

Osteochondral Fractures of the Knee in Skeletally Immature Patients: Short-Term Results of Operative Fixation using Omnitech Screws

Osteochondrální zlomeniny kolena u skeletálně nezralých pacientů: krátkodobé výsledky operační fixace s použitím Omnitech šroubů

S. LIDDER^{1,2}, M. THOMAS², A. DESAI¹, A. SKYRME¹, A. ARMITAGE¹, S. RAJARATNAM¹

¹ Eastbourne District General Hospital, Department of Trauma and Orthopaedics, Eastbourne, East Sussex, UK

² Guys and St Thomas' Hospital, Department of Trauma and Orthopaedics, Westminster Bridge Road, London, UK

ABSTRACT

PURPOSE OF THE STUDY

Retrospective case series looking at the use of Omnitech compression screws for the management of osteochondral fractures in skeletally immature patients.

MATERIAL AND METHODS

Nine patients with a mean age of 14 were included in the study with a mean follow up of 26 months.

RESULTS

The average KOOS, IKDC and Tegner Lysholm Scores were 86.7, 90.34 and 96.1 respectively.

CONCLUSION

The use of Omnitech screws in the acute setting for skeletally immature patients shows excellent short-term outcomes.

Key words: knee, osteochondral fractures, Omnitech compression screws, adolescents.

INTRODUCTION

Osteochondral fractures of the knee arise from acute traumatic injury that damages the articular cartilage of the knee joint. Osteochondral fractures differ in aetiology from other causes of osteochondral defect (i.e. osteochondritis dissecans) in that they occur as a result of trauma. They are most often found following patella dislocation, direct trauma or twisting injuries to the knee in adolescents (9, 14).

Adolescents are particularly vulnerable to this type of injury. The peak incidence of osteochondral fractures is 20 years (9). The cartilage of a skeletally immature person is found to predispose skeletally immature individuals to osteochondral defects (4, 5). It has been proposed that calcification of the tidemark is important for stability of the interface between cartilage and subchondral bone (9).

Furthermore these injury patterns are becoming more prevalent in today's practice due to an increase uptake of competitive sporting activity in children and improved imaging allowing earlier diagnosis. Given that this pathology is not self-resolving entity it represents an important orthopaedic entity.

The role of articular cartilage is to provide a low-friction gliding surface minimizing peak pressures on subchondral bone (2) and to act as a shock absorber. These key functions emphasize its importance and injury may lead to early joint degeneration (15). There is limited ability to regenerate (8) and thus appropriate management is fundamental to reduce the long-term morbidity associated with injury to the articular surface.

Current practice includes three main surgical treatment approaches. First the defect may be fixed by securing the dislocated fragment, second the dislocated fragment may be removed and third a regenerative technique may be applied (9). The latter broadly involve bone marrow stimulation or chondrocyte engineering. Bone marrow stimulating techniques including microfractures, abrasion arthroplasty and drilling, used to encourage formation of fibro-cartilagenous repair tissue (5). Cartilage tissue based therapy such as mosaicplasty aim to fill a defect with osteochondral plugs taken from non-weight bearing surfaces. Cartilage cell-seeded therapies include autologous chondrocyte implantation (ACI) and matrix-assisted chondrocyte implantation (MACI) (16), whereby harvested cartilage is cultured and multiplied before being re-im-

planted back into the osteochondral defect. Fixation methods include the use of both absorbable and non-absorbable implants, with case studies focusing on bioabsorbable implants, fibrin adhesive and bone pegs (3, 6, 10, 11, 12, 17–19).

Although several studies investigate management of osteochondral fractures there is still disagreement on best management practice (9). We offer the first paper to look specifically at the use of Omnitech (non-absorbable) screws in the fixation of this type of traumatic injury in skeletally immature patients.

This retrospective single-centre study presents the short-term results following operative fixation of osteochondral fragments of the knee using Omnitech® (Biotech International, Salon-de-Provence, France) compression screws in skeletally immature patients.

