Do Microfractures Improve High Tibial Osteotomy Outcome?

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The aim of this study was to determine if microfractures improve the outcome of high tibial osteotomy in patients with medial compartmental osteoarthritis in genu varum. Forty patients presenting with Outerbridge grade III and IV chondropathies on the femoral and/or the tibial joint surface underwent high tibial osteotomy with Puddu plates (Arthrex, Inc, Naples, Florida) for primary medial compartment osteoarthritis in genu varum at our institution. Patients were randomly assigned to either the high tibial osteotomy plus microfractures group (A; n=20) or the high tibial osteotomy alone group (B; n=20). Final assessment was conducted 5 years postoperatively, including clinical response measured by the International Knee Documentation Committee (IKDC), Lysholm score, and patient satisfaction score. All patients were blinded to the treatment received and followed the same rehabilitation protocol. A statistically significant improvement between pre- and postoperative values was observed for Lysholm and IKDC scores in both groups, without any statistically significant difference between them. Regarding the satisfaction score, there were no differences between the 2 groups in terms of preoperative self-assessment ($P>0.05$), whereas postoperative subjective satisfaction at 5-year follow-up was significantly higher in group A than in group B ($P=0.0036$).

Our study results provide further evidence that medial tibial osteotomy is an effective surgical option for treating a varus knee associated with medial degenerative arthritis in patients wishing to continue accustomed levels of physical activity. In particular, patient satisfaction was higher among those who underwent the combined treatment involving high tibial osteotomy to correct femorotibial angle and microfractures.
Treatment of unicompartmental knee osteoarthritis continues to raise discussion. As initially described by Jackson et al, the causes of knee joint cartilage degeneration have been primarily attributed to medial deviation of the functional axis of the knee, tibial and femoral bone deformities, and malalignment and disorientation due to primary laxity of the collateral ligaments. High tibial osteotomy is a treatment of choice, particularly in patients wishing to continue to practice high levels of physical activity. Unicompartmental prosthesis is a more definitive treatment than high tibial osteotomy and is indicated in patients affected by wider cartilage degeneration or in older patients.

First described by Jackson and Waugh in 1982, high tibial osteotomy attracted attention following publication of long-term results in a study by Coventry et al. Debevre and Artigou outlined the technique of open wedge medial tibial osteotomy. With the introduction of the Puddu plate (Arthrex, Inc, Naples, Florida) into clinical practice in the late 1990s, which simplified the technique, high tibial osteotomy has reached wider acceptance. However, controversy exists about the use of high tibial osteotomy in association with microfractures to stimulate cartilage regeneration.

Johnson reported that microfracture is a suitable treatment for knee cartilage lesions, providing repair of the lesions by the formation of fibrocartilage. Although favorable results have been reported in patients with slight deviation of the functional axis, the long-term outcome remains unclear. In their studies, Bergenudd et al and Odenbring et al found that high tibial osteotomy can lead to long-term clinical improvement in cases of knee cartilage lesions.

The aim of this study was to assess patient satisfaction and functional outcome after high tibial osteotomy in combination with microfractures in patients with medial osteoarthritis in genu varum.

**Knee joint cartilage was evaluated arthroscopically by the same surgeon preoperatively according to Outerbridge’s criteria:**

- grade 0 = normal;
- grade 1 = softening and slight fibrillation of the surface;
- grade II = generally smooth joint surface but with unevenness, fragmentation, fissuring, and fibrillation over an area < 1.5 cm;
- grade III = white fibrous tissue, fragmentation, fissuring, and fibrillation over an area > 1.5 cm;
- grade IV = subchondral bone exposure and eburnation over almost all the joint surface.

**Symptoms were evaluated by the International Knee Documentation Committee (IKDC) and Lysholm scales preoperatively and at 6 months, 1 year, 2 years, and 5 years postoperatively. This study presents the 5-year follow-up data. Lysholm scores were considered:**

- < 64 = not sufficient;
- 65-83 = sufficient;
- 84-94 = good;
- 95-100 = excellent.

Patient satisfaction was measured according to a satisfaction scale (score 1-10).

**SURGICAL TECHNIQUE**

High tibial osteotomy was performed by wedge interlocking osteotomy and fixation with a Puddu plate. Prior to osteotomy, the degree of joint degeneration was measured arthroscopically. In group A, abrasion arthroplasty was performed using a steel abrader to a depth of approximately 1 mm; microfractures were created by drilling holes in the perimeter and the central area of the damaged cartilage to a depth of approximately 1 mm until bleeding of the subchondral bone occurred. This procedure was performed on the tibial plateau and femoral condyle in all patients except for 3 patients in group A who did not present with chondropathy of the tibial plateau and who received microfractures of the femoral condyle only. Group B patients underwent high tibial osteotomy only.

