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Criteria of Patient Selection in High Tibial Osteotomy in Treatment of Medial Compartemental OA Knee

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Abstract

Background: Osteoarthritis (OA) is among the world's leading disability causes. According to epidemiological research, there are approximately 43 million afflicted individuals in the U.S alone and approximately 15 percent of the global community. That research purposed to perform a systematic literature reviewregarding high tibial osteotomy (HTO) as an effective way for management of medial compartmental OA knee and criteria of patient selection for good surgical results of HTO. Methods: This systematic review was conducted utilizing SCOPUS, PubMed, Cochrane Library and Web of Science electronic databases. Authors performed and revised search techniques to increase their sensitivity. Search method comprised various phrases and synonyms for osteoarthritis and knee joint in conjunction with high tibial osteotomy, indications, arthroplasty, and life quality, functional capacity, or physical exercise. Results: Twelve papers enrolled in this study from 2013- 2018 with 6943 patients underwent high tibial osteotomies, 83% of the studies were retrospective and 17% were prospective.There were 1687 male patients and 1408 female patients among the 3958 patients admitted in 7 articles that described the allocation of gender in their investigations. The percentage of male to female patients was 42.6% to 35.5%, correspondingly. In these investigations, patientsaverage age who received high tibial osteotomies was 49.4 years. The follow up duration of patients was estimated as 3.6 years. Conclusions: Literature demonstrates that instability is not a true contraindication for HTO, regardless of whether or not the operation is graded, provided it is well managed. When this recommendation was followed and the procedure's limitations were considered, HTO had favourable results, with a mean 5-year and 10-year survival rate of 89.3 percent (range: 75-98.7 percent) and 77.6 percent (range: 51-97.7 percent), correspondingly.

Keywords: Medial Compartemental; High Tibial Osteotomy; Osteoarthritis Knee.

1. Introduction

OA is among greatest prevalent causes of disability worldwide. According to epidemiological research, there are approximately 43 million afflicted individuals in the U.S alone and approximately 15 percent of the global population[1]. It is expected that 100,000 new cases occur annually[2]. Mobility limitations danger induced by knee OA alone is larger than that produced by any other medical disease in those aged 65 and older[3].It results in significant social, psychological, and economic hardships for patients, as well as significant financial ramifications[4].In a period of ten years, the cumulative health expenses arising from OA nearly doubled[1].As a result to obesity growing incidence and elevated life expectations of our community, we must anticipate additional growth[5].

HTO is an accepted procedure for medial compartmental OA individuals management, with survival rate of 70 to 75percent for 10-year. Benefits of HTO involve joint conservation, the stimulation of biological restructuring, decreased synovitis, local osteosclerosis, and articular cartilage restoration[6].

As long as possible, one of the aims of therapy is to postpone total knee replacement (TKR) need for. Even though numerous individuals thatreceive osteotomy do not need TKR, osteotomy must be conducted with premise that every individual remains an optimum candidate of TKR following surgery[7].

HTO is designed to relocate the mechanical axis from the medial to the somewhat lateral aspect of the knee's midline to reduce stress and hence postpone OA[8].Some investigations revealed that regenerating procedure begun following readjustment[9].Jackson's 1958 description of isolated medial compartment OA in varus knees prompted consideration of HTO as a possible treatment[9].This procedure was not widespread until 1973, when Coventry revealed positive outcomes[10].After advancements in surgical method, fixation devices, and patient selection that resulted in fewer problems, HTO became increasingly popular among young, physically active individuals[11].

Proximal tibial osteotomy indications are (1) pain and impairment caused by OA that considerably impede high-demand career or recreational activities (2) On weight-bearing radiographs, there is evidence of degenerative arthritis restricted to the medial compartment with a matching varus distortion. The person

must be capable of utilizing crutches or a walker and possess enough muscular strength and desire to participate in a recovery program. Contraindications for proximal tibial osteotomy include constriction of lateral compartment cartilage space, lateral tibial subluxation greater than 1 cm, medial compartment tibial bone loss greater than 2 or 3 mm, flexion contracture greater than 15 degrees, knee flexion less than 90 degrees, more than 20 degrees of correction required, inflammatory arthritis, and significant peripheral vascular disease[12].

