Opening wedge high tibial osteotomy as treatment for chronic multiple ligament injuries in the varus knee: the rationale of treatment and early results

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Received 10 April 2013
Accepted 10 May 2013

The Egyptian Orthopaedic Journal
2016, 51:223–230

Background
In patients with chronic multiple ligament-injured knee, failure to correct the varus malalignment of the knee and posterolateral instability will often result in failure of ligament reconstruction. Opening wedge high tibial osteotomy (HTO) can address both the varus and anteroposterior instability.

Purpose
To assess the functional outcomes of opening wedge HTO in treating anteroposterior instability and varus malalignment of the knee in patients with chronic multiple ligament-injured knee.

Patients and methods
Overall, 12 patients with 12 knees with combined grade 3 posterolateral, anterior cruciate ligament (ACL), and posterior cruciate ligament (PCL) instability and varus alignment of the knee were treated with opening wedge HTO. All 12 varus knees had grade 3 posterolateral instability. Moreover, six patients had ACL deficiency, four patients had PCL deficiency, and two patients had combined ACL and PCL deficiency. Posteromedial opening wedge HTO was done for the ACL-deficient knees to decrease the tibial slope. Anteromedial opening wedge HTO was done for the PCL-deficient knees to increase the tibial slope. Knees with combined ACL and PCL deficiency were treated by posteromedial opening wedge HTO to address the ACL deficiency. Second-stage ligament reconstruction was performed in patients with continued instability after the osteotomies had healed and after at least 6 months of rehabilitation.

Results
Of 12 knees, eight had sufficient improvement in knee function that a subsequent ligament reconstruction was not necessary. There was a significant difference between the preoperative and postoperative coronal (femorotibial angle) alignments. There was a significant difference between the preoperative and postoperative posterior tibial slopes in the ACL patient group but not for the PCL patient group. Of six patients with ACL injuries, two required posterolateral complex (PLC) reconstruction, one of them needed in addition ACL reconstruction. Of four patients with PCL injury, one required PLC and PCL reconstruction. Of two patients with combined ACL and PCL injury, one required PLC and PCL reconstruction. Of six patients with high-velocity knee injuries, four needed further ligament reconstruction.

Conclusion
Opening wedge HTO can be an effective method of treatment for patients with combined chronic multiple ligament injuries and varus knee. Patients with an appropriate opening wedge and manipulation of the slope to enhance stability may not require the second soft tissue procedure. Patients with low-velocity knee injuries may not require a second-stage ligament reconstruction after healing the osteotomy and rehabilitation.

Keywords:
genu varus, multiple ligament-injured knee, opening wedge tibial osteotomy

Egypt Orthop J 51:223–230

1110-1148

Introduction

Multiligament knee injuries are rare and represent one of the most difficult diagnostic and treatment dilemmas. Failure to manage them appropriately can lead to devastating outcomes. It is well recognized that the best outcomes occur in patients who are treated acutely with surgical repairs [1,2]. Evaluation in the acute scenario (dislocation) should focus on diagnosing and treating injuries that threaten life and limb. In the

DOI: 10.4103/1110-1148.208912

chronic scenario, a primary repair becomes difficult owing to the development of scar tissue planes, tissue necrosis, and tissue retraction. In chronic Multi Ligament Injured Knee (MLIK), evaluation should focus on limb alignment, gait, state of the menisci, and articular cartilage integrity from a stability point of view [1]. Noyes *et al*. [3–6] have documented the development of varus deformity and secondary varus gait abnormalities in the MLIK. Failure to diagnose and correct varus malalignment will put extremely high loads on the graft, and any soft-tissue reconstruction is doomed to failure [7,8].