Starting from postoperative day 2, the physiotherapy regimen comprised physiotherapist-assisted continuous passive motion exercises, approximately 4 hours...
daily for 2 weeks, as well as isometric gymnastic and passive and active kine-
sis for approximately 2 hours daily for
2 weeks (Figure 2).15,16 The work load
was adjusted at 6 to 8 weeks, before full
weight bearing was permitted.
Analysis of variance (ANOVA) was
performed on continuous data; the chi-
square test was used to analyze the cate-
gorical scores. Statistical signifi cance was
set at $P<.05$.
Using an alpha value of 0.05 and a
power of 80%, the power calculations
were derived from an estimated difference
of 8 points in postoperative Lysholm score
between the 2 groups. The sample size re-
sulted in 20 patients for each group.

**RESULTS**
The clinical characteristics of the pa-
tients are summarized in Table 1. Group
A comprised 13 men and 7 women, and
group B comprised 15 men and 5 women.
Average patient age at surgery was 50±4.6
years (range, 44-64 years) in group A and
49.7±5.8 years (range, 43-67 years) in
group B ($P<.05$).
Eleven patients in group A and 13 pa-
tients in group B were affected by Outer-
bridge grade III lesions, whereas all other
patients, 9 in group A and 7 in group B,
presented with grade IV cartilage lesions.
All patients presented with femoral and
tibial eburnation, with the exception of 3
patients in group A and 2 patients in group
B who did not have tibial eburnation.
Three patients in group A and 2 in group
B had received arthroscopic debridement;
the remaining patients, 17 in group A and
18 in group B, had undergone conserva-
tive treatment for 1 year. All patients were
affected by multiple lesions, differing in size and in Outerbridge grade, but no
cases involved the entire tibial plateau or
condyle. A significant difference between
pre- and postoperative values in terms of
femorotibial angle correction was present in
each group (178.5±1.5 and 184.5±0.9
for group A, respectively; 178.2±1.6
and184.6±0.9 for group B, respectively;
all $P<.05$), but no statistically significant
differences between the 2 groups were ob-
served ($P<.05$).
The same trend was observed for the
Lysholm and IKDC scores preoperative-
ly and 5 years postoperatively: analysis
showed a statistically significant improve-
ment in postoperative Lysholm scores in
both groups compared to the preoperative
scores ($P<.05$), but there was no statisti-
cally significant difference in pre- and
postoperative scores between the 2 groups
($P>.05$) (Table 2). Preoperative IKDC
score was D in 70% and 75% of patients
in group A and B, respectively ($P>.05$).
Postoperative IKDC score significantly
increased in both groups: 16 patients in
the combined treatment group (80%) and
17 patients treated with high tibial oste-
otomy alone (85%) scored A, whereas the

| Table 1 |
| Patient Clinical Characteristics |
| Group A | Group B |
| Eburnation | | |
| No. femoral | 20 | 20 |
| No. tibial | 17 | 18 |
| Mean age, y | 50±4.6 | 49.7±5.8 |
| Mean BMI | 26.3±2.9 | 28.6±3.7 |
| Outerbridge classification | | |
| No. grade III | 11 | 13 |
| No. grade IV | 9 | 7 |

| Table 2 |
| Mean Pre- and Postoperative Lysholm and Satisfaction Scores |
| Group A | Group B | $P$ |
| Lysholm score* | | |
| Preoperative | 46.5±12.3 | 48.8±10.4 | .519 |
| Postoperative | 80.3±8 | 78.3±7.7 | .425 |
| IKDC score | | |
| Preoperative | | |
| No. C | 14 | 15 |
| No. D | 6 | 5 | .425 |
| Postoperative | | |
| No. A | 16 | 17 | .524 |
| No. B | 4 | 3 |
| Satisfaction score* | | |
| Preoperative | 3.3±1.4 | 3.2±1 | .791 |
| Postoperative | 7.8±1.3 | 6.9±0.9 | .0036 |

Abbreviation: BMI, body mass index.
*High tibial osteotomy plus microfractures; $n=20$.
**High tibial osteotomy alone; $n=20$.

*Data expressed as mean±standard deviation.
others scored B, with no significant differences between the 2 groups (P > .05).

