



Distal femoral medial closing wedge osteotomy for degenerative valgus knee : mid-term results in active patients

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Distal femoral medial closing wedge osteotomy (DFMCWO) may be a valuable treatment for arthritic valgus knees in young and active adults, with the possible aim of procrastinating knee replacement. 32 valgus knees (mean age : 41.4 ± 11.2) treated with DFMCWO were retrospectively reviewed. All the knees had a lateral compartment osteoarthritis graded I-II-III according to Kellgren Lawrence classification. 20 knees had osteochondral lesions, treated with microfractures (8) or bone marrow derived cells transplantation (12). Patients were clinically (IKDC, KOOS, NRS, Tegner) and radiologically evaluated. A mean follow-up of 62.12 ± 15.65 was achieved.

KOOS score peaked at 24 months, showed a decremental trend, achieved a final results of 79.59 ± 17.14 . Similar trend was evident for IKDC. The final NRS score was 2.73 ± 1.82 ; the final Tegner score was 4.81 ± 1.56 . Radiographs showed degenerative progression in 5 knees : 2 patients underwent knee replacement at the final follow-up.

DFMCWO is an effective treatment to treat osteoarthritic symptomatology, delay degenerative progression and avoid knee replacement in valgus knees at mid-term follow-up

Key words : Distal femoral osteotomy ; Closing wedge osteotomy ; Valgus knee.

INTRODUCTION

Valgus knee is a malalignment caused by congenital etiologies, growth plates disturbances, lateral meniscectomy, or traumatic events (2) : it is

recognized as a possible cause of lateral cartilage damage and osteoarthritis (OA) (6). Lateral meniscectomy and malrotation may increase the cartilage shear forces, accelerating the degenerative process; even hip biomechanics and anatomy (short neck, short head/shaft distance) have been correlated with lateral compartment OA in valgus knee (2,6). Lateral OA is usually well tolerated; thus, there is a large consensus that conservative treatments are the first line approach (9). In case of failures, few surgical treatments may be performed, mostly in case of young and active patients (10). Unicompartmental knee prosthesis for lateral unicompartmental OA has been recently advocated as a good surgical option : unfortunately, no large case series are currently available and the surgical indications require a strict selection of patients (13). Despite the large interest in knee replacement, osteotomy can be an effective joint-sparing, biological procedure

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for non end-stage lateral compartment OA in young and active patients (11). This procedure unloads the compartment, allowing performing a concomitant cartilage repair procedure to improve articular surfaces condition (7).

Three approaches have been adopted for valgus malalignment correction : proximal tibial medial closing wedge osteotomy, distal femoral lateral opening wedge osteotomy and distal femoral medial closing wedge osteotomy (DFMCWO) (15).

Proximal tibial medial closing wedge osteotomy should be reserved to valgus malalignment lower than 12 degrees (5,14,15). In case of more deformed knees, the lateral shear forces may be increased due to a varus or medial tilt of the joint line, causing possible subluxation of the femur on the tibia. The results described by Shoji and Insall were not satisfying in many cases (17).

Usually, a distal femoral osteotomy is currently preferred to correct a valgus knee (1,2,8,9,11,12,14,16). This approach addresses the main joint deformity, the hypoplastic lateral condyle, and it restores the orientation of the joint line (transepicydylar line becoming perpendicular to mechanic axis) without damaging the medial collateral ligaments stability (2,14). Distal femoral osteotomy may be performed through a lateral or a medial approach, adding or removing a bone wedge (15).

Aim of this retrospective case series is evaluating the DFMCWO outcomes at mid-term follow-up in cohort of young and active patients with lateral compartment OA with valgus knee.

MATERIALS AND METHODS

The study was approved by authors' hospital ethical committee and it was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. All the patients involved in the study gave their informed consent prior to their inclusion in the study.

35 patients with OA in the lateral compartment were retrospectively evaluated.

Inclusion criteria were lateral OA (graded 1,2,3 according to Kellgren Lawrence), valgus alignment between 5° and 15° (mechanical axis intersection in weight bearing full leg X-rays), non-traumatic

etiology, anteroposterior and lateral stability of the knee, will to perform sport activity, age between 16 and 60 years, a minimum follow-up of 24 months. Mild patellofemoral arthritis was considered acceptable. Exclusion criteria were instability of the knee, end stage OA, bi-tricompartimental OA, flexion deformity, osteonecrosis, hematological or rheumatological diseases (1,2,8). 27 were considered eligible for the study (32 knees).