MATERIAL AND METHODS

The knee database at our institution was retrospectively reviewed to identify children and adolescents who underwent surgery for patella dislocation, locked knees and trauma between 2008 and 2012. The inclusion criteria: an age criterion is applied, the patients must be under the age of 16 presenting to our institution with injury in keeping with acute trauma. They had a pre-operative anteroposterior (AP), lateral and skyline views radiographs of the knee joint showing an osteochondral lesion with open physes around the knee. A preoperative MRI was also performed.

Exclusion criteria were: 1. incomplete preoperative radiographs, 2. deviation from the standard protocol.

Twelve patients were identified (12 knees) with nine patients (9 knees) completing follow up. There were two females and seven males with a mean age at operation of 15 years (range 14–16) for females and 14.6 years (range 13–16) for males. There were 5 left knees and 4 right knees (Table 1).

The causes of the osteochondral fracture were a twisting injury in 5 of the patients, 2 children had a knee that gave away, one locked knee and one generalized painful knee. All patients had new onset painful swollen knees in keeping with a recent injury.

Clinical outcome

Patients were evaluated at follow up clinically and by questionnaire using three validated scoring tools; the

Knee Injury and Osteoarthritis Outcome Score (KOOS) (20), the International Knee Documentation Committee (IKDC) score (13) and the Tegner Lysholm Knee Scoring (TLKS) scale (7).

Radiographic assessment

Diagnosis of the osteochondral lesions were made on AP and lateral radiographs (Fig. 1) by an orthopaedic consultant and confirmed by a musculoskeletal radiologist. Magnetic resonance imaging (MRI) (Fig. 2) further characterized the lesion. Seven patients were found to have a defect on the lateral femoral condyle, one medial femoral condyle defect and one patella pole defect. On average, the surface area of the defects was 24.4 mm² (range 32.0–64.8 mm²).

Operative technique

Patients under general anesthesia were positioned in a supine position with a thigh tourniquet at 250 mmHg and leg bolster to allow arthroscopic evaluation of the osteochondral defect. A mini-arthrotomy was then performed to allow ease of access to the defect bed, which was prepared to receive the osteochondral fragment by gently curetaging to allow bleeding. The osteochondral fragment was then fixed to the defect under direct vision using Omnitech® screws (Fig. 3). These headless screws allow appropriate compression of the fragment onto the defect site and were buried under the articular cartilage. Three screws on average (range 1–5) were used for fixation of the fragments.

Post-operative treatment and rehabilitation

Post operatively, patients underwent a total of 6 weeks partial weight bearing in a hinged knee brace (Donjoy, USA), and then continued to be fully weight bearing. Post-operative radiographs were also taken at six weeks and 3 months (Fig. 4).

RESULTS

Post operatively patients were found to have a good range of movement with no wound complications at mean follow up of 25.6 months (range 12–53). The average KOOS score (out of 100) at final follow up was 86.7. This could be subdivided as follows; Pain, 93 (range 81–100), function in daily living (ADL), 97 (range 84–100), function in sport and recreation, 84

Table 1. Table providing demographic data and clinical outcome scores

Patient	Age	Sex	Side	Mechanism	Location of OCD	Total screws	Follow up (months)	KOOS	IKDC	Lysholm
1	16	Male	Right	Twisting injury	Lateral femoral condyle	4	12	100	100	100
2	16	Female	Left	Twisting injury	Lateral femoral condyle	3	20	100	100	100
3	14	Female	Left	Locked knee	Medial femoral condyle	2	23	89.3	80.5	89
4	16	Male	Left	Giving away	Lateral femoral condyle	3	15	69	82.8	95
5	13	Male	Right	Twisting injury	Lateral femoral condyle	4	15	50	98	97.7
6	15	Male	Left	Giving away	Lateral femoral condyle	3	40	100	95.4	96
7	15	male	left	Twisting injury	Lateral femoral condyle	3	31	94	100	98.9
8	13	Male	Right	Twisting injury	Lateral femoral condyle	5	22	91.7	71.3	97
9	13	Male	Right	Painful knee	Patella Pole	1	53	86	85.1	91



Fig. 1. AP and lateral radiographs of the left knee showing an osteochondral defect of the lateral femoral condyle.