Medial opening wedge high tibial osteotomy (MOWHTO) use for varus mal-aligned knees therapy has elevated as it is easy to accomplish, adjust disFigment similar to its origin, offers more dependable adjustments and better bone stock conservation, and avoids peroneal nerve and proximal tibiofibular joint injury. This osteotomy also allows surgeon to prevent complications related to a contemporaneous fibula osteotomy. This procedure causes a wedge-shaped defect in the bone, that may be treated by allowing it to mend on its own or by bone grafting or replacement [13].

Following MOWHTO, numerous fixation strategies may be utilised to preserve adjustment. On the basis of before and after standing hip-to-ankle (long-leg) radiographs, preoperative planning and postoperative analysis were conducted, correspondingly. The weight-bearing line was designed and estimated to cross Fujisawa's point (at 30–40 percent lateral to tibial plateau midpoint)[14].

Preoperative and postoperative medial joint space, that is described as joint space smallest width in medial tibiofemoral compartment as visible from knee anteroposterior aspect, were determined using measuring instruments, preoperative and postoperative femoral varus angle, corrective angle (difference among preoperative and postoperative femoral angles), and osteotomy medial fault,which is expressed as defect length that is 5 mm broad at least, measured from the defect's lateral edge to the lateral plate border perpendicular to the tibial axis[15].

Aim of thatresearch was to make a systematic review of literature according to HTO as an effective way for management of medial compartmental OA knee and criteria of patient selection for good surgical results of HTO.

2. Methods

4 steps were involved in that systematic review, Step 1: including systematic literature search, Step 2: studies selection, Step 3: study characteristics recording, Step 4:data collection about clinical results and comparisons among surgery groups.

Step 1: data sources and search strategy:

Following electronic networks were used for literature search: SCOPUS, PubMed, Cochrane Library and Web of Science. Authors made and revised search techniques to increase responsiveness. Search approach used several keywords and synonyms for osteoarthritis (OA) and knee joint in conjunction with HTO, indications, arthroplasty, and life quality, functional capacity, and physical exercise.

Step 2: selection of studies and Screening of titles and abstracts:

Initially, all titles and abstracts were evaluated based on upcomingeligibility: Article linked (1) a clinical trial and (2) individuals with primary knee OA. In addition, (3) only English-language papers were evaluated for consideration in this study. For each of chosen titles and abstracts, full-text publications were collected for further evaluation. In addition to the first three criteria, the filtering of full-text publications also includes further criteria: The research was (4) limited to knee OA patients who received HTO as a surgical procedure.Additionally, chosen publications lists of reference were examined for research that are pertinent.

Step 3: study characteristics:

Research following features will be retrieved systematically from chosen full-text papers: author, publication year, intervention types (knee osteoarthritis, Surgical technique), design of study (Clinical trials Phase II or Randomized controlled trials),patients'number in each criterion of patients, HTO group, age and follow-up duration (mean and SD or median and range), clinical and functional results of every intervention.

Step 4: outcomes of the included studies:

From the chosen full-text publications, the following outcome features and scores will be retrieved: radiographic results, pain alleviation and analgesic impact, and less morbid surgical intervention.