Demographical data of the included patients are specified in Table I. All the patients underwent DFMCWO between 2007 and 2013 : the mean follow-up achieved was 62.12±15.65 months (range 24-90). In 25 cases, an associate procedure was arthroscopically performed : 14 selective meniscectomy, 20 cartilage repair procedures (8 bone marrow derived cells transplantation, 12 microfractures). Cartilage procedures were performed in case of focal osteochondral lesion (graded III-IV according to ICRS).

The included patients (27) were clinically and radiologically evaluated in the pre-operative and post-operative setting. Subjective IKDC (International Knee Documentation Committee) score, KOOS (Knee Osteoarthritis and Outcome score) score, NRS-11 (Numeric Rating Scale) and Tegner score were taken preoperatively and annually. Weight bearing full leg X rays, Rosemberg and lateral views, and skyline view of patellofemoral joint were pre-operatively performed. Anteroposterior and lateral X-rays views of the knee were taken at

Table I. — demographical data of the study population

DEMOGRAPHICAL DATA	
Number of patients	27
Number of knees	32
Male/female patients	9/23
Right/left knee involvement	18/14
Mean age (years)	41.4±11.2
Patients with previous surgery	8
BMI (kg/m square)	25.3±5.1
Smokers	9
Associate procedures	25
Selective meniscectomy	14
Cartilage repair procedure	20

1 and 3 months in the post-operative. Every year, weight bearing X rays were performed to assess the OA progression and check for eventual loss of correction.

Surgical procedure

Pre-operative planning

The angle of correction was evaluated calculating the difference between the real mechanical axis and the desired mechanical axis, looking for neutral correction, in the weight-bearing full leg X rays. The angle of the wedge is reported on the X-ray, positioning the hinge point of the osteotomy over the lateral condyle, 0,5 cm medial to the lateral cortical.

Surgical procedure

The patient was positioned in supine decubitus, after a spinal or general anesthesia. A standard knee arthroscopy was performed to assess meniscal lesions and cartilage status. Meniscal lesions were treated with a partial meniscectomy (14 cases). Basing on the focal osteochondral lesions of the lateral compartment, microfractures (defect < 2 cm²) or bone marrow derived cells transplantation (BMDCT) (defect > 2 cm²) were performed. Cartilage repair procedures were executed using the same techniques previously described in other papers. (3,18).

Through a medial approach to the distal femur, a 7 cm incision was performed starting from the medial epicondyle. The vastus medialis was bluntly dissected from the intermuscular septum and the distal medial cortex of the femur was exposed. Two retractors were positioned, one superiorly to lift the vastus medialis belly and one inferiorly to protect the neurovascular bundle. A K wire was inserted from medial to lateral and from proximal to distal, pointing to the supracondylar lateral cortex. A second K wire was inserted, with the same direction of the previous K wire, describing the angle measured in the pre-operative planning. The wedge to be removed was identified. Using an oscillating saw and then osteotomes, a single plane osteotomy was performed and the wedge was removed, taking care not to damage the lateral

cortex. The bone surfaces were apposed, and a Titan plate was applied (Citieffe, Bologna, Italy), with four non-locking screws. The restoration of a good alignment was checked by fluoroscopic images in two projections. The plate was covered by muscular bellies and a suction drainage was positioned. The layers were sutured with resorbable stitches. At the end of the surgery, an elastocompressive bandage was applied and an extension knee brace was positioned.

Post-operative care and return to sport

Continuous passive motion was started the day after surgery. No weight bearing was allowed and knee brace was worn. After one week passive and active ROM exercises, isometric exercises, soft tissue and patellar mobilization were allowed and gradually increased. Beginning of straight leg exercises, trunk strengthening, hip adduction and abduction was allowed after 4 weeks. Partial weight bearing was permitted at six weeks and, in case of radiographic signs of bone consolidation, tolerated weight bearing, with an initial period of brace protection, was allowed at eight weeks. Proprioceptive and balance activities, walking and cycling were introduced at 3 month. The patients returned to sport activities at 6 or 12 months, according to the cartilage procedures performed (6 months for microfractures and debridement, 12 months for BMDCT).

