

High Tibial Valgus Osteotomy and Functional Outcome

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Abstract

Background: This is a case series of 76 knees of 62 patients who underwent upper tibial valgus osteotomy for treatment of medial compartment osteoarthritis during a 20-year period and who were followed for a mean of 7.6 years.

Methods: The patients were evaluated by validated outcome assessment systems of general health status short form (SF-36), the Western Ontario McMaster osteoarthritis index (WOMAC), McMaster Toronto arthritis patient preference questionnaire (MACTAR) and also knee society clinical rating system (KSS). Two control groups—one consisting of 60 patients with similar age with osteoarthritis who had not received any surgical treatment and another 60 patients who had received knee replacement for osteoarthritis—were also studied. The results were compared among these three groups.

Results/Conclusion: Tibial osteotomy caused improvement in SF-36 and WOMAC scores compared to the non-operated control group, but it did not do so when it was compared with knee arthroplasty. The mean±SD KSS was 103.37±12.19 with a failure rate (defined as candidacy for knee arthroplasty) of 28.94%. Improvement in patients' pain level, social activity, housework activities and self-esteem was observed. Stair navigation, surface walking, getting on and off a car were not significantly better than the non-operated group.

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Keywords • Osteoarthritis, knee • osteotomy • treatment outcome • knee replacement arthroplasty

Introduction

Osteoarthritis of knee is more commonly seen in medial compartment in the initial stages. In order to unload the arthritic medial side, valgus osteotomy has been used extensively. Following the initial description by Jackson and Waugh about changing the body weight axis through the knee joint, Coventry upper tibial closing wedge osteotomy became very popular.^{1,2} With improvements in designs, techniques and instrumentations in knee arthroplasty, there has been a decline in the number of osteotomies performed for knee osteoarthritis.³ Nevertheless, more physically-active and younger group of patients with single compartment arthritis with good knee motion would benefit from high tibial osteotomy (HTO), with the idea of delaying the knee replacement surgery till they are older. The higher cost of knee replacement, its limitations

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in doing certain activities such as heavy labor work, and, in certain societies, some other social restraints such as floor-sitting habits, use of special toilets, etc, all would still make HTO a good operative option.

The results of HTO have been extensively reported in the literature.⁴⁻⁷ Results of 80% excellent or good in the first five years, with gradual deterioration down to about 60% after 15 years have been reported.^{6,8} The more common methods of reporting has been based on pain experienced, radiographic findings and range of motion.^{8,9} The knee society clinical rating system (KSS) which combines some of the above objective parameters with some functional parameters has been another method of assessment.¹⁰ The more recent systems of functional evaluation according to patients' own assessment and feelings and based on their expectations have been used to some extent in HTO.¹¹ Patients general health status and measurement of end results which include relevant clinical outcomes important to the process of care, are obtainable through questionnaires exemplified in short form 36 (SF-36),¹² Western Ontario and McMaster university osteoarthritis index (WOMAC),¹³ or McMaster Toronto patient preference questionnaire (MACTAR).¹⁴

We are reporting the results of HTO in Iran where special social customs require sitting on the floor cross-legged for meals or in social gatherings, sitting with full knee bent for praying and using squatting position for toiletting. The functional outcome instruments, as well as KSS were used for evaluation and reporting.

Patients and Methods

In this study, patients with knee osteoarthritis who underwent valgus HTO were studied. All patients were operated by a single surgeon during a 20-year period. Of 82 patients who had undergone HTO, 62 (76%) came back for follow-up. Those consisted of 48 women and 14 men with a mean follow-up of 7.6 (range: 1–20) years. These 62 patients with 76 knees (group I) operated were evaluated clinically and radiographically.

Four functional well-validated questionnaires which assess self-reported pain, physical function, mental health and personal satisfaction were completed for all patients to determine their outcomes. The questionnaires included SF-36,¹² WOMAC,¹³ MACTAR,¹⁴ and KSS.¹⁰

After complete clinical examinations of the knees, standing radiographs were taken. Thereafter, the status of patients' general health, knee arthritis and subjective functional

results of the surgery were assessed by all the above criteria.