In a patient with a multiple ligament-injured knee, varus malalignment and thrust, surgery may be staged to avoid potential complications associated with performing osteotomy and multiligament reconstruction in the same setting [4]. Although high tibial osteotomy (HTOs) were initially used to correct deformities in the coronal plane, opening wedge osteotomies can simultaneously alter tibial slope in the sagittal plane [9]. An opening wedge HTO would be performed as the initial procedure to address both the coronal (varus/valgus) and sagittal planes (tibial slope). Then, at ~6 months after the osteotomy, the cruciate/collateral ligament reconstruction is performed [2]. There is some evidence that patients with an appropriate opening wedge osteotomy and manipulation of the slope to enhance stability may not require the second soft tissue procedure [10]. The sagittal slope can be altered in instability patterns to decrease tibial translations and assist with knee stability. Increasing the tibial slope will diminish posterior translation. Conversely, decreasing the tibial slope will decrease anterior laxity [2,11,12].

Purpose

We tested the hypothesis that bony correction techniques address both limb alignment and pathological laxity. A posteromedial opening wedge osteotomy reduces the tibial slope in the sagittal plane and increases stability in anterior cruciate-deficient knee. In contrast, an anteromedial opening osteotomy increases the tibial slope in the sagittal plane and increases stability in the posterior cruciate-deficient knee.

Our purpose is to prospectively assess the outcomes of patients who underwent opening wedge HTO for treatment of a symptomatic chronic combined grade 3 posterolateral complex (PLC) injury, anterior cruciate ligament (ACL), and/or posterior cruciate ligament (PCL) in a varus knee and to determine those factors that show improved function without the need for a second-stage ligament reconstruction.

Patients and methods

Inclusion criteria

Selecting the ideal patient is crucial in achieving good results. Patients older than 18 years with concurrent chronic unilateral PLC, ACL, and/or PCL knee injuries and genu varus alignment were included in this study. The criteria for inclusion were patients who have functional instability and pain with combined genu varus alignment and varus thrust gait with PLC, ACL, and/or PCL knee instability at a minimum of 3 months after sustaining their knee injury. Varus alignment was defined as being present in those patients whose mechanical axis, as drawn on long-leg standing radiographs, passed medial to the tip of the medial tibial spine [10].

Exclusion criteria

The criteria for exclusion were age greater than 60 years, patient not compliant and motivated to handle the surgery and convalescence, advanced arthritic changes of the medial compartment (≥grade 4 [13]), symptomatic osteoarthritis of the lateral compartment, a range of movement of less than 100° flexion, and flexion contracture of more than 15°. Patients with medical comorbidities, rheumatoid arthritis, diabetes, peripheral neuropathy, vascular insufficiency, and morbid obesity were excluded from the study.

Patient data

Between January 2008 and January 2012, 12 consecutive patients with 12 knees met these criteria (Table 1). A 100% follow-up was obtained, with a mean of 36 months (12–58 months) after the osteotomy. Half of the patients (*N*=6) were victims of a high-velocity road traffic accident. The other six patients sustained low-velocity sports-related injuries. The study was conducted at Mansourah University Hospitals, Egypt.

Planning

Physical examination

Clinical examination consisted of side-to-side knee comparison with the normal contralateral knee and included several parameters. It started with both knees exposed and inspection of the patient standing to observe varus malalignment. Gait was evaluated for varus thrust pattern. Passive knee range of motion was recorded. ACL integrity was assessed by the use of the Lachman examination (graded as 0, 1, 2, or 3). PCL integrity was assessed by use of the posterior drawer test at 90° of knee flexion (graded as 0, 1, 2, or 3). MCL integrity was assessed by the use of the valgus stress test at 0 and 30° of knee flexion (graded as 0, 1, 2, or 3).