3. Results

Our preliminary literature search yielded 67 distinct entries. After examining titles and abstracts, 55 full-text publications were chosen for additional inspection. In our final analysis, 12 full-text papers (6943 patients) were involved. **Fig (1)**

12 papers enrolled in this study from 2013- 2018 with 6943 patients underwent high tibial osteotomies, 83% of the studies were

retrospective and 17% were prospective. **Table (1).**

There were 1687 male patients and 1408 female patients among the 3958 participants involved in 7 articles that described gender distribution in their investigations. The percentage of male to female patients was 42.6% to 35.5%, correspondingly. Mean age of participants who recived high tibialosteotomies during these studies was 49.4 years old. The follow up duration of patients was estimated as 3.6 years.**Table (2)**

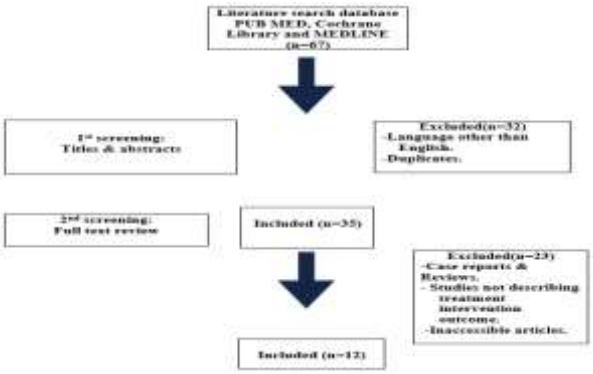

Fig. (1) Literature search flow chart.

Table (1) Type of study design.

Authors	Year	Type of the study
Floerkemeier et al.[16]	2013	Prospective cohort study
fu et al.[17]	2013	Prospective cohort study
Yimjh et al.[18]	2013	retrospective cohort study
Benedict U et al.[19]	2014	retrospective cohort study
Bonasia et al.[20]	2014	retrospective cohort study
Dettoni et al.[21]	2014	retrospective cohort study
Koshbin et al.[22]	2015	retrospective cohort study
Duivenvoorden et al.[23]	2015	retrospective cohort study
Egmondn et al.[24]	2016	retrospective cohort study
Kyrch AJ et al.[25]	2017	retrospective cohort study
Santosa and Wu.[26]	2017	retrospective cohort study
Koh et al.[27]	2018	retrospective cohort study

Table (2) Baseline characteristics and follow up durations in years of enrolled studies.

Authors	Year	No of patients	Male/ female	Mean Age in years (range)	Follow-up years	Type of osteotomy
Floerkemeier et al.	2013	533	166/367	49.3	7.5	CWHTO
fu et al.	2013	759	Ns	Ns	3	OWHTO
Yimjh et al.	2012	58	7/51	58.3	5.1	OWHTO
Benedict U et al.	2014	1047	Ns	40.7	3.6	OWHTO
Bonasia et al	2014	84	Ns	54.5	NS	Ns
Dettoni et al.	2014	54	Ns	57.9	3	OWHTO+ DOME
Koshbin et al.	2015	2671	1147/661	44	5	OWHTO
Duivenvoorden et al.	2016	466	276/190	49.2	3.2	OWHTO+C WHTO
Egmondn et al.	2016	50	31/19	48.7	3.4	OWHTO
Kyrch AJ et al.	2017	57	41/16	43	2.3	OWHTO+C WHTO
Santosa and Wu	2017	1041	Ns	42.7	1.6	OWHTO+C WHTO
Koh et al.	2018	123	19/104	56	4	OWHTO

Table (3) Body Mass Index BMI of patients involved in the study.

Authors	Year	Body Mass Index BMI
Floerkemeier et al.	2013	27.2
fu et al.	2013	Ns
Yimjh et al.	2013	Ns
Benedict U et al.	2014	Ns
Bonasia et al	2014	27.6
Dettoni et al.	2014	Ns
Koshbin et al.	2015	Ns
Duivenvoorden et al.	2016	29.1
Egmondn et al.	2016	29
Kyrch AJ et al.	2017	31.8
Santosa and Wu	2017	Ns
Koh et al.	2018	25.8

The relationship between BMI and OWHTO outcomes is still debated. In a study of 313 patients, Flecher et al. discovered that individuals with a BMI of less than 30 had better results. Howells et al. corroborated this result in their analysis of 95 HTO individuals. Individuals with a BMI larger than 10% over normal values had a pain-free time of 5 years, while those with a BMI less than 10% over

normal values had a pain-free duration of 7.8 years. Since normal BMI values range from 18.5 to 24.9, we may conclude that a BMI higher than 27.4 is linked with a worse prognosis. Bonasia et al., in their analysis of 99 OWHTO, demonstrated that people with a BMI more than 30 had a tenfold increased chance of surgical failure. We may infer that the optimal BMI range for HTO is among 25 and 27.5.**Table (3)**

