

It has previously been reported that 96% of patients are able to return to work after HTO with concomitant OCA.[13] Furthermore, Hsu et al[26] demonstrated that patients experience statistically significant improvements in the International Knee Documentation Committee score and report a high rate of satisfaction (92%). It is important to note that a ceiling effect exists with PROMs; therefore, statistically significant improvements in functional outcome measures may not be clinically relevant.[23,28] Evaluating RTS may provide a more accurate representation of postoperative outcomes in young, active patients. RTS has been investigated for HTO and OCA independently, with data on OCA being most comparable with our cohort, as studies reporting isolated HTO have an older population and indications of diffuse medial compartment arthritis instead of a focal chondral defect.[3,27,44,45] Nielsen et al[38] reported a 75.2% rate of RTS after isolated OCA of the knee, and McCarthy et al[36] reported a 77% rate of RTS in young, competitive athletes, which are similar to the rate of the present study. A meta-analysis and a systematic review have both reported overall rates of RTS after OCA of 88%.[5,30] However, direct comparison with a meta-analysis or systematic

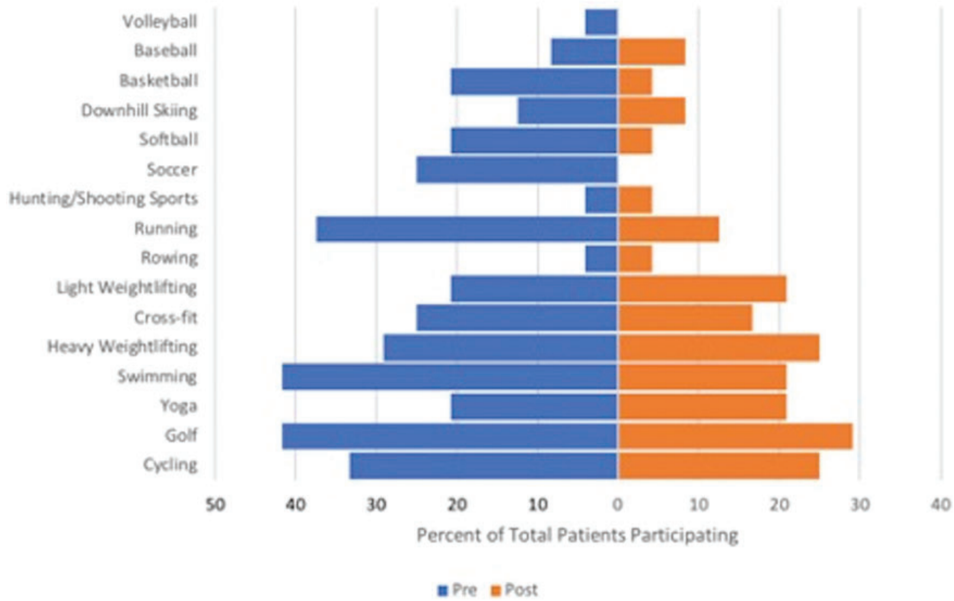


**Figure 3.** Sport-specific return to sport.[AQ9]

review is inherently flawed because of the inclusion of multiple techniques, patient populations, OCA locations, and methods of evaluating RTS.

In addition to reporting overall RTS, this study also investigated the postoperative sports level of intensity and level of competition. In this study, 41.7% of patients reported they were able to return to the same or greater level of intensity of their chosen sports after concomitant HTO and OCA. Additionally, only 1 patient was able to return to competitive sports, while the rest participated recreationally. Krych et al[31] previously evaluated RTS based on level of intensity after isolated OCA of the knee, reporting 88% limited RTS and 79% full RTS. Concomitant HTO and OCA has previously been shown to show significant improvement in PROMs and sustained graft survival.[26] The results of this investigation suggest that patients with varus malalignment and medial femoral condyle chondral lesions, as well as patients with isolated chondral lesions, may be unable to return to their previous level of sports. Additionally, evaluating RTS intensity and level of competition provides an important aspect of evaluating patient functional outcomes. Last, RTS is dependent on the intensity of the sport. High-intensity activities, such as running, basketball, and soccer, had low rates of RTS. On the other hand, low-intensity sports, such as yoga, golf, and weightlifting, had higher rates of RTS after HTO + OCA. It is imperative that patients be appropriately counseled that they may RTS at their previous level of function; however, return to higher-intensity activities may be limited.