Sixty more patients were recruited as one of the control groups (group II). Those patients had symptomatic primary osteoarthritis of knee and aged between 35 and 63 years. They were selected from orthopedic or rehabilitation units of Nemazee Hospital. This group of patients had to have non-traumatic non-inflammatory unicompartmental osteoarthritis with good range of motion of the knee who could be candidates for HTO. They all filled the four above-mentioned functional assessment questionnaires. Radiographs were also taken.

A third group (group III) consisting of 60 successive patients who underwent total knee replacement (TKR) by the same surgeon during a 15-year period,¹⁵ were also included in this study.

The data on all these three groups of patients were collected and analyzed by SPSS 11.5. Kruskal-Wallis and Mann-Whitney U tests were used to compare the three study groups. A $p < 0.05$ was considered statistically significant.

The HTO surgeries were all done by the senior author (GHS) with a uniform technique including a curved antero-lateral skin incision with resection of proximal tibiofibular joint, removal of a laterally-based wedge of bone above the tibial tubercle, valgus osteotomy with one cm anterior shift of distal fragment to decompress the patella, fixation with two staples, prophylactic subcutaneous fasciotomy and finally cast immobilization for six weeks. The size of the removed bone wedge was measured to give a 7-degree valgus to the knee. Overcorrection was avoided since the first cases did not, cosmetically, like the exaggerated knee valgus deformity.

The radiographs were categorized into five classes according to the severity of osteoarthritis. The classes included grade 0 when knees are completely normal; grade I when doubtful narrowing of joint space and possible osteophytic lipping were present; grade II when doubtful osteophytes and possible narrowing of joint space existed; grade III when moderate multiple osteophytes, definite narrowing of joint space, some sclerosis and possible deformity of bone ends occurred; and grade IV when large osteophytes, marked narrowing of joint space, severe sclerosis, definite deformity of bone ends, and/or possible subchondral cyst were present.¹⁶

Results

This study reviewed the HTO in 62 patients with 76 knees. The patients had a mean follow-up of 7.6 (range: 1–20) years.

Sixteen patients (22 knees) had significant clinical and radiographic changes and would have been candidates for knee arthroplasty (29% of knees). These patients were, on average, 8.4 years post-surgery (with eight cases with >8 years of follow-up). These 16 patients, despite their severe initial knee osteoarthritis, had very good pain relief and functional improvement upto 4.7 years. Over half of these candidates were not prepared for knee arthroplasty mainly due to financial restrains or inability to adjust to the required life style changes necessary for joint arthroplasty.

Fifty-five (92%) patients were quite satisfied with their operations in the first few post-operative years. The five unhappy ones had no clear cut radiographic findings to show they should not have been selected for HTO.

When we looked at satisfaction rate in 15 patients with longer follow-ups (mean: 12.8; range: 11–20 years), there were only seven (47%) patients who were still happy with their HTO.

The mean±SD collective SF-36—a measure of general health—was 60.08±6.48 for those who underwent HTO, 57.23±4.71 for those in the control group II, and 67.2±17.97 for patients who underwent total knee arthroplasty (TKA) (group III) (table 1). Although a trend towards a better health status was seen in patients that underwent osteotomy compared to those with non-operated arthritic knees, the difference was not statistically significant ($P=0.5$).

Table 1: The mean±SD measured assessment scores in the three study groups—group I: HTO cases; group II: non-operated cases; and group III: TKA cases.

	Group I	Group II	Group III
SF-36	60.08 ±6.48	57.23 ±4.71	67.2 ±17.97
WOMAC	56.48 ±6.91	58.22 ±4.62	47.78 ±21.81
KSS	103.37 ±12.19	105.89 ±9.23	134 ±39

Health status after TKA, however, showed a significantly ($P=0.006$) improved outcome when compared to group II patients.

Those who underwent HTO did not have a score on SF-36 significantly different from those with TKA ($P=0.1$).

