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Intramedullary Polymer Osteosynthesis (IlluminOss), biomechanical comparative Tests and initial clinical Experience with metacarpal Bone Fractures

IlluminOss is an innovative minimally-invasive surgical procedure for intramedullary fixation of metacarpal bone fractures. A balloon-catheter is inserted into the opened medullary space via a cutaneous incision and the catheter is then filled with liquid monomer after repositioning. A hard polymer is formed within approximately 200 seconds by irradiation with visible light (436nm) via an intramedullary introduced fiber-optic cable. This plastic compound has been used for many years in dentistry and has been approved for use in human medicine and explicitly at the metacarpal bone since the end of 2008.

The subcapital fracture of the metacarpal bone is one of the most frequent fractures of the upper extremity. Fractures with rotatory malposition, severe shortening or palmar axial deviation above 30° can be treated surgically. For these, a large number of osteosynthesis procedures are used. The goal of the present work is to compare the primary stability of the IlluminOss-Implant with the osteosynthesis procedures commonly used for subcapital fracture of the metacarpal bone.

A standardized subcapital osteotomy was performed on 96 freshly isolated human metacarpal bones II-V and the preparations were then randomly assigned to 6 osteosynthesis groups (dorsal fixed angle mini-T-plate, fine thread screw osteosynthesis, intramedullary K-wire splinting, mini-external fixator, IlluminOss, IlluminOss with interlocking). In a material testing machine, a dorso-palmar force was applied by a stamp to each of 8 preparations of a group at a strain rate of 100 mm/min. The force resulting at a maximum 3 mm deformation was determined as the primary stability of the osteosynthesis procedure. In addition, the polycyclic load test was carried out between 2 and 50 N for 100 cycles on each of the 8 remaining preparations of a group. The biomechanical data of the different osteosynthesis procedures was compared statistically.

With monocyclic dorso-palmar stress of the osteosynthetically treated metacarpal head, average force values between 92±14 N (K-wire) und 137±28 N (dorsal fixed-angle mini-T-plate) were achieved. The osteosynthesis procedures by means of fine thread screws, mini-external fixator and dorsal fixed-angle mini-T-plate exhibited no significantly higher primary stability at a deformation of 3 mm than the IlluminOss procedure. The largest deformation could be detected under polycyclic stress after 100 cycles with the intramedullary K-wire splinting and the sole IlluminOss-Osteosynthesis, while the mini-T-plate had the smallest deformation. The interlocked IlluminOss-osteosynthesis was significantly superior to the intramedullary K-wire-splinting and possessed stability comparable to all other osteosynthesis procedures.

From January to October 2010 altogether 10 patients (6 men/4 women) were treated by means of IlluminOss. The average age was 25.9 years (16-49). An additional interlocking took place with 4 patients. The average operation period was 79.1 minutes (67-101), the time interval between trauma and surgery averaged 5.9 days (3-9). The average follow-up period was 5.1 +/- 3.2 months, (2-11). Osseous healing

could be detected in all 10 patients by radiology. All patients had a free function with complete stretching and bending of the finger, no rotational deformities were found. The mean DASH-Score was 31.8 points. One patient had pronounced tissue swelling immediately after the operation, which healed under conservative therapy and with free functioning.

The IlluminOss-Implant thus shows itself to be an innovative alternative to the established osteosynthesis procedures.