Fig. 3. Diagram demonstrating position of the osteochondral defects on the femur and intra-operative pictures showing some of the osteochondral defects pre- and post-fixation.



Fig. 2. T2 weighted coronal and sagittal MRI of the left knee. An Osteochondral defect is seen within the lateral femoral condyle with associated bone bruising and large effusion present within the suprapatellar bursa.

(range 55–100), knee related quality of life, 79 (range 44–100) and other symptoms, 77 (range 36–100).

The average IKDC scores at final follow up was 90.34 out of 100, with an average Tegner Lysholm Knee Score of 96.1.

Radiographic assessment + arthroscopy or MRI

Patients underwent a post-operative radiographs routinely. Subsequent imaging and investigations were led by clinical need as assessed by the operating surgeon during follow up. Two patients underwent MRI, which revealed well-healed osteochondral lesions with no evidence of screw protrusion (Fig. 5). One patient had a repeat arthroscopy for loose body symptoms three months after initial fixation where a small loose body unrelated to the fixation was removed. At time of arthroscopy it was noted that the old repaired defect was well healed with buried screws.

Complications

No patients had any intra-operative or immediate post-operative complications.

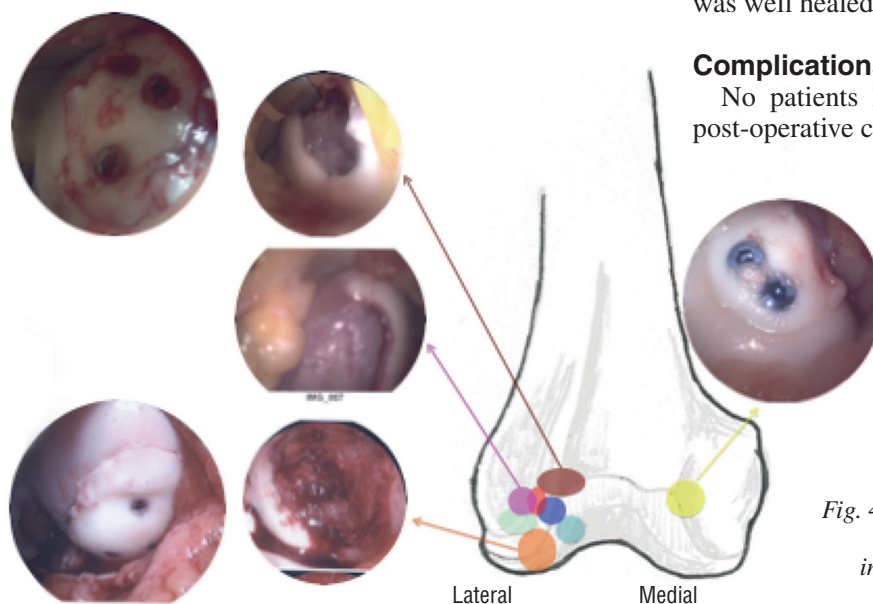


Fig. 4. Postoperative AP and lateral radiographs of the left knee showing Omnitech® screws insitu, used to fix the osteochondral fragment to the lateral femoral condyle.



Fig. 5. Post-operative T2 weighted coronal MRI of the knee demonstrating a well healed osteochondral lesion with no evidence of screw protrusion.

At a mean follow up of 25.6 months (range 12–53) there were no revision procedures for failure of fixation.

DISCUSSION

The short-term results of osteochondral fragment fixation in skeletally immature patients using headless compression screws are presented. The incidence of osteochondral fracture is currently increasing with improved diagnosis. A recent review looking at 993 consecutive arthroscopies over a 6-month period found that 66% had damage to their articular cartilage with localized cartilage defect in 20% of these (1).

Patients may present with a painful, swollen knee, occasionally locking or with the patient unable to bear weight. The long-term effects of leaving these osteochondral defects untreated include further articular damage, associated meniscal injury and early onset osteoarthritis (16).

Previous reported methods of osteochondral defect fixation in skeletally immature patients include the use of screw fixation, restorable pins and pull out suture. Chotel et al. conducted a retrospective multicenter study, which looked at 14 patients (mean age 12.9 years for girls, 14 years for boys). These patients were followed up to average 30 months. No conclusion was drawn about which method is preferred but that early treatment is preferential (4).