Table 1 Patient demographics and details of treatment

Sex	Age	Injury	Chronicity	Diagnosis	Arthroscopy	Complications	Stability after HTO	Second-stage reconstruction	FU
M	20	HV	3 m	PLC and ACL	Microfr	–	No	PLC	12 m
M	26	LV	9 m	PLC and ACL	–	–	Yes	–	55 m
M	42	LV	5 m	PLC and ACL	–	–	Yes	–	47 m
M	18	HV	7 m	PLC and ACL	–	–	No	PLC, ACL	12 m
F	50	HV	14 m	PLC and ACL	P. menis	–	Yes	–	31 m
F	39	LV	10 m	PLC and ACL	P. menis	–	Yes	–	58 m
M	36	HV	12 m	PLC, ACL, and PCL	P. menis	–	No	PLC, ACL	16 m
F	53	HV	12 m	PLC, ACL, and PCL	–	Intr Fr	Yes	–	50 m
M	41	LV	4 m	PLC and PCL	–	Intr Scr	Yes	–	33 m
M	29	LV	8 m	PLC and PCL	P. menis	–	Yes	–	48 m
F	33	LV	3 m	PLC and PCL	–	–	Yes	–	56 m
M	36	HV	6 m	PLC and PCL	Microfr	–	No	PLC and PCL	14 m

ACL, anterior cruciate ligament; F, femle; Fr, fracture; FU, follow-up; HTO, high tibial osteotomy; HV, high velocity; Intr., intra-articular; LV, low velocity; M, male; Menis, menisectomy; Microfr, microfractures; P., partial; PCL, posterior cruciate ligament; PLC, posterolateral complex; Scr, screw.

Fibular collateral ligament/PLC integrity was assessed by the use of the varus stress test at 0 and 30° of knee flexion (graded as 0, 1, 2, or 3), and the external rotation/posterior drawer test at 30 and 90° of knee flexion (graded as 0, 1, 2, or 3).

Imaging

Double long-leg standing antero-posterior alignment radiographs were obtained for all patients. Lateral radiographs in 30° of knee flexion and 45° patellar axial views were also obtained. The weight-bearing line and the mechanical axis were determined on long-leg film as the line between the center of the femoral head and center of the ankle joint. The femorotibial angles (FTAs) were measured on long-leg film as the angle that was formed by lines drawn from the midpoint between the tibial spines to the center of the femoral head proximally and to the center of the ankle joint distally. Tibial slope has been defined as the angle between a line perpendicular to the mid-diaphysis of the tibia and the posterior inclination of the tibial plateau on the lateral film [11,12]. We chose the Insall–Salvati (IS) index and Blackburne–Peel (BP) ratio for measurement of patellar height on the lateral radiograph [14,15].

Correction

Preoperative planning includes the degree of angulation, the wedge size, and location of the osteotomy based on the preoperative imaging templating. The method for the preoperative determination for the correction wedge was the same as previously described by Dugdale *et al.* [16]. The mechanical axis was calculated to pass through the lateral tibial plateau at 62% of the width of the plateau if 2–4° valgus overcorrection was required.

In full-length standing radiographs, a line drawn from the center of the femoral head to the midpoint of the ankle joint represents the mechanical axis of the leg. A second line is drawn from the center of the femoral head to a point located at 62% coordinate on the tibial plateau. A third line is drawn from the center of the ankle joint to the previous point. The angle formed by the intersection of the second and third lines determines the degree of correction required for realignment of the mechanical axis [16]. The goal is to calculate the angular correction necessary to produce 2–4° of mechanical or 8–10° of anatomical valgus [16–18].

The bone graft wedge was inserted posteriorly in patients with a concurrent ACL deficiency in an attempt to decrease the sagittal tibial slope (posteromedial opening-wedge HTO) and was put anteriorly in patients with concurrent PCL deficiency in an attempt to increase the posterior tibial slope (anteromedial opening wedge HTO).

Surgical technique

The standard operation technique was performed using a tourniquet and spinal anesthesia as previously described by Hernigou *et al.* [19]. A diagnostic knee arthroscopy was performed on every patient to ensure an intact lateral compartment, at which time we treated additional intra-articular lesions.

