5. Tibial Plateau Fracture
CERAMENT®|BONE VOID FILLER in the treatment of Tibial Plateau fractures

**Background:**

Proximal tibia fractures are often complex and difficult to treat.

Two main injury mechanisms exist:
- Low energy injuries, often present in elderly, osteoporotic patients after minor trauma
- High energy injuries, usually present in younger patients, e.g. after a fall from height or a motor vehicle accident [1]

**Classification:**

AO classification [2]

[R2.1](#) Lateral total depression

[R2.2](#) Lateral total depression

[R2.3](#) Medial depression

[R3.1](#) Lateral split depression

[R3.2](#) Medial split depression

[R3.3](#) Oblique split depression

Schatzker classification [3]:

- **TYPE I**
  Lateral split

- **TYPE II**
  Split with depression

- **TYPE III**
  Pure lateral depression

- **TYPE IV**
  Pure medial depression

- **TYPE V**
  Bicondylar

- **TYPE VI**
  Split extends to metadiaphysis

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Diagnostics:

- Clinical examination, X-rays AP (Anterior Posterior), and lateral, CT-scan, MRI (ligament injury) [4]

Therapy:

Conservative treatment:

- Indication [5]:  
  - Non-displaced fractures with intact ligaments  
  - Stable in varus and valgus stress  
  - Low energy trauma with minimal osseous impression  
  - Peripheral subminiscal fractures  
  - Severe comorbidity of patient

- Therapy:  
  - Bed rest for 3-4 days with cryotherapy, compression, elevation, pain management and medical antiphlogistic therapy (RICE-therapy: rest, ice, compression, elevation)  
  - If splinting is necessary, immobilisation in a hinged fracture brace should be used [6]  
  - Start active range of motion exercises as soon as possible  
  - No weight bearing or only partial weight bearing up to 10kg for 6–8 weeks  
  - Progressive weight bearing should begin at 6–8 weeks, according to radiographic controls

Operative treatment [6]:

- All displaced tibial plateau fractures  
- Open fractures  
- Concomitant compartment syndrome  
- Fractures with nerve or vessel injury

Surgical techniques:

- Closed reduction and minimal invasive internal fixation with cannulated screws [6–8]  
- Closed reduction and external fixation (Ilizarov [9], Tailor Spatial Frame [10], Hybrid external fixation [11])  
- Open reduction and internal fixation (ORIF), usually with a Locking Compression Plate (LCP) [8, 12] or Less Invasive Stabilisation System (LISS) [8, 13]

The reduction of the depressed fragment of the tibia plateau can be achieved by lifting up the fragment with bone punches through a cortical window [7]. This manoeuvre leads to a bone void.

Treatment options of bone voids

There is still a lack of evidence to determine the best method for treating the bone defects in tibial plateau fractures [15]. Different treatment options exist, some are listed below:

- Autologous bone graft [7, 16]  
- Allograft [17]  
- Calcium phosphate bone cement [18, 19, 20]  
- Hydroxyapatite calcium carbonate synthetic bone graft [21]  
- Hydroxyapatite cement [22]  
- Bioactive glass granules [23]  
- Calcium sulphate / Calcium phosphate bone substitute: CERAMENT®|BONE VOID FILLER [24]
Literature

Surgical positioning and preoperative procedures:
- Mark the site of surgery while informed consent of patient is obtained
- The use of a radiolucent table is recommended
- Prepare mobile C-arm
- Antibiotic prophylaxis 30 min before incision [1]
- Place the patient in a supine position with a pillow under the ipsilateral knee
- Place a pneumatic thigh tourniquet and activate it
- Skin preparation and draping as usual
- Team time-out

Surgery:
- Usually an anterolateral, parapatellar approach is used.
- Via this approach a lateral arthrotomy enables a direct view of the lateral joint surface.
- A lateral cortical window is prepared. Four holes in the shape of a $1 \text{ cm}^2$ are drilled using a 2 mm drill bit. The drill holes are connected with a small osteotome and the cortical bone window opened.
- The depressed fragment is now lifted up using a bone punch through the cortical window.
- Temporal fixation of the fragment realized by K-wires. (Fig. 1C).
- For internal fixation cannulated screws, a LCP or the LISS can be used.
- In case of screws 3.5 mm [2] up to 6.5 mm [3] cannulated screws (with washers) are placed over K-wires.
- In case of a plate usually an anatomically shaped LCP is used according to the suggested surgical technique [4,5].
- If the LISS is used, follow the established surgical instructions [5,6].
- Fracture reduction and implant placement should be controlled by fluoroscopy.
- As a next step, the bone void, which resulted from the reduction of the fragment, is filled.
- Mix CERAMENT®|BONE VOID FILLER as per Instructions for use.
- Wait for three minutes until the material will be more viscous.
- Inject CERAMENT®|BONE VOID FILLER in the void in backfill technique under fluoroscopic control. (Fig. 1D).
- The cortical bone window can be closed if appropriate.
- Wait for 10 minutes until CERAMENT®|BONE VOID FILLER has hardened.
- The surgical tourniquet can be released and accurate hemostasis should be achieved.
- If required a drain with contact to the cortical window can be used.
- Perform a layered wound closure.
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Follow Up:
- Clinical and radiographic controls

Tips and tricks:
- Ensure good contact with cancellous bone
- Wait three minutes after mixing before you start to inject CERAMENT® BONE VOID FILLER (‘Spaghetti-test’)
  - Control bleeding during surgery
  - Extensive bleeding might result in intermixing of blood with the CERAMENT® paste
  - Consider using a tourniquet
- Follow normal surgical practice and if applicable use a drain with contact to the hardened CERAMENT®
  - The drain may draw white coloured fluid some hours after surgery, which does not endanger the success of surgery
- Close soft tissue and skin in layers:
  - Complete all deep sutures first before tightening them in a second step