Matsusue et al offered evidence to support the use of biodegradable (L-lactide) pins in fixation of osteochondral fractures in adolescents (11). Braune et al. used a different type of bioabsorbable pin (poly-p-dioxanone) and concluded that they are offered an acceptable result in short-term follow up (7 months) (3). No paper has yet looked specifically at compression screws in surgical fixation of osteochondral fracture in skeletally immature patients.

Wouters et al. (19) studied the application of Meniscus arrows® in the fixation of osteochondral fragments. The

study included five patients with only two patients having long-term follow up (average 8 years). The remaining three patients who all underwent repeat arthroscopies were found to have healed osteochondral lesions. In this study there was no functional assessment to assess patient outcomes, although two children returned to their pre-injury activities.

Our short-term results have shown that the use of Omnitech® screws allowed for good fixation of osteochondral fractures with a return to normal activities in all our patients. Our follow-up has shown that patients are performing well in activities of daily living, with subjective reduction in pain. All patients are back to their pre-injury sporting activity. From our cohort, two patients underwent further arthroscopies due to pain. One undertaken three months post operatively for loose body sensation where a small chondral fragment was removed. At the time of arthroscopy, it was noted that the screws were still well buried and there was good evidence of healing of the osteochondral lesion. The second patient complained of ongoing knee pain. His repeat arthroscopy nine months post operatively showed a single screw with 2 mm protrusion with no opposite articular wear. This screw was removed, however the patient continued to have the initial knee discomfort. Additionally, two patients underwent post op MRI using cartilage mapping acquisition sequencing. These found well healed osteochondral lesions in both patients.

In this study, patients presented acutely to our services, however it is recognised that a preceding osteochondral injury cannot be ruled out. As all patients presented with new onset symptoms, all injuries were regarded as new defects within our study.

CONCLUSION

This short-term study shows that excellent outcomes can be achieved in skeletally immature patients using headless compression screws to allow healing of the osteochondral fragment. Injuries should be treated as acute fractures requiring urgent imaging and then early open reduction and internal fixation of the osteochondral fragment.

References

1. ARØEN, A., LØKEN, S., HEIR, S., ALVIK, E., EKELAND, A., GRANLUND, O. G., ENGBRETSSEN L.: Articular cartilage lesions in 993 consecutive knee arthroscopies. *Am. J. Sports Med.*, 32: 211–215, 2004.
2. BHOSALE, A. M., RICHARDSON, J. B.: Articular cartilage: structure, injuries and review of management. *Br. Med. Bull.*, 87: 77–95, 2008.
3. BRAUNE, C., REHART, S., KERSCHBAUMER, F., JÄGER, A.: Resorbable pin refixation of an osteochondral fracture of the lateral femoral condyle due to traumatic patellar dislocation: case management, follow-up and strategy in adolescents. *Z. Orthop. Ihre Grenzgeb.*, 142: 103–108, 2004.
4. CHOTEL, F., KNORR, G., SIMIAN, E., DUBRANA, F., VERSIER, G., FRENCH ARTHROSCOPY SOCIETY: Knee osteochondral fractures in skeletally immature patients: French multicenter study. *Orthop. Traumatol. Surg. Res.*, 97: S154–S159, 2011.

