Title: EPIDURAL SPINAL ELECTRICAL STIMULATION (ESES) IN SEVERE LIMB ISCHAEMIA

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Introduction. The approach to treatment of patients with chronic occlusive arterial disease of the lower extremities depends on the severity and extent of obstructive lesions. Arterial reconstructive surgery remains the therapy of choice, but in approximately 20% of the patients with ulceration and gangrene, vascular surgery is not effective. Epidural Spinal Electrical Stimulation (ESES) is an accepted therapy for the treatment of low back pain, causalgia, and phantom limb pain. Recently ESES has also been suggested to improve heating of skin ulcers even in patients with limb threatening occlusive arterial disease in whom vascular reconstruction is impossible or has failed. It is likely that in these patients ischaemic phenomena takes at the level of the microcirculation.

In the present study we evaluated the effects of ESES on the microcirculation using incident bright field and fluorescence (dynamic) video capillary microscopy.

Patients and Methods. ESES was performed on ten patients with severe limb ischaemia (Fontaine stage III-IV) due to atherosclerotic or diabetic disease. The mean age of the patients was 77 years. Prior to ESES patients underwent vascular reconstructive suregery or sympathectomy without satisfactory result. Angiography showed occluded crural arteries technically unsuitable for reconstructive surgery. All patients had rest pain and eight of them suffered from nonhealing ulcers. The technique consists of surgical incision parallel to the spinous processes of lumbar 3rd and 4th vertebrae under local anesthesia whereafter the electrode is introduced into the epidural space via a Tuohy needle. The electrode is advanced upto the level of T9, 10 in midline under Xray image intensifier control. Test stimulation is now started and the electrode manipulated to a height where maximum, pleasant parasthesias are felt extending down in both legs up to the toes. Stimulation was performed with a pulse width of 0.2 milliseconds, a frequency of 85-120 Hertz and an amplitude ranging between 3 and 9 volts. The following macro and microcirculatory parameters were assessed one day before and one day after spinal cord stimulation.

Macrocirculation. The systolic ankle/arm pressure index expressed as a percentage was measured with a continuous wave Doppler instrument. The systolic toe pressure, expressed in mmHg, was assessed by photoplethysmography.

Microcirculation. Bright field microscopy was used to assess capillary diameters and red blood cell (RBC) velocity (flying spot method) in the nailfold. Fluorescence microscopy was used in combination with intravenously injected sodium fluorescein to study capillary density (i.e. number of capillaries/mm^2) and sodium fluorescein appearance time (seconds) and distribution in the dorsum of the toe.

Results. After ESES nine out of ten patients had complete relief of pain and in one patient the pain was reduced. During the follow up period in five of the eight patients with ischaemic ulcers complete healing occured. In other three patients amputation could not be avoided.

Macrocirculation. The mean systolic ankle/arm pressure index was 32 prior to ESES and did not change significantly after stimulation. The mean toe pressure increased from 9 mmHg to 19 mmHg which was not a significant difