Arthroscopic-Assisted Intraosseous Balloon-Assisted Repositioning of a Tibial Plateau Fracture: A Case Report

Artroskopicky asistovaná "balónová" intraosální repozice zlomeniny plató tibie – kazuistika

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SUMMARY

This is the first description of an arthroscopic-assisted intraosseous balloon-assisted repositioning and defect filling of a tibial plateau fracture.

The bone defect was filled with calcium phosphate cement in a liquid/paste form. The described technique was therefore introduced in order to allow an arthroscopic control of reposition and intra-articular cement escape during defect filling. X-rays showed an exact reposition without cement escape and the clinical outcome was satisfactory.

Key words: tibial plateau fracture, arthroscopy, balloon-assisted kyphoplasty, calcium phosphate cement.

INTRODUCTION

Tibial plateau depression fractures continue to pose a considerable therapeutic challenge. A particular problem is the reconstruction of the joint surface (6, 8, 9). One of the main problems in the case of tibial plateau fractures is the anatomical reconstruction of the joint surface and the posttraumatic gonarthrosis that develops over the long-term course (3, 5, 10).

Whereas, before the introduction of locked implants, the secondary loss of repositioning limited the radiological outcome, intraoperative repositioning is mainly responsible for the outcome today as a result of the biomechanical superiority of current implants.

The balloon-assisted kyphoplasty technique has become established over the past few years in the treatment of vertebral body fractures, achieving good results (1). The transfer of this technique to the therapy of a tibial plateau depression fracture was first published by Ahrens in the context of a cadaver study (4). The first application on patients was described by Hahnhaussen. Here, the repositioning was performed using two balloon systems (2). In subsequent trials, Heiney showed both a better repositioning and a smaller residual bone defect compared with the conventional technique (7).

In contrast to the conventional technique, however, the bone defect is not filled with cancellous bone, but with an initially liquid bone substitute material – a so-called calcium phosphate cement. Bone cements on the basis of calcium phosphates that are injected in paste form solidify in the body and are suitable for minimally invasive surgical techniques. Since the calcium phosphate phases formed [hydroxyapatite (HA) and bruschite] are very similar in composition to natural bone, they are more or less resorbable depending on their phase content.

Since the calcium phosphate cement is fundamentally applied in a liquid/paste form, it can in principle escape intra-articularly. This prompted us to extend the described technique in order to allow an arthroscopic control during repositioning and defect filling of a tibial plateau fracture.

CASE DESCRIPTION

A 59-year-old male patient suffered a knee distortion due to a fall while skiing. The clinical examination showed normal soft tissues. The capsular ligament apparatus appeared to be stable. The main symptoms were extensive tenderness to pressure above the lateral tibial plateau and a moderate knee joint effusion. Due to suspicion of a tibial plateau fracture in plain radiographs (Fig. 1), a CT scan was performed to confirm the diagnosis and plan surgery. Here, a lateral tibial plateau depression fracture was confirmed (AO 41 B3, IC1, MT 1, NV1), (Fig. 2). After primary immobilisation in an orthosis, surgery was performed on the second post-traumatic day.

Fig. 1. Plain radiograph of the tibial plateau fracture.

Surgical technique

1. A standardised arthroscopy was performed for irrigation of the knee joint and for exclusion of concomitant intra-articular injuries. Finally, the joint displacement was located and imaged continuously during the following surgical steps.
2. The future plate area of the tibial plateau was then prepared via a unilateral approach.
3. From the medial side of the affected tibial plateau, a K-wire was initially introduced into the fracture

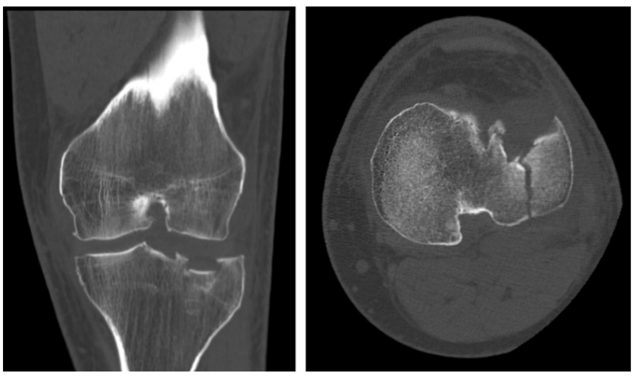

Fig. 2. Computed tomography of the tibial plateau fracture.

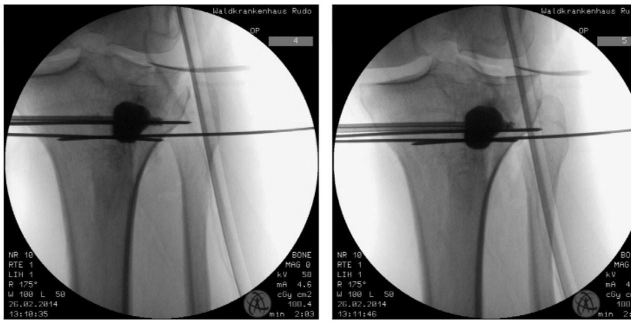

Fig. 3. Fracture reduction through the dilatation of the balloon.

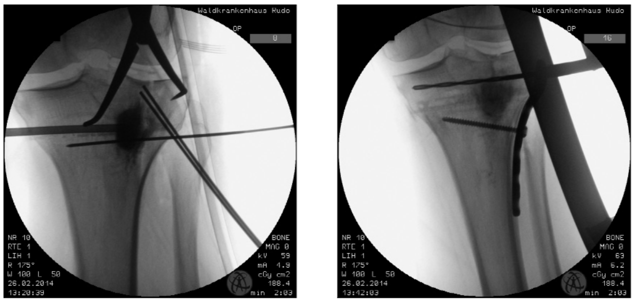

Fig. 4. Additional fracture reduction and positioning of the first screw.

zone under fluoroscopy via a stab incision, followed by a trocar system.
4. Then, three 1.8-mm K-wires were advanced below the future balloon introduction area in order to prevent the balloon from escaping distally upon dilatation (Fig. 3).
5. Now the balloon was positioned with the support of an image converter and filled with contrast medium under arthroscopic and radiological control.
6. After anatomically Correct repositioning, the repositioned fragments were fixed from the lateral using 1.4-mm K-wires.
7. The balloon was then removed and the remaining defect cavity was filled under arthroscopic and radiological control with the HA-forming calcium phosphate cement Stryker HydroSet (Stryker Corporation, Kalamazoo, USA). This ruled out the possibility of any uncontrolled intra-articular leakage.
8. Finally, the osteosynthesis was completed with a locked plate (Figs 4 and 5).

The postoperative procedure was in accordance with the follow-up schedule applied in our hospital for tibial plateau fractures. This included the application of an A-V impulse system, the fitting of a knee orthosis, early functional physiotherapy as well as current application. Partial loading was allowed with a maximum of 5 kg, and thrombosis prophylaxis was administered with enoxaparin 40 mg. At the end of the sixth postoperative week, a radiological check was performed and weight-bearing was increased. After radiological monitoring, pain-adapted loading was performed from the sixth post-operative week onwards up to full weight-bearing.

Fig. 5. Osteosynthesis with a locked plate.

RESULTS

No problems were experienced during the postoperative inpatient stay, so that the patient could be discharged for further outpatient treatment on the fourth postoperative day, with infection-free wound conditions.

Clinical monitoring after 6 weeks showed free mobility of the knee joint (ROM 0-0-130 degrees). Radiology showed increasing osseous integration of the fracture zone, without evidence of correction loss. Loading was increased in stages adapted according to pain up to full weight-bearing in the tenth postoperative week.

DISCUSSION

Percutaneous balloon dilatation for the therapy of tibial plateau depression fractures offers the possibility of sparing and optimal fracture repositioning if appropriately indicated. We consider the particular advantages of the technique presented here with additional arthroscopic control of repositioning and defect filling to be the more exact fracture repositioning as well as exclusion of the intra-articular leakage of bone substitute material.

The repositioning manoeuvres most commonly used to date, which raise the depressed material using a push rod via a window in the cortical bone, are inferior to balloon dilatation with regard to repositioning and the bone defect produced (7, 11). The cancellous bone defect that is produced in a controlled and uniform manner by balloon repositioning can be filled out with bone substitute material after perfect repositioning. The advantages of the calcium phosphate cement used are the short curing time and the problem-free integration into the subsequent plate and screw instrumentation. Apart from this, the material is fully degradable.

The synchronous arthroscopy shown in this case description during repositioning and the subsequent application of calcium phosphate cement makes it possible to check the repositioning outcome and any potential intra-articular leakage and, if necessary, make corrections. This may extend the spectrum of indications for the balloon dilatation of tibial plateau fractures to include smaller osteochondral defects, which have been a contraindication for this sparing procedure to date.

A further advantage of arthroscopic control is the possibility to do without contrast medium during the dilatation, so that an escape of contrast medium can be avoided in the event of rupture of the balloon system.

CONCLUSION

Arthroscopically assisted intraosseous balloon dilatation in tibial plateau depression fractures represents an innovative and minimally invasive method for repositioning. The advantage lies in the precise and sparing fracture repositioning. The ensuing defect can be bridged by applying a resorbable bone substitute material, and a potential intra-articular leakage of cement can be detected and corrected under arthroscopic control. In our case study, a complication-free postoperative course was achieved, with a very good clinical and radiological outcome.

References

1. AHRENS, P., SANDMANN, G., BAUER, J., KÖNIG, B., MARTETSCHLÄGER, F., MÜLLER, D.: Balloon osteoplasty--a new technique for reduction and stabilisation of impression fractures in the tibial plateau: a cadaver study and first clinical application. Int. Orthop., 36: 1937–1940, 2012.
2. GIANNOUDIS, P. V., TZIOUPIS, C., PAPATHANASSOPOULOS, A., OBAKPONOVWE, O., ROBERTS, C.: Articular step-off and risk of post-traumatic osteoarthritis. Evidence today. Injury, 41: 986–995, 2010.
3. HAHNHAUSSEN, J., HAK, D. J., WECKBACH, S., HEINEY, J. P., STAHEL, P. F.: Percutaneous inflation osteoplasty for indirect reduction of depressed tibial plateau fractures. Orthopedics, 35: 768–772, 2012.
4. HEINEY, J. P., KURSA, K., SCHMIDT, A.H., STANNARD, J. P.: Reduction and Stabilization of Depressed Articular Tibial Plateau Fractures: Comparison of Inflatable and Conventional Bone Tamps: Study of a Cadaver Model. J. Bone Jt Surg., 96-A: 1273–1279, 2014.
5. MCKINLEY, T.O., BORRELLI, J., D'LIMA, D. D., FURMAN, B. D., GIANNOUDIS, P. V.: Basic science of intra-articular fractures and posttraumatic osteoarthritis. J. Orthop. Trauma, 24: 567–570, 2010.
6. MUSAHL, V., TARKIN, I., KOBBE, P., TZIOUPIS, C., SISKA, P. A., PAPE, H.-C.: New trends and techniques in open reduction and internal fixation of fractures of the tibial plateau. J. Bone Jt Surg., 91-B: 426–433, 2009.

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