Statistical analysis

The Wilcoxon test, the Mann–Whitney test, and the Student's paired t test were used to test for significant differences between baseline and various follow-up measurements. A p value of 0.05 was considered significant. All statistical analysis were performed using SPSS v.19.0 (IBM Corp., Armonk, NY, USA)

RESULTS

Clinical results

Two cases of superficial infection of the surgical wound were reported by 15 days after surgery.

The infection was successfully treated with oral antibiotics. Only a post-operative complication was reported. A 43 year-old female patient fell down in the first month after surgery, breaking the implant and losing the correction. She underwent a revision procedure, with successful results (the results of revision procedure were not included in the case series). 2 cases (6,25%) removed the hardware for a local discomfort.

2 patients out of 27 had OA progression and required knee replacement (6,25%) at the final follow-up.

KOOS score achieved a peak at 24 months ($83,34 \pm 13,56$), and a consequent little decremental trend was recorded ($79,59 \pm 17,14$ at 60 months) ($p < 0.05$). (Table II)

IKDC score had a similar trend, achieving the best at 24 months ($84,63 \pm 14,19$), and ending in $80,09 \pm 14,87$ points at 60 months ($p < 0.05$). [TAB 2]

NRS achieved a post-operative value of 2.73 ± 1.82 (range : 0-7). The pre-operative value was 6.10 ± 1.36 .

Tegner results improved from the pre-operative value of 2.65 ± 1.89 to the final value of 4.81 ± 1.56 (range : 2-7).

The post-operative results (IKDC, KOOS, NRS, Tegner) were significant when compared to pre-operative outcomes ($p < 0,05$).

Sex, age, smoke, BMI, associate procedures on cartilage and menisci did not significantly impact the final results ($p > 0,05$).

Radiographic results

5 patients (15,62%) had progression of the OA stage : in 2 cases, a total knee replacement was required, in other 3 cases the osteotomy was not converted to knee replacement. All patients had a Kellgren Lawrence stage 3, showing that pre-operative radiographic OA degree could influence the radiographic results ($p < 0.05$).

Radiographic results showed that the angle of correction at the final follow-up was $0.65^\circ \pm 1.34$ in valgus. The range encompassed a varus angle correction of 1.5° and a valgus angle correction of 2.1° . No loss of correction over the time was reported. Good healing of the bone was achieved in

every case : no delayed consolidation or non-union were reported (Figure 1).

DISCUSSION

Distal femoral osteotomy for valgus knees in active population achieved good outcomes in a review by Saithna et al., demonstrating long survivorship (mean range : 64%-87% at 10 year follow-up) and good function (mean range of post-operative HSS score : 72-88) (16). The review included opening wedge and closing wedge osteotomies : no differences in the final outcomes were reported (16).