Examining some more specific items in SF-36 revealed more points worth mentioning: 16 (26%) patients of group I viewed their health as "good" or "excellent." None of the control patients, however felt "excellent" about themselves. Thirty-two (53%) patients of group I had normal social activities in terms of keeping their daily activities and relation to their family and friends. On the other hand, 37 (62%) patients in group II had problem with these issues. Feeling pain in the month prior to this survey was four-fold less in those that under-

went HTO than group II patients. Moreover, the ability for house-activity performance was 1.5-fold better in group I compared to group II patients. These four parameters reflected a favorable response to surgery.

The WOMAC score—an arthritis-specific questionnaire—would be 113 in the worst case-scenario. Lower scores mean a better status. The mean±SD score were 56.48±6.91, 58.22±4.62, and 47.78±21.81, in group I, II, and III patients, respectively (table 1). These figures showed significant improvement with TKA ($p<0.05$) as compared to non-operated cases (group II). The score was not significantly different between HTO and group II patients.

WOMAC questionnaire refers to five groups of questions, namely pain, joint stiffness, emotional, physical and social functions.

Looking carefully into the "physical function" section in our osteotomy patients, improvements in certain activities such as sitting on the floor and chair, standing, getting out of bed, using Persian-style toilet, daily house activities and shopping could be apparent in the operated cases (group I). Difficulties in navigating stairs, surface walking, getting on and off a car and bending to pick objects up the floor, were some of the items that did not improve with surgery—group I scores were not better than group II.

The MACTAR questionnaire—reflecting patients' expectations and their achievements—revealed that their main functional disabilities in descending order included stair navigation (70%), use of Persian-style toilet (67%), kneeling for prayers (63%), getting up from the floor (62%) and from the sitting position (62%) (fig 1). The two control groups—the non-operated and TKA patients—had very similar complaints. Both groups, however were hoping for a post-operative improvement in walking, rising from the floor, less pain and better stair navigation. The ability to use Persian-type toilets or ability to sit on the floor for prayers were at the bottom of their preference list. The HTO surgery fulfilled their expectations by providing better walking (54%), lesser pain (43%), easier raising from the floor (23%), easier household activities (16%) and more acceptable gait and limb alignment (11%), in descending order (fig 2). Eight percent of patients did not achieve any of their expectations.

The mean±SD KSS were 103.37±12.19, 105.89±9.23, and 134±39 in group I, II, and III patients (table 1). According to the knee score section of KSS, the range of motion of knee in 23 (30%) of those who underwent HTO remained in an acceptable range of 10–120 degrees. A flexion contracture of up to 20 degrees was seen in only 11 (14%) patients. All but one patient, maintained >90 degrees of flexion. All

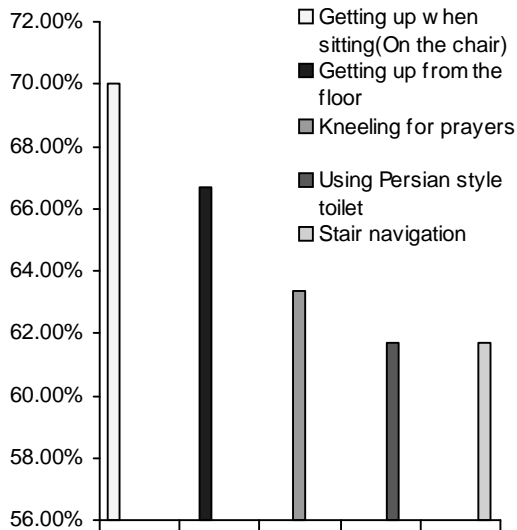


Fig 1: Relative frequency of main functional disabilities before HTO in group I patients regarding to MACTAR score.

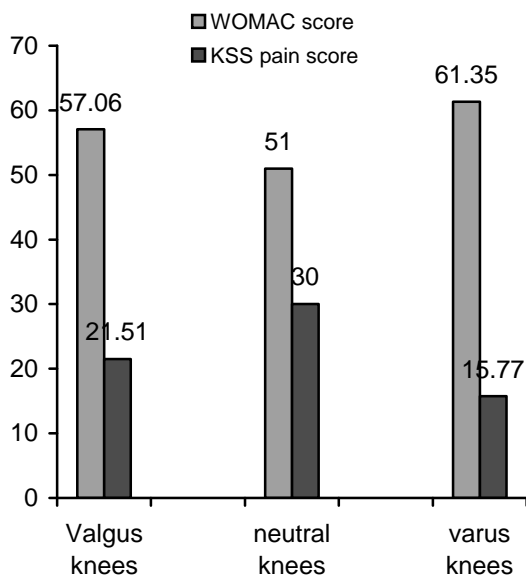


Fig 2: Relative frequency of patients who achieved their different expectations after HTO procedure according to MACTAR score.