5. FLASCHMANN, R., BROOM, N. D., HARDY, A. E., MOLTSCHANIWSKYJ, G.: Why is the adolescent joint particularly susceptible to osteochondral shear fracture? *Clin. Orthop. Relat. Res.*, 381: 212–221, 2000.
6. FUCHS, M., VOSSHENRICH, R., DUMONT, C., STÜRMER, K. M.: Refixation of osteochondral fragments using absorbable implants. First results of a retrospective study. *Chirurg*, 74: 554–561, 2003.
7. KOCHER, M. S., STEADMAN, J. R., BRIGGS, K. K., STERETT, W. VI., HAWKINS, R. VJ.: Reliability, validity, and responsiveness of the Lysholm knee scale for various chondral disorders of the knee. *J. Bone Jt Surg.*, 86-A: 1139–1145, 2004.
8. KRYCH, A. J., HARNLY, H. W., RODEO, S. A., WILLIAMS, R. J.: Activity levels are higher after osteochondral autograft transfer mosaicplasty than after microfracture for articular cartilage defects of the knee: a retrospective comparative study. *J. Bone Jt Surg.*, 94-A: 971–978, 2012.
9. KÜHLE, J., ANGELE, P., BALCAREK, P., EICHINGER, M., FEUCHT, M., HAASPER, C., ALEXANDER, G., JUNG, T., LILL, H., MARQUASS, B., OSTI, M., ROSENBERGER, R., SALZMANN, G., STEINWACHS, M., VOIGT, C., VOGT, S., ZEICHEN, J., NIEMEYER, P.: Treatment of osteochondral fractures of the knee: a meta-analysis of available scientific evidence. *Int. Orthop.*, 37: 2385–2394, 2013.
10. LINDHOLM, S., PYLKKÄNEN, P., OSTERMAN, K.: Fixation of osteochondral fragments in the knee joint. A clinical survey. *Clin. Orthop.*, 126: 256–260, 1977.
11. MATSUSUE, Y., NAKAMURA, T., SUZUKI, S., IWASAKI, R.: Biodegradable pin fixation of osteochondral fragments of the knee. *Clin. Orthop. Relat. Res.*, 322: 166–173, 1996.
12. MYLLYNEN, P., ALBERTY-RYÖPPY, A., HARILAINEN, A.: Cortical bone pegs in the treatment of osteochondral fracture of the knee. *Ann. Chir. Gynaecol.*, 75: 160–163, 1986.
13. SCHMITT, L. C., PATERNO, M. V., HUANG, S.: Validity and internal consistency of the international knee documentation committee subjective knee evaluation form in children and adolescents. *Am. J. Sports Med.*, 38: 2443–2447, 2010.
14. TEN THIJE, J. H., FRIMA, A. J.: Patellar dislocation and osteochondral fractures. *Neth. J. Surg.*, 38: 150–154, 1986.
15. VAQUERO, J., FORRIOL, F.: Knee chondral injuries: clinical treatment strategies and experimental models. *Injury*, 43: 694–705, 2012.
16. VIJAYAN, S., BENTLEY, G., BRIGGS, T., SKINNER, J., CARINGTON, R., POLLOCK, R., FLANAGAN, A. M.: Cartilage repair: A review of Stanmore experience in the treatment of osteochondral defects in the knee with various surgical techniques. *Indian J. Orthop.*, 44: 238–245, 2010.
17. WACHOWSKI, M. M., FLOERKEMEIER, T., BALCAREK, P., WALDE, T. A., SCHÜTTRUMPF, J. P., FROSCH, S., DATHE, H., KERTESZ, A., STÜRMER, K. M., FROSCH, K. H.: Mid-term clinical and MRI results after refixation of osteochondral fractures with resorbable implants. *Z. Orthop. Unfall.*, 149: 61–67, 2011.
18. WALSH, S. J., BOYLE, M. J., MORGANTI, V.: Large osteochondral fractures of the lateral femoral condyle in the adolescent: outcome of bioabsorbable pin fixation. *J. Bone Jt Surg.*, 90-A: 1473–1478, 2008.
19. WOUTERS, D. B., BURGERHOF, J. G. M., DE HOSSON, J. T. M., BOS, R. R. M.: Fixation of osteochondral fragments in the human knee using Meniscus Arrows. *Knee Surg. Sports Traumatol. Arthrosc.*, 19: 183–188, 2011.
20. XIE, F., YE, H., ZHANG, Y., LIU, X., LEI, T., LI, S.-C.: Extension from inpatients to outpatients: validity and reliability of the Oxford Knee Score in measuring health outcomes in patients with knee osteoarthritis. *Int. J. Rheum. Dis.*, 14: 206–210, 2011.

Corresponding author:

Surjit Lidder, FRCS (Tr & Orth)

Guys and St Thomas' Hospital, Department of Trauma and Orthopaedics

Westminster Bridge Road

London, SE1 7EH, UK

E-mail: surjitliddar@me.com