power. In terms of NNT, we would need to give 34 patients a bone graft to prevent one additional failure of healing.


1A.26

“Cut and run”. Rapid life saving amputation using fire service hydraulic cutting equipment in entrapped trauma victims

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Background: We investigated the potential to utilise fire service hydraulic cutting equipment to effect life saving amputations in entrapped trauma victims.

Materials and methods: After a successful pilot study using four cadaveric porcine hind-leg models; three fresh frozen bequeathed cadaveric lower limb specimens each underwent five guillotine amputations using the hydraulic cutting equipment and conventional war surgical techniques. Video-documentation of each guillotine amputation was studied to define the: (i) number of cutting actions required to complete the amputations without the need for other cutting instruments, (ii) total time to achieve a completed amputation, (iii) quality of cut and (iv) proximal extent of fracture propagation.

Results: Our study confirms that this equipment would enable extraction from immediately life threatening circumstances between two and seven times quicker than conventional amputation techniques.

Conclusion: The equipment allows effective access to facilitate maximal stump length preservation and protects attending staff and the injured patient from the dangers of conventional amputation techniques in these difficult circumstances.

Keywords: Life saving; Amputation; Hydraulic; Cutting; Equipment


1A.27

A robotic hexapod external fixator for the correction of angular deformity of long bones

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Introduction: External fixation is a commonly used technique for fracture fixation as well as for limb lengthening and correction of deformities either congenital or caused by trauma. Fracture treatment primarily requires immobilization and anatomical reduction of the fracture gap, while distraction osteogenesis utilizes exact fixator movements to gradually form new tissue. The gradual distraction stimulates the body’s self-healing capacities to form new bone and has been proposed for limb lengthening and treatment of deformities already 100 years ago. The hexapod external fixator is based upon parallel kinematics well-known from high-precision robotics. This allows for fracture movements in all six degrees of freedom without losing stability of fixation. In current clinical routine the fixator movements are effected manually by the patient several times a day over the course of healing. A system is presented to improve the treatment with robotic actuators replacing the manual actuation.

Patients and methods: The hexapod external fixator is based upon parallel kinematics. Six linear manual actuators (distractors) are fixed on two rings with nonblocking ball joints. External fixators described by Ilizarov still in common use lose stability while being adjusted as hinges have to be unblocked to allow movements of the device. Due to the parallel kinematics the hexapod external fixator always maintains stability of fixation thus allowing even complex fracture movements without patient discomfort. A motor-driven actuator was developed to replace the manual actuation elements of the fixator system. The actuators are assembled from two main parts: the telescopic bar also used in the manual system and a motor unit. It contains a small electric motor (Maxon RE13) with three watts of electrical power, a magnetic encoder and an actuator system. The speed of the linear actuators is up to 2.5 mm per second while the force of the robotic fixator is equal to 300 N.

Accuracy of the robotic fixator is identical to the manual system with a typical error of less than 1° and 1 mm respectively. The robotic hexapod external fixator was applied clinically for the final adjustment of a distraction osteogenesis. A male patient of 35 years suffered a fracture of his left lower leg in 2000. The fracture was treated with an Ilizarov external fixator yet a shortening of 1.5 cm and varus deformation remained.

In April 2009 tibia and fibula were cut and distraction osteogenesis was initiated to correct the shortening and deformity. The patient was not fully compliant due to pain developing during actuation. Therefore the distraction osteogenesis was finished prematurely and the hexapod fixator was scheduled to be removed in May 2009.

Results: Upon removal of the manual hexapod external fixator the robotic system was applied (Fig. 2) to correct the remaining angular deformities under fluoroscopic control.

An angle of 3.5° in varus and 13.3° posterior deformity was determined with two X-ray images taken from frontal and lateral. After robotic reduction the varus deformity was corrected successfully while the posterior deformity was reduced to 6°. Shortening of the leg was not corrected.