knees were stable in antero-posterior and mediolateral testing. No extension lag was observed. According to functional score of KSS, the pain was reported as severe in 34%, moderate in 31% and mild in 28% of patients. Only 6% had no knee pain during follow-up.

In terms of ability to walk, almost 40% could walk either 10 blocks or more. Almost 7% of patients would not walk outside their house. To climb up or down the stairs, almost 70% had to use stairs' hand rails, 20% could not use stairs at all, and only 10% had normal stair navigation.

Regular use of walking aids—primarily cane (which is often despised by Iranian patients)—was observed only in 17 (28%) patients.

The radiographic osteoarthritic changes were measured as grade IV in 66% and grade III in 34% of patients. In non-operated cases (group II), 24% had grade IV changes, 64% had grade III and 12% had grade II changes. We could access to only 19 good-quality pre-operative radiographs in group I. The change in radiographic grading with one grade worsening was seen in 11; eight cases remained in grade III or IV, even several years later. With this few number of radiographs we could not therefore make any strong comments regarding the expected x-ray changes after HTO.

The knee alignment showed 1–15 degrees valgus in 51%, 1–15 degrees varus in 41% and neutral changes in 8% of cases. Considering the objective of seven degrees valgus change in the initial post-operative knee alignment, the figures indicated recurrence of varus deformity in 49% of cases.

To see the relation of alignment to functional status of patients, the WOMAC and KSS results were stratified according to knee alignments. Those with varus alignment in the final follow up had lower WOMAC and KSS scores (61.35 and 15.77, respectively) than patients with neutral (51 and 30) or valgus alignment (57.06 and 21.51). The difference, however, was not statistically significant in either groups. We could not, therefore claim that an overcorrection into valgus alignment would have necessarily resulted into a better outcome (fig 3).

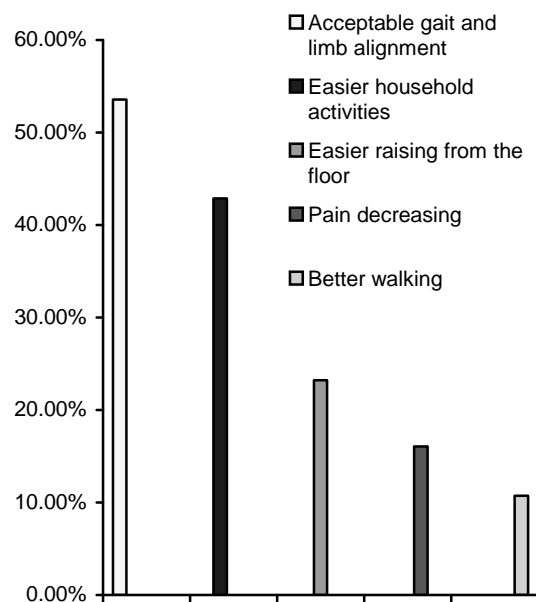


Fig 3: The mean WOMAC and KSS pain scores for patients after HTO with different knee alignments

Discussion

The results of valgus tibial osteotomy for knee osteoarthritis have been extensively reported in the literature. A medial compartment osteoarthritis in a young patient with good arc of motion is expected to give a satisfactory motion, better function with less pain in 80% of the time after five years. This would, however, deteriorate with time.^{5,8,17} Arthroplasty, however, despite excellent pain relief and improved function, would not be a life-long remedy for a young person.^{15,17-20} In addition, it is expensive and also imposes some functional limitations—things which are not always acceptable in developing countries. Open medial wedge osteotomies preserve better bone stock, and cause less patella infra, thus providing an easier future conversion to knee arthroplasty.²¹⁻²³ This kind of osteotomy is, however, a more extensive surgery, with more possible complications; and the long-term results are not clearly evident yet.²⁴ Unicompartmental replacement for medial osteoarthritis has had its share of enthusiasm and rejection over the years.²⁵⁻²⁸ The difficulty in revising a unicompartmental to a total arthroplasty, has been the concern for some people, making them favor HTO over uni-compartmental replacement for medial compartment osteoarthritis.²⁹ The newer designs of uni-compartment replacement seem to take out much less bone, and the results, when used with proper indication, are encouraging.³⁰⁻³² The economic issues and yet-unclear long-term results are some of the problems with unicompartment arthroplasty.