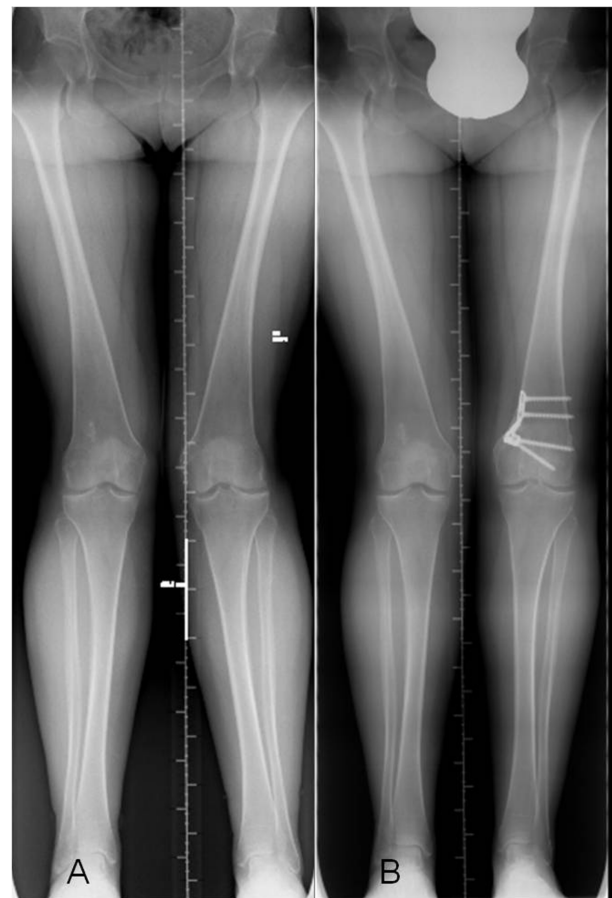


Fig. 1. — Pre-operative weight-bearing X-ray of a female patient (42 years old), with an aching valgus knee (A) : the patient underwent a DFMCWO. After 5 years, the clinical and radiological results with the weight-bearing X-ray were satisfying (B).

Table II. — IKDC and KOOS outcomes at different follow-ups : a little decremental trend was evident over the time

	Pre-op	6 months	12 months	24 months	36 months	48 months	60 months
KOOS	45,21±18,17	55,74±11,97	73,81±17,43	83,34±13,56	81,56±16,46	81,36±15,79	79,59±17,14
IKDC	44,96±19,83	56,62±13,02	74,02±15,42	84,63±14,19	82,02±15,74	81,35±16,29	80,09±14,87

Good clinical results and a low rate of complications with DFMCWO and internal fixation were confirmed in few specific case series (1,8,9,11). In a recent work by Brinkman et al., DFMCWO was compared to lateral opening wedge osteotomy : the advantage of the medial closing wedge approach is the good bone healing potential and the stability given by the oblique bone cuts (2). Moreover, it avoids the disadvantages of the lateral opening wedge technique : the weak hinge of the medial cortex, the need of a graft, and the lower healing potential (2). Higher rate of hardware removal and discomfort were reported with lateral opening wedge osteotomy (2,11,12,16).

Due to these advantages of the closing wedge osteotomy, we performed DFMCWO for valgus knee correction in a group of young and active patients. No complications related to bone healing or loss of correction were reported. The results of this retrospective series demonstrated good mid-term outcomes, with a conspicuous reduction of the pain and an acceptable improvement of the function. The KOOS and IKDC score showed a durable result over the time, with a little decremental trend starting from the second year. The survival rate showed that only 2 patients required a replacement procedure (6,25%). The trend of this case series was substantially in line with the expert literature, concerning closing wedge osteotomies (1,8,9,11).

The improvements of the Tegner score outcome were not particularly satisfying, in line with previous literature : this finding can be correlated with the location of the deformity in the valgus knee, as in 90° of flexion, the supracondylar osteotomy exerts a little efficacy (4,8).

Radiographic results were positive, with 5 patients out of 32 with OA progression. Also the final tibiofemoral angle was maintained at the final follow-up, encompassing values in the recommended range according to literature (between 5° of varus and 5° of valgus) (2,8,15,16).

Only pre-operative radiographic OA stage significantly impacted the clinical and radiological results at the final follow-up. Pre-operative and intraoperative features did not significantly improve the final outcomes. Even age and BMI did not correlate with the final results.

The concomitant cartilage repair procedures did not significantly impact the final results, accordingly with previous works (7,8).

It has to be highlighted that previous case series used different internal fixations (blade plate, locking fixation), theorizing a possible beneficial effect of the adopted device (2,8,11). In this case series, the fixation was performed with another device, a titanium plate and 4 cortical screws : no bone healing complications were reported.

This study has some limitations : it is a retrospective case series, with a limited patient cohort. The follow-up is quite short, and only radiographic evaluation was performed to assess OA progression.

DFMCWO is an effective procedure for valgus knee, restoring good function and reducing the pain, with quite stable results at mid-term follow-up. The survivorship rate is satisfying, and DFMCWO could be considered a good procedure in order to delay or even avoid knee replacement. Moreover, the closing wedge osteotomy with a medial approach resulted in a low rate of complications, in particular related to bone healing. DFMCWO could be successfully performed even in older patients with high BMI, being age e BMI relative contraindications for this procedure. Cartilage repair procedures could be added, although no significant improvement should be expected

REFERENCES

1. Backstein D, Morag G, Hanna S, Safir O, Gross A. Long-term follow-up of distal femoral varus osteotomy of the knee. *J Arthroplasty*. 2007 ; 22 : 2-6.