For the surgeon, malalignment is a difficult challenge. It is crucial to identify among primary, doubleand triple varus knee. Authors in this study confirmed that a good outcome of HTO occurred with varus degree below 15 degrees and the lowest varus degree, the best outcome of HTO will be achieved.**Fig (2)**

Severity of medial compartment OA is a significant indicator of prognosis following HTO. According to research by Flecher et al., 23 of 31 knees classified as Ahlback Grade 3 preoperatively required revision at a mean follow-up of 16 years.Bonasia et al. discovered substantially critical improvements in prognosis for Ahlback Grade 0 patients. Floerkemeier studied 533 individuals an average of 3.6 years after operation; 85 percent of individuals had grade III or IV OA before surgery. Authors observed favourable results in severe mono compartmental arthritis individuals, with a rate of 6% for local postoperative sequelae. ROM is an additional factor that must be addressed prior to doing an OWHTO. Diverse authors have documented a correlation between decreased ROM and worse results, with flexion contracture serving as a contraindication to OWHTO. A preoperative ROM less than 120 degrees accompanied by flexion contracture more than 5 degrees was linked with early failure. Bonasia et al. evaluated 99 OWHTO; using basic logistic regression, they determined that a range of motion (ROM) of less than 120° impacted the result, resulting in a fourfold rise in the chance of failure operation. As other recent investigations have demonstrated, a preoperative ROM of less than 120 degrees raise poor result probability. **Table (4)**

Hardware failure: The pooled proportion of total postoperative hardware failure response (6 studies, 1313 patients) following HTO was 0.043%. postoperative infection rate: The pooled proportion of total serious adverse effects response (5 studies, 1256 patients) following HTO was 0.035%.Regarding the unsatisfaction rate: The pooled proportion of total patients who were unsatisfied after HTO (7 studies, 1371 patients) was 0.088%.**Table (5).**

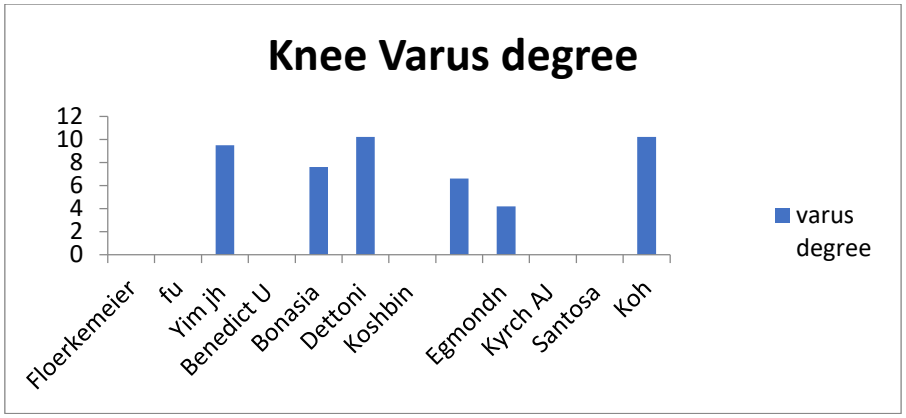

Fig (2) preoperative Varus deformity of knee

Table (4) preoperative O.A degree and range of motion of the affected knee of enrolled patients.