The more common patterns of reporting the end results of knee surgery procedures in the past were on the basis of radiographic changes, range of motion of knee or a rough patient's subjective satisfaction.^{8,9} It has now become clear that pure objective data in many disease conditions and in most musculoskeletal illnesses are not reliable reflections of patient's improvement or regression. The way a patient functions and the change that is produced in his/her functions following an intervention seem to be better parameters to evaluate. For this reason, many scales of assessments have been designed to measure the patients' general feeling about their own health and their feelings regarding a particular disease, such as knee osteoarthritis, and also the achievement of their expectations after an intervention (such as tibial osteotomy or knee replacement for osteoarthritis of knee).^{12-14,33,34} Some of the more tested and validated instruments and systems are SF-36 for general health,¹² WOMAC—a disease-specific osteoarthritis tool—,¹³ and MACTAR—an arthritis-

patient-preference scale.¹⁴ The KSS, although not a purely functional score, is a tool that combines pain with stability testing and motion with some functional questions, and is still a widely-used tool for knee evaluation in many articles.^{7,15,35}

The WOMAC, as a specific measure for arthritis-related functions has been validated, modified and adopted in different papers.^{34,36,37} Knee injury and osteoarthritis outcome score (KOOS) which is the WOMAC score with some modifications, has been claimed as a more responsive evaluation system for osteoarthritis in Sweden.³⁸ Patient acceptable system state (PASS) for reporting knee and hip arthritis has also been advised by Tubach and his group from France. They have used WOMAC with a visual analogue scale for pain and function.³⁹ The American Academy of Orthopedic Surgeons has used a lower limb outcome score for all conditions of the lower limb and claims it to be comprehensive and efficient.³³ This includes SF-36 as well. Comprehensive osteoarthritis test (COAT), aggregated locomotor function (ALF) and social support questionnaire (SSQ) are lists of some of the used instruments for evaluation of knee function.^{37,40,41} There is not very much to find about the use of functional evaluation systems in HTO in the English literature. A group from Sweden used a functional assessment system (FAS) in 57 patients who underwent valgus HTO. The only goal achievements in their group were improvement in pain and leisure time activities in a short follow-up of 6–12 months. The rest of lower limb functions did not show any improvements and only 40% reached the treatment goals.¹¹ The present research with a mean of 7.6 years of follow-up using different assessment tools revealed similar results. The WOMAC for those who underwent HTO was not significantly better than that for the control non-operated osteoarthritic knees. Some specific functions, however, improved and were quite significant for our patients. Among these were the ability to sit on the floor, stand for a period of time (like at the kitchen sink), get out of bed, use the Persian-type toilets, and doing daily house activities. The ability to comfortably go up and down the stairs, walk long distances, get in and out of a car did not improve, nevertheless. Wolfe and colleagues in their "brief assessment questionnaire" concluded that going downstairs and difficulty shopping were the best predictors of change in health status in cases of osteoarthritis.⁴² The difference with the Swedish findings might be partly due to a shorter follow-up in that study. It is also necessary to consider the social habits which bring about different priori-

ties depending on where one lives. The need for full knee flexion is obvious in some cultures including ours and Japanese population. Koshino, *et al*, from Japan have suggested medial and lateral retinacular release with HTO to improve floor-sitting capabilities.⁴³

Some of the items in the WOMAC or MACTAR questionnaires that we had modified, seemed to have been useful. In our population, sitting on a carpeted floor or using the Persian-style toilet, are the necessities of life. The western-type toilets or chair and bench for sitting are not available in most places, and these are some of the reasons for not being able to advocate knee arthroplasty for the majority of patients in our practice. It is important to note that the type of toilet use or position of praying (squatting with full knee bent) were not the very top expectations of this group of patients, and they would be happy as long as they could get some pain relief, walk better and get up easier from a sitting position.