A medial approach was performed, shifting the pes anserinus and the superficial medial ligament dorsally. A Kirschner wire was inserted parallel to the joint line. A second wire was inserted just proximal of the tuberosity parallel to the first one; along this wire, the osteotomy was performed. The osteotomy was started just above the tibial tubercle, ~2–3 cm distal to the joint line.

The lateral cortex was left intact. The gap was opened gradually and the preoperatively calculated correction angle was checked with a measuring device. After this, the height of the medial gap was measured and the appropriate wedge of tricortical iliac bone autograft was inserted in the preplanned site whether anteriorly or posteriorly. Internal fixation was performed using a four-hole conventional T-profile AO plate and cortical screws. Intraoperatively, we check the limb alignment with a metallic rod or a diathermy cable extended from the hip to the ankle. Care was taken not to break the lateral cortex during the tibial osteotomy to preserve some degree of stability between bone fragments [20]. All patients received antibiotic prophylaxis and anti-thrombotic therapy (low-molecular-weight heparin) was given for 6 weeks.

Postoperative radiographs were taken after the operation, then subsequently 6 and 12 weeks after the surgery and then as required, until the bone healing was evident. Full radiological consolidation was defined as bridging of the osteotomy gap with bone on both sides of the osteotomy, with no radiolucencies around the wedge [16].

Postoperative rehabilitation

The patients underwent the appropriate rehabilitative program to preserve the force of the knee muscles, keep the full range of motion, and to prevent the development of patella infera or arthrofibrosis [21]. The patient is allowed touchdown weight bearing in a knee brace for the first 6 weeks to prevent excessive forces at the osteotomy site. Early knee range of motion is initiated. Isometric quadriceps exercises are initiated. Patella baja can be avoided with immediate motion and active quadriceps contractions. After 6 weeks, weight bearing is increased. Full weight bearing is allowed when radiographic consolidation has taken place from the 12th week onward.

We strongly recommended to all patients in this study a return to only light recreational sports activities and avoidance of high-impact athletic activities or heavy manual work.

Second-stage ligament reconstruction was performed in patients with continued instability after the osteotomies had healed and after at least 6 months of rehabilitation.

Statistical analysis

Statistical comparison between preoperative and postoperative data (at last follow-up) was performed using a paired sample *t*-test. A *P*-value of 0.05 was considered to be statistically significant.

Results

In total, 12 consecutive patients with chronic combined PLC, ACL, and/or PCL deficiency and genu varus alignment were retrospectively evaluated during the period of January 2008 to January 2012. There were eight men and four women. The average patient age at the time of surgery was 35 years (range, 18–53 years).

All patients had sustained an injury to PLC, ACL, and/or PCL at least 3 months before presentation and had genu varus malalignment as determined from standing long-leg radiographs. All patients had PLC deficiency; moreover, six patients had ACL deficiency, four patients had PCL deficiency, and two patients had both ACL and PCL deficiency.

Clinical evaluation

At a mean follow-up of 36 months (range, 12–58 m) after the osteotomy, 8 of 12 (66.7%) patients reported satisfaction with their results after the osteotomy, and thus, a second-stage ligament reconstruction was not necessary. None of these patients required a brace for activities. They can manage activities of daily living such as normal walking, stair climbing, and squatting without pain swelling or giving way. They returned to light sports activities such as running, swimming, and bicycling-based on our advice-without symptoms. To test whether a patient is ready to return to running, we use the step-down test. With the patient on a platform (~8-inches high), they are instructed to step forward and down toward the ground [1]. A total of 10 patients returned back to their occupations with no problems: four in light occupations, two in moderate occupations, two were students, and two were homemakers. Based on our advice, two had to change their heavy manual work to light occupation with no symptoms. Overall, four patients underwent a second-stage ligament reconstruction. No patients were lost to follow-up.

