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Innovative intramedullary Stabilization of Metacarpal Shaft Fractures

Initial clinical Experiences with a photodynamic Polymer (IlluminOss)

Steffen Heck¹, Sascha Gicki, Bob Rabiner, Dietmar Penne¹

Steffen Heck, M.D.

In addition to conservative therapies, metacarpal fractures are treated with various osteosynthetic techniques. The spectrum of fracture stabilization extends from K-wire pinning, fine-thread screw osteosynthesis using intramedullary fixation nails or K-wire splinting and plate osteosynthesis right up to minifixator systems. The methods used combine the properties of the plastic materials utilized successfully in the last 10 years in dentistry with the Dacron balloon catheters known and tried and tested in interventional radiology and cardiology.

Up to now both materials have not been used in modern trauma surgery/orthopedics. The methacrylates used were approved at the end of 2008 for fracture treatment in human medicine.

The sizes of balloon catheters (4 mm x 30 mm – 7 mm x 70 mm) available at the start of development suggested their use in metacarpal fracture stabilization.

Minimally-invasive intramedullar insertion of plastic implants used for the first time in a small number of human subjects stabilized the fracture and brought about bone healing. In the Seldinger technique, after repositioning of a fracture a balloon catheter is inserted into medullary space previously reamed with use of a flexible cannulated drill. The balloon is filled with liquid monomer which is converted into a hard polymer within 200 seconds by application of visible blue light at 436 nm wavelength. The design of the implant additionally offers the opportunity to increase stability by locking with screws, introduced at any angle, at every reasonable anatomically site.

Biomechanical tests resulted in a higher primary stability compared to intramedullary K-wire splinting, and with additional locking of the IlluminOss-implant a primary stability comparable to osteosynthesis by means of mini-T-plate or a minifixator.

From January 2010 to March 2011 in total 12 patients (8 men/4 women) were treated with the aid of IlluminOss. The average age was 27.2 years (16-49).

Four patients received an additional locking with fine-thread screws. The average operation time was 75.8 minutes (49-101), the time interval between trauma and operation was 5.8 days (3-9). Eleven of 12 patients had a fractured ray, and one had fractures of two metacarpal bones. Altogether ten fifth metacarpal bones and two fourth

metacarpal bones were treated operatively with the polymer. In the case of one patient with two fractured metacarpal bones, the fourth ray was treated with a fine-thread screw. Diaphyseal fractures were included exclusively in the study.

The patients received a two-finger plaster splint in intrinsic-plus-position of the finger for one week postoperatively. Subsequently, the splints were removed and a twin-tape (buddy splint) applied for another 1-3 weeks.

Ten of 12 patients could be sequentially followed-up clinically and radiologically. The osseous healing could be verified radiologically with all ten patients. The average follow-up period was 13.6 +/- 3.7 months, (8-20).

Fig. 1: (050 top left to bottom right) Filling of the balloon catheter with liquid monomer- intramedullary introduction of the filled catheter using an inserter – hardening of the plastic by means of visible blue light – intraoperative X-ray photos with correct implant position and axial alignment.

Fig. 2: radiological documentation of osseous healing – post-operative range of movement

All patients had free functioning with complete extension and bending of fingers, there was no rotational error. The average DASH-Score was 31.8 points. A distinct reddening and soft-tissue swelling occurred immediately after the operation in the case of one patient, which healed under conservative therapy without secondary damage and with free functioning.

IlluminOss can prove itself to be a sensible alternative treatment for metacarpal fractures. This indication has meanwhile been extended through the development of longer balloons with greater diameter for care of fractures of long tubular bones.

Herewith, an implant is available that adjusts itself to the individual medullary space of the person..

Sascha Gicki, M.D., Prof. Dietmar Pennig, M.D.,
¹Department for Trauma Surgery/Orthopedics,
Hand and Plastic Surgery St. Vincent Hospital Cologne

ADDRESS FOR CORRESPONDENCE

Steffen Heck, M.D.
Department for Trauma Surgery/Orthopedics,
Hand and Plastic Surgery St. Vincent Hospital Cologne
Merheimer Street 221-223
50733 Cologne
steffen.heck@vinzenz-hospital.de