Authors	Year	Degree of O.A	Range of motion
Floerkemeier et al.	2013	Ahlback I-II	146 degrees
fu et al.	2013	Ns	Ns
Yimjh et al.	2013	Ahlback II	135.2 degrees
Benedict U et al.	2014	Ns	Ns
Bonasia et al	2014	Ahlback 0-I	135 degrees
Dettoni et al.	2014	Ahlback I-II	121 degrees
Koshbin et al.	2015	Ns	Ns
Duivenvoorden et al.	2016	Ns	123 degrees
Egmondn et al.	2016	Ahlback I-II	117 degrees
Kyrch AJ et al.	2017	Ns	Ns
Santosa and Wu	2017	Ns	Ns
Koh et al.	2018	Ahlback I-II	112 degrees

Table (5) postoperative hardware failure, postoperative infection rate and Unsatisfactionrate.

Authors	Year	No of patients	Follow up years	No. of Hardware failure	No. of postoperative infection	No. of unsatisfied patients after HTO
Floerkemeier et al.	2013	533	7.5	1	14	12
fu et al.	2013	759	2-4	Ns	Ns	Ns
Yimjh et al.	2013	58	5.1	Ns	Ns	1.3
Benedict U et al.	2014	1047	3.6	Ns	Ns	Ns
Bonasia et al	2014	84	NS	22	13	3
Dettoni et al.	2014	54	3	Ns	Ns	Ns
Table (5) Continue						
Koshbin et al.	2015	2671	5	Ns	Ns	Ns
Duivenvoorden et al.	2016	466	3.2	12	14	81
Egmondn et al.	2016	50	3.4	4	1	8.8
Kyrch AJ et al.	2017	57	2.3	13	Ns	7.4
Santosa and Wu	2017	1041	1.6	Ns	Ns	Ns
Koh et al.	2018	123	4	5	3	6

4. Discussion

HTO is a generally acknowledged treatment for varus knee alignment accompanied by medial compartment overload/OA. The operation, which may include a medial opening wedge, lateral closing wedge, dome, or "en chevron" osteotomy, is intended to transfer the mechanical axis of the lower limb from the medial to the lateral compartment, therefore minimising the stress and contact area over the medial compartment. The earliest references to high tibial osteotomy (HTO) date back to 1961; for

many years, the preferred therapy in this region was closing wedge high tibial osteotomy (CWHTO). Therefore, there are various research addressing CWHTO-related facets (survival and complications). CWHTO is characterised by common peroneal nerve dissection, fibular osteotomy, bone stock loss and proximal tibiofibular joint disruption.

Additionally, it is difficult to do progressive axis correction using this method. In recent years, OWHTO has gained popularity for these causes. In addition, OWHTO permits improved osteotomy tuning as well as triplanar and gradual adjustment. In recent years, a variety of articles on various OWHTO-related topics have been published: indications, surgical method, restrictions and outcomes. This study's objective is to conduct a literature review on OWHTO, taking into account indications and prognostic variables, results, and limitations of the operation.

Indications

Proper patient screening is required for successful OWHTO treatment. Regarding to the research, the prognosis may be affected by age, BMI, OA grade, ROM and related instability. To acquire a better OWHTO right indications knowledge, we have evaluated the most current research on each of these aspects.

Age

There is consensus in scientific literature about relationship among age and HTO results. Some authors discovered that failure likelihood rose by 7.6% every year of age. At 10 years, individuals younger than 65 HTO survival rate was 90%, compared to 70% for those above 65. Bonasia et al.[20], Age was a preoperative characteristic substantially connected to a poor result in a study of 99 OWHTOs: The probability of failed surgery was five times greater for individuals older than 56, suggesting that a narrower age range may be necessary.