Knee examination and stability

Laxity was determined clinically by manual passive varus stress testing at 30°, external or posterolateral tibial rotation test at 30 and 90°, anterior translation on the Lachman test, and posterior translation on the posterior drawer test. We modified the Noyes *et al.* [6] functional rating system to establish criteria for knee instability. A functional classification was given when less than 3 mm of increase in lateral joint opening, less than 5° of increase in external tibial rotation, 1+ Lachman (0–5 mm anterior translation), and 1+ posterior drawer (0–5 mm posterior translation). A partially functional classification was given when between 3 and 5 mm of increase in lateral joint opening, 6–10° of increase in external tibial rotation, 2+ Lachman (6–10 mm anterior translation), and 2+ posterior drawer (6–10 mm posterior translation) was detected. A grade of failure was given if more than 5 mm of increase in lateral joint opening, more than 10° of increase in external tibial rotation, 3+ Lachman (>10 mm anterior translation), and +3 posterior drawer (>10 mm posterior translation) was detected.

At follow-up, 8 of the 12 (66.7%) patients received functional rating for the lateral and posterolateral structures, ACL, and PCL. The outcome was satisfactory with no further surgeries contemplated. A total of four (33.3%) patients failed. Further ligament reconstruction was planned based on individual ligament failure. Of six knees with combined PLC and ACL, two (33.3%) failed. In one knee, both PLC and ACL failed, for which both were reconstructed, whereas in the other, PLC failed and ACL had partial function, for which PLC reconstruction only was performed. Of the four knees with concurrent PLC and PCL, one (25%) failed, and both PLC and PCL were reconstructed. Of the two (50%) knees with PLC, ACL, and PCL, one showed failure of PLC and PCL, whereas ACL had partial function; therefore, reconstruction of PLC and PCL was considered.

Mechanism of injury

The mechanism of injury was a motor vehicle or motorcycle accident in six, sports injuries in four, and work-related falls in two. The six (100%) patients with low-velocity sports-related and work-related injuries did not require a second-stage ligament reconstruction. Comparatively, four of the six (66.7%) patients who were involved in high-velocity motor vehicle accidents required a second-stage ligament reconstructions.

Radiographic analysis

The radiographic measurements are summarized in Table 2. The comparative results of preoperative and postoperative FTA, posterior tibial slope, IS, and BP ratios are summarized in Table 3. The mean preoperative FTA was −5° (range, −9–0; SD=3.4). This was significantly corrected to the mean of 4.8° (range, 0–8; SD=2.2) postoperatively (P=0.00). There were no significant differences in the preoperative or postoperative IS index and BP ratio. The mean preoperative IS ratio was 1.1 (range, 1.0–1.2; SD=0.07) whereas the mean postoperative one was 1.2 (range, 1.0–1.3; SD=0.09) (P=0.111). The mean preoperative BP ratio was 0.9 (range, 0.7–1.2; SD=0.18) this was insignificantly changed to 0.8 (range, 0.6–0.9; SD=0.09) postoperatively (P=0.075) The mean preoperative posterior tibial sagittal slope of the eight patients with combined PLC and ACL deficiency (six with PLC and ACL whereas two had PLC, ACL, and PCL deficiency) was 14.6° (range, 10–17; SD=2.5). This was significantly changed to 9.8° (range, 4–12; SD=3.5) postoperatively (P=0.00). The mean preoperative posterior tibial sagittal slope of the four patients with combined PLC and PCL deficiency was 12.8° (range, 10–16; SD=3.2). This was significantly increased postoperatively to 17.8° (range, 15–20; SD=2.6) (P=0.001).

Complications

There were two major and two minor complications. The major two complications were in two patients. One had intra-articular lateral plateau fracture, which was fixed at the time of surgery with no influence on the final clinical results. The other had intra-articular screw placement, which was surgically rectified. Two patients had irritation from the plate, which required a separate surgery for plate and screw removal. There were no complications in our series at the iliac graft site.