The general health measure (SF-36) had a better but not statistically significant score in those who underwent HTO compared to the non-operated cases. The patients often felt better about themselves, had less pain and greater social companionship transactions. Those who underwent knee arthroplasty, did not necessarily, participate in social gatherings in our population (for the reasons mentioned earlier).¹⁵ This might be an added benefit in this part of the world for those who are undergoing HTO.

The mean±SD KSS was 103.37±12.19 for HTO and 134.37±39 for the arthroplasty group. This is somewhat comparable to many similar papers on this subject.⁴³⁻⁴⁵ However, the overall KSS scores in our HTO patients were slightly lower than some of other reports,^{20,44}— particularly, for the functional part of KSS. We had similar findings of lower KSS in our TKR cases as well.¹⁵ There might be psychosocial reasons and the difference in patients' expectations accounting for such observations. Besides, many of our cases had severe osteoarthritis with more than one compartment involved. They were not however candidates for TKR due to poor social or economic conditions and their need to return to heavy work activities.

A study conducted in Japan with a 19-year follow-up reported a KSS of 167.⁴⁵ A paper from China stressing on tibio-femoral angle correction and candidacy for TKR as the point of failure, reported good and excellent results in 78.2% of patients and a failure rate of 11.8 % after 7.5 years of follow-up.⁷ The scores reported in both these papers were somewhat better than those of our study. Some of the social habits mentioned in our population are similar to those of Japan and China. A good,

long-lasting surgery as claimed by some of the reports from these places, could not be supported by our observation. The very detailed questionnaires and assessment systems we used, may account for some of the observed discrepancies. Many of our patients had more than one compartment involved at the time of HTO. They received HTO because they could not accept joint replacement. Therefore, the results would deteriorate faster. It was, however, interesting to note that all of our patients but five were happy with the surgery they had and would still have undergone the operation having known then what they currently know.

Our failure rate was 28% which was worse than China's report. The majority of the HTO cases we interviewed were overweight ladies, with no regular physical exercises and often emotionally depressed.⁴⁶ These might be reasons for the difference observed in our cases. The body mass index, as an important factor in regression of good initial results, has been discussed by many authors;^{5,7,47} however, a higher chance and earlier failure in thinner patients has also been reported.⁴⁸ A study from Italy on 92 patients reported a KSS of 70 after 15 years of follow-up. The total score and the functional scores in that group were lower than ours but they obtained a better pain control in their patients.³⁵

The degree of valgus alignment obtained at surgery and, more so, the remaining valgus alignment with passage of time have been reported as positive factors affecting the results.^{5,7,8,35} Almost half of our patients had maintained their valgus alignment; 41% had regressed to valgus and only 8% had converted to a neutral alignment. The total WOMAC score and pain section of KSS showed best results with knees in neutral, followed by valgus knees. Although a higher valgus alignment and over-correction is claimed to be associated with better results,^{5,7,8} the functional scores used in this paper did not support the idea. In fact many of our female patients would strongly object towards the idea of a knee in valgus alignment.

HTO in social settings, where floor sitting (rather than chair sitting) and use of toilets without seat are common, and also where economy, in terms of health-insurance coverage, are important issues, is one of the useful armamentarium in the hand of an orthopedic surgeon. An improvement in functional scoring, particularly in items such as pain, surface walking, use of Persian-style toilets, floor sitting, shopping, participation in social activities and self-esteem are to be expected in over seven years period. The SF-36, WOMAC, and MACTAR are useful instruments for evaluation,

but are not probably very sensitive for osteoarthritis cases that have undergone HTO. The results are not often statistically very significant, though trends towards better functions in some of the questions are evident. Specific questions related to the usual daily activities in any particular region must be added to the above-mentioned questionnaires to make them more sensitive tools. In our region, we still find a good role for HTO for unicompartmental osteoarthritis. But, we now have a better list of what they should and what they should not expect after such an operation.

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