2. **Brinkman JM, Freiling D, Lobenhoffer P, Staubli AE, van Heerwaarden RJ.** Supracondylar femur osteotomies around the knee : patient selection, planning, operative techniques, stability of fixation, and bone healing. *Orthopade.* 2014 ; 43 : S1-10.
3. **Buda R, Vannini F, Cavallo M, Baldassarri M, Luciani D, Mazzotti A, Pungetti C, Olivieri A, Giannini S.** One-step arthroscopic technique for the treatment of osteochondral lesions of the knee with bone-marrow-derived cells : three years results. *Musculoskelet Surg.* 2013 ; 97 : 145-51.
4. **Chambat P, Ait Si Selmi T, Dejour D.** Varus tibial osteotomy. Osteotomies about the athletic knee. *Oper Tech Sports Med* 2000 ; 8 : 44-47.
5. **Coventry MB.** Proximal tibial varus osteotomy for osteoarthritis of the lateral compartment of the knee. *J Bone Joint Surg Am* 1987.69 : 32-38.
6. **Felson DT, Niu J, Gross KD et al.** Valgus malalignment is a risk factor for lateral knee osteoarthritis incidence and progression : findings from the Multicenter Osteoarthritis Study and the Osteoarthritis Initiative. *Arthritis Rheum.* 2013 ; 65 : 355-62.
7. **Filardo G, Di Martino A, Kon E, Delcogliano M, Marcacci M.** Midterm Results of a Combined Biological and Mechanical Approach for the Treatment of a Complex Knee Lesion. *Cartilage* 2012 ; 3 : 288-292.
8. **Forkel P, Achtnich A, Metzloff S, Zantop T, Petersen W.** Midterm results following medial closed wedge distal femoral osteotomy stabilized with a locking internal fixation device. *Knee Surg Sports Traumatol Arthrosc.* 2015 ; 23 (7) : 2061-7.
9. **Gupta V, Kamra G, Singh D, Pandey K, Arora S.** Wedgeless 'V' shaped distal femoral osteotomy with internal fixation for genu valgum in adolescents and young adults. *Acta Orthop Belg.* 2014 ; 80 : 234-40.
10. **Iorio R, Healy WL.** Unicompartmental arthritis of the knee. *J Bone Joint Surg Am.* 2003 ; 85-A : 1351-64.
11. **Kosashvili Y, Safir O, Gross A, Morag G, Lakstein D, Backstein D.** Distal femoral varus osteotomy for lateral osteoarthritis of the knee : a minimum ten-year follow-up. *Int Orthop.* 2010 ; 34 : 249-54.
12. **Jacobi M, Wahl P, Bouaicha S, Jakob RP, Gautier E.** Distal femoral varus osteotomy : problems associated with the lateral open-wedge technique. *Arch Orthop Trauma Surg* 2011. 131 : 725-728.
13. **Ollivier M, Abdel MP, Parratte S, Argenson JN.** Lateral unicompartmental knee arthroplasty (UKA) : contemporary indications, surgical technique, and results. *Int Orthop.* 2014 ; 38 : 449-55.
14. **Omid-Kashani F, Hasankhani IG, Mazlumi M, Ebrahimzadeh MH.** Varus distal femoral osteotomy in young adults with valgus knee. *J Orthop Surg Res.* 2009 ; 13 : 4-15.
15. **Puddu G, Cipolla M, Cerullo G, Franco V, Gianni E.** Osteotomies : the surgical treatment of the valgus knee. *Sports Med Arthrosc.* 2007 ; 15 : 15-22.
16. **Saithna A, Kundra R, Modi CS, Getgood A, Spalding T.** Distal femoral varus osteotomy for lateral compartment osteoarthritis in the valgus knee. A systematic review of the literature. *Open Orthop J.* 2012 ; 6 : 313-9.
17. **Shoji H, Insall J.** High tibial osteotomy for osteoarthritis of the knee with valgus deformity. *J Bone Joint Surg Am* 1973. 55 : 963-973.
18. **Steadman JR, Rodkey WG, Briggs KK.** Microfracture to treat full-thickness chondral defects : surgical technique, rehabilitation, and outcomes. *J Knee Surg.* 2002 ; 15 : 170-6.