Discussion

In this study, we investigated the effect of biplanar correction on both limb alignment and pathological laxity. The data confirmed our hypothesis that in patients with combined genu varus alignment and chronic PLC, ACL, and/or PCL deficiency, we found that the bony correction alone created sufficient improvement and subjective stability such that a subsequent second-stage ligament reconstruction was unnecessary in 66.7% of the patients we studied. In our study, we intentionally changed the tibial slope to compensate for the ACL/PCL deficiency. Also, we counseled the patients and advised them not to return to activities that might result in giving way. Nevertheless, four of six (66.7%) patients with high-velocity knee injuries required a second-stage reconstruction. Probably in knees with interstitial failure of the posterolateral tissues owing to stretched out but otherwise intact attachment sites, HTO allowed for a physiologic remodeling and adaptive shortening of these structures [3].

These findings are consistent with a recent study by Arthur *et al.* [10] that also reported on 21 patients with chronic PLC deficiency, genu varus alignment, and varying ACL and/or PCL deficiency. All the patients

Table 2 Preoperative and postoperative radiographic measurements of the femorotibial angle, posterior tibial slope Insall–Salvati and Blackburne–Peel ratios

Preoperative FTA	Postoperative FTA	Preoperative TS	Postoperative TS	Preoperative IS	Postoperative IS	Preoperative BP	Postoperative BP
−8	6	16	12	1.2	1.3	1.0	0.7
−7	3	14	10	1.1	1.2	1.1	0.8
−5	6	12	5	1.0	1.1	0.9	0.9
0	8	17	11	1.0	1.1	0.7	0.7
−7	6	10	4	1.1	1.2	0.8	0.8
−1	6	15	10	1.1	1.2	0.7	0.9
−3	4	17	14	1.1	1.1	0.7	0.6
−9	0	16	12	1.1	1.1	0.8	0.7
−4	6	15	20	1.1	1.3	0.7	0.7
−9	2	16	20	1.0	1.0	1.2	0.9
0	5	10	15	1.2	1.1	1.1	0.7
−7	6	10	16	1.2	1.2	0.8	0.8

BP, Blackburne–Peel; FTA, femorotibial angle; IS, Insall–Salvati.

Table 3 Ratio comparisons (preoperative and postoperative)

	Mean preoperative	Mean postoperative	*P*-value
Femorotibial angle	−5	4.8	0.000
Tibial slope (ACL def)	14.6	9.4	0.000
Tibial slope (PCL def)	12.8	17.8	0.001
Insall–Salvati ratio	1.1	1.2	0.111
Blackburne–Peel ratio	0.9	0.8	0.075

ACL, anterior cruciate ligament; def, deficient knees; PCL, posterior cruciate ligament.

were treated initially with a proximal tibial opening wedge osteotomy. They made the decision of a second-stage ligament reconstruction based on the patient's function and stability after the osteotomy had healed and they had undergone the appropriate rehabilitation. Of 21 patients, eight (38%) did not need a second-stage ligament reconstruction. Similar to our study, they found that the most common factor in determining the need for a second-stage ligament reconstruction was the severity of the initial knee injury. Of nine patients with high-velocity knee injuries, seven (71%) required a second-stage reconstruction [10].

In a healthy knee, the mechanical axis runs through the center of the knee, giving an equal distribution of weight on both compartments. In a knee experiencing varus malalignment, however, the mechanical axis is shifted medially, leading to an increased load on the medial compartment. This causes the ligaments to stretch out over time leading to functional instability, which may show as a varus thrust gait pattern [4,22]. Some patients in our study were aware of gradually increasing varus alignment, particularly during running, where the varus thrust becomes pronounced. Noyes *et al.* [3–6] have documented the development of varus deformity and secondary varus gait abnormalities in the MLIK. Changing the leg's alignment by performing an opening wedge osteotomy aims to overcorrect the mechanical axis, which results in a reduced and more neutral loading pattern [23,24].