Regarding the satisfaction score, there were no differences between the 2 groups in terms of preoperative self-assessment (P > .05), whereas postoperative subjective satisfaction at 5-year follow-up was significantly higher in group A than in group B (P = .0036). The inverse correlation between BMI and postoperative Lysholm score (r = −0.049; P = .001) was statistically significant only in group B patients. Furthermore, a negative correlation emerged between age and lesion grade according to Outerbridge’s criteria in group B patients: with increasing age, the lesion grade decreased (grades III and IV at an average age of 51.8 and 46.9 years, respectively; P = .014).

Postoperative Lysholm score was sufficient in 65% and good in 35% of group A patients, whereas in group B it was insufficient in 5%, sufficient in 60%, and good in 35% of patients. The patients who scored highest on the Lysholm scale were those with the highest preoperative lesion grade.

Magnetic resonance imaging assessment 5 years postoperatively disclosed regeneration of cartilage tissue on the femoral and tibial bones. In 3 cases of residual pain and articular stiffness in the operated knee, an arthroscopic second look of the joint observed good formation of a covering tissue (Figure 3). At 1-year follow-up, 1 patient was excluded from the study because of failure to return for examination. At 5-year follow-up, 2 patients (5%) were noted to have 3° undercorrection in genu varum that produced arthroscopically and clinically insufficient healing. For this reason and because of persistent pain, both received total knee arthroplasty (TKA). Deep venous thrombosis in 1 patient (2.5%) resolved with medical and compression therapy and did not affect the final analysis of the results.

**DISCUSSION**

Our study results provide further evidence that medial tibial osteotomy is an effective surgical option for treating a varus knee associated with medial degenerative arthritis in patients wishing to continue accustomed levels of physical activity. In particular, patient satisfaction was higher among those who underwent the combined treatment involving high tibial osteotomy to correct femorotibial angle and microfractures. Furthermore, an inverse correlation emerged between BMI values, Lysholm and IKDC scores, patient age, and degree of correction.

In this study population, a second intervention was necessary in only 2 cases where correction of the mechanical axis failed to restore normal valgus and serious pain persisted at 5-year follow-up. The 2 patients subsequently underwent TKA.

Published data suggest that abrasion-microfractures fail to completely resolve knee joint damage in patients with medial compartment arthritis associated with severe genu varum. Indeed, symptoms may later return, even after initial good results at 1-year postoperatively. For this reason, as described by Shaw and Moulton, high tibial osteotomy associated with microfractures is a valid attempt to correct the primary cause of arthritis. As demonstrated in a study by Puddu et al., medial tibial osteotomy is able to produce a clear improvement in clinical and subjective symptoms. Given the subjective nature of pain symptoms, our results show that the combined treatment achieved greater postoperative patient satisfaction, although the clinical results in the 2 treatment groups were objectively definitely comparable. This was probably due to the fibrocartilage formation that abrasion and microfracture are able to promote by stimulating the incoming of subchondral bone marrow blood to the surgical site. Fibrocartilage formation leads to enhanced restoration of physiological knee joint equilibrium, thus reducing pain and increasing patient satisfaction.

Six years postoperatively, we performed arthroscopic reintervention for a medial meniscal lesion in 3 patients. In these patients we were able to observe the new regenerated cartilaginous tissue on the area treated by microfractures. In 2 of these patients, the new formed tissue completely covered the chondral lesion, both approximately 1 cm², at femoral condyle level in 1 case and on the tibial plateau in the other. In the third patient, where the lesion size was approximately 3 cm², the new regenerated cartilaginous tissue just partially covered the tibial area. However, despite the results obtained by the second look arthroscopy in 3 of our patients showing no differences between condyles and tibial plateau, our surgical experience allowed us to observe that normally the use of microfractures in combination with osteotomy yields better subjective results in the femoral condyle than in the tibial plateau.

Even if it is known that chondral lesions microfractures could not result in exhaustive and durable results, in particular in lesions > 1 cm², this technique is still the most used treatment for isolated cartilage lesions. When patients present an axial deviation, the outcome could ameliorate combining microfractures with high tibial osteotomy. However, when high tibial osteotomy is not practical, as in normal morphotype patients, alternative treatments could be used for larger cartilage lesions according to patient age, activity level, and

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**Figure 3:** Arthroscopic second look after 1 year with microfracture treatment of a medial femoral condyle.
This evidence induced us to use microfractures in patients with focal chondral lesions, whereas for larger lesions, and in cases of correct indications, we performed high tibial osteotomy or a uniprosthesis.

REFERENCES