BMI

In the literature, the association among BMI and OWHTO results is still a matter of contention. In a study of 313 patients, Flecher et al.[28]discovered that individuals with a BMI of less than 30 had better results.In their research of 95 HTO patients, Howells et al.[29]validated this result. Giagounidis and sell[30]evaluated the varus and valgus alignment of 112 knees (94 patients) following HTO (the osteotomy was performed on the medial or lateral side in relation to the type of malalignment).Individuals with a BMI larger than 10% over normal values had a pain-free time of 5 years, while those with a BMI less than 10% over normal values had a pain-free duration of 7.8 years. Because normal BMI values range from 18.5 to 24.9, we may conclude that a BMI higher than 27.4 is linked with a worse prognosis. Naudie et al.[31], in a survival examination of 106 HTOs, discovered that individuals with a BMI less than 25 had considerably worse outcomes. On the basis of the idea that individuals who weigh less tend to be more active, the authors hypothesised that this result may be associated with greater stress on the osteotomy site. Bonasia et al.[20], after analysing 99 OWHTOs, found that the probability of failed surgery is 10 times higher in patients with a BMI more than 30, while Akizuki et al.[32]reported that a BMI larger than 27.5 is related with initial demise of osteotomy.

Grade of osteoarthritis

OA severity in the medial compartment is an important predictor of outcome after HTO.

In research by Flecher et al.[28], 74 percent of knees categorised as Ahlback Grade 3 preoperatively needed revision after an average of 16 years of follow-up. Bonasia et al.[20]observed that patients with Ahlback Grade 0 had significantly better results. Floerkemeier et al.[16] analysed 533 individuals an average of 3.6 years after surgery; 85 percent of these patients had grade III or IV OA prior to surgery. Local postoperative problems occurred in 6% of patients with severe monocompartmental arthritis, according to the investigators' findings. Additionally, no association was discovered among patient age and the Oxford Knee score. Even in elderly patients with a significant degree of medial cartilage degeneration, these authors reported positive midterm outcomes with OWHTO. Despite the findings of Floerkemeier et al.[16], it is widely accepted in the literature that a low degree of arthrosis is associated with better results; nonetheless, tricompartimental OA is a contraindication to osteotomy. In extremely young individuals, it appears that a neutral orientation is desirable. Adjustment to a femorotibial valgus angle between 6° and 14° was related with the best clinical outcome. Undercorrection of femorotibial valgus to less than 5° was linked with a significant failure rate (62.5%).

Range of motion

ROM is an additional factor that must be addressed prior to doing an OWHTO. Diverse writers have documented a correlation between decreased ROM and worse results, with flexion contracture serving as a contraindication to OWHTO. In a retrospective analysis of 35 patients receiving a total of 39 OWHTOs, Berman et al.[33]discovered that early failure collapsed in individuals with a ROM of less than

90 degrees. Akizuki et al.[32]found 100° of preoperative ROM as the dividing line between excellent and poor outcomes. A ROM less than 100° was associated with a 6.785 hazard ratio, while in the same research, the authors reported that a preoperative maximal flexion value less than 120° was associated with a 2.982 hazard ratio. Naudie et al.[31]observed that a preoperative ROM less than 120° and a flexion contracture larger than 5° were linked with an increased risk of early failure. Bonasia et al.[20] evaluated 99 OWHTOs; using basic logistic regression, they determined that a range of motion (ROM) of less than 120 degrees impacted the outcome, resulting in a fourfold rise in the likelihood of failure operation.

Instability

The combination of knee instability and malalignment presents the surgeon with a difficult challenge. It is essential to differentiate between a primary varus knee, a double varus knee, and a triple varus knee. According to Noyes et al.[34], a primary varus is defined by a primary varus distortion of the lower limb in the absence of ligament instability; which is the best indication for an OWHTO. Double varus is characterised by the presence of a varus bone distortion and ligament instability, most notably of the anterior cruciate ligament (ACL). Triple varusis defined by the combination of varus distortion, central ligament weakness (anterior and posterior cruciate ligaments), and posterolateral corner failure. Typically, this problem is accompanied by a varus push while walking.

5. Conclusion

Literature demonstrates that instability is not a true contraindication for HTO, regardless of whether or not the operation is staged, provided it is well planned. When this indication was followed and the procedure's restrictions were considered, HTO had favourable results, with a mean 5-year and 10-year survival rate of 89.3 percent (range: 75-98.7 percent) and 77.6 percent (range: 51-97.7 percent), correspondingly. Definitely, further follow-up studies addressing OWHTO are necessary.

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