Although HTOs were initially used to correct deformities in the coronal plane, they can simultaneously alter tibial slope in the sagittal plane. The normal posterior tibial slope is 7–10°, but this shows significant variability [9]. From a stability point of view, in contrast to a lateral closing wedge HTO, an opening wedge osteotomy has the theoretical advantage of tightening the posterior capsule and oblique popliteal ligament complex, which can ultimately, increases both the varus and external rotation stability [25].

The concept of compensating for cruciate deficiency via bony realignment to decrease tibial translation is supported by several authors. They have suggested performing an osteotomy to restore 'sagittal balance' (i.e. tibial translation) in ligament-deficient knees [26–29]. Numerous studies provide the biomechanical data to support the use of sagittal osteotomies in the treatment of chronic cruciate-deficient knees. Giffin *et al.* [11,12] suggested that increasing the tibial slope will improve stability in the PCL-deficient knee. This can be easily visualized as the femur 'sliding' posteriorly down the inclined tibia, thus resulting in an anterior tibial translation. They recommended osteotomy for patients with grade 2 or 3 posterior instability with concomitant varus malalignment to unload the medial compartment in the coronal plane, whereas the tibial slope is increased in the sagittal plane to reduce posterior subluxation of the tibia [11,12]. This concept was supported by Agneskirchner *et al.* [30] and Rodner *et al.* [31]. Dejour and Bonnin [32] recommended decreasing the posterior tibial slope in ACL-deficient knees if it exceeds 10°.

On the contrary, correcting the varus malalignment in the coronal plane could not be shown to alter the mediolateral tibial translation. This is owing to the more complex bony anatomy and conformity. It is rather giving the chance to the stretched-out posterolateral structures to shrink and remodel into a more stable state [3,33]. That is why, we consistently did overcorrection even in some young patients without osteoarthritis. Badhe and Foster [33] evaluated a heterogeneous population of 14 patients with ligamentous instability and genu varus alignment. These patients had a variety of instability patterns and were treated using various methods. In their study, nine patients had a PLC injury with or without a PCL injury. Six of these patients were treated with a tibial osteotomy and ligament reconstruction, whereas the remaining three were treated with tibial osteotomy alone. The three patients without ligamentous reconstruction were reported as having improved. The authors concluded that if the posterolateral structures were lax and not completely disrupted, an opening wedge tibial osteotomy without ligament reconstruction may help to stabilize the knee and avoid a ligament reconstruction [33].

We believe that by correcting the mechanical axis out of varus alignment into valgus alignment, we can restore the coronal balance and address the chronic PLC deficiency. Also, opening wedge osteotomy allows for slope manipulation to address instability associated with either an ACL or PCL deficiency. We achieved sufficient mechanical and functional stability in a significant number of patients (8 of 12; 66.7%) with MLIK treated with opening wedge HTO.

Limitations

One limitation of the current study is the inherent heterogeneity of the patient population and the relatively small number of patients (n=12), which precludes any definitive conclusions being made. However, combined chronic multiligament knee injuries and varus malalignment of the knee are infrequent, and to find a truly homogenous population of patients would dramatically limit the number of patients studied. Another issue is that this is a short-term study with a mean follow-up of 36.6 months. We recognize that longer follow-up is necessary to determine the efficiency of this procedure in patients for the long term. With these issues in mind, we believe the treatment protocol in this study improved the quality of life in most patients (8 of 12; 66.7%).

Conclusion

The results from this study suggest that an initial opening wedge HTO followed by a period of rehabilitation to determine subsequent clinical and functional stability is a reasonable approach for treatment of chronic MLIK with concurrent genu varus malalignment. Correction of their coronal and sagittal alignment alone will create sufficient improvement in 66.7% of patients who will be able to resume light recreational activities (based mostly on our advice) without the need for a second-stage ligament reconstruction.

Patients with low-velocity injury pattern were most likely to benefit from alignment correction alone with proper rehabilitation and return to light sports and jobs after a corrective proximal tibial opening wedge osteotomy.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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