In comparison with a cohort of patients who underwent isolated HTO by the senior author with a similar duration of follow-up,[33] a lower rate of patients returned to sport (79.2% vs 88.2%) after HTO + OCA. Furthermore, patients in this investigation demonstrated a higher postoperative SANE score (71.2 vs 66.7) as well as a higher level of pain (3.2 vs 2.9) and a lower average Marx Activity Scale score (2.5 vs 3.1). It is possible that patients may exhibit a lower rate of RTS and lower functional outcomes because of the added morbidity of an additional procedure. However, it is difficult to directly compare these cohorts since patients undergoing isolated HTO were older (42.7 vs 37.0 years) and had a higher grade of osteoarthritis at baseline (90% vs 10.3% of Kellgren-Lawrence grade III/IV). In comparison with patients undergoing OCA,[10] patients in the present investigation exhibited a similar rate of RTS (79.2% vs 75%-82%). Differences in activity level and subjective functional scores may also be because of the increased morbidity associated with the osteotomy, expectations, or differences in baseline patient characteristics. Furthermore, patients exhibited variable improvement or decline in Marx Activity Scale after isolated OCA.[10] Although preoperative Marx Activity Scale was not collected in this investigation, HTO + OCA carries a theoretical advantage that the HTO can offload the medial compartment, which creates a more suitable environment for the osteochondral allograft to incorporate into the host tissue.[29] Therefore, patients with chondral defects and varus malalignment may undergo HTO with concomitant OCA to optimize the biomechanical microenvironment for cartilage restoration.[12,15,37]

In this investigation, many patients (50.0%) underwent some type of reoperation, but only 3 patients (10.7%) required conversion to arthroplasty at a mean follow-up of 6.63 ± 4.06 years. The most common procedures performed were hardware removal and arthroscopic debridement. In comparison with patients undergoing OCA, patients undergoing HTO + OCA demonstrated a similar rate of failure at 5 years postoperatively (10.7% vs 13.3%).[11] Similarly, Cavendish et al[6] demonstrated that the rate of failure after OCA was approximately 18%. Failure of OCA may be a result of immunologic rejection, failure of osseous incorporation, and chondrocyte death that causes breakdown of cartilage matrix.[46] Furthermore, patients in this investigation demonstrated a higher rate of reoperation (50.0%) than what has been reported in previous systematic reviews (30.2%-37.0%).[6,46] The variation in reoperation rate is likely related to differences in baseline patient characteristics, patient expectations, and indications for reoperation. Furthermore, the majority of patients (n = 24; 85.7%) reported experiencing at least 1 problem with their knee since their surgery, with the most common issues being pain, stiffness, and swelling. These results demonstrate a discrepancy between graft survival, persistent symptoms, and return to preinjury activity level and further emphasize the importance of preoperative patient education. Although HTO + OCA allows patients to RTS and has a high rate of satisfaction, patients may continue to experience some degree of residual symptomatology and may return to the operating room for further intervention. These findings can help in counseling patients on appropriate postoperative expectations.

The limitations of this study include the retrospective design, male predominance within the patient population, and patients who were lost to follow-up. Despite a similar study design having previously been employed to evaluate RTS for other orthopaedic procedures, the retrospective questionnaire may have contributed to significant recall bias.[17-21,34,35] The sample size of this investigation is also limited; however, this is a homogeneous cohort of patients who underwent HTO + OCA with a single surgeon. Although it is not uncommon to treat meniscal injuries at the time of OCA, the inclusion of patients who underwent concomitant meniscal allograft transplantation may affect the results of the investigation. Preoperative PROMs were unable to be collected, which limits the interpretation of the postoperative measures. The lack of preoperative PROMs makes it difficult to discern the magnitude of improvement postoperatively. Additionally, postoperative legacy outcome measures were not collected to avoid respondent fatigue and to improve compliance. However, this hinders a standardized method to assess postoperative improvement after HTO + OCA. Additionally, our cohort was composed of 78.6% male patients, which may limit the generalizability of these findings, although we performed a multivariate analysis to control for these factors. Finally, 28.2% of the cohort was not able to be reached for follow-up, requiring them to be excluded from the analysis.

## CONCLUSION

In young, active patients with varus deformity and focal medial femoral condyle chondral defects, HTO with concomitant OCA allows 79.2% of patients to RTS by 11.41 ± 6.42 months postoperatively. However, only 41.7% of patients were able to return to their preinjury level or better. It is imperative that patients be appropriately educated to manage postoperative expectations regarding sports participation after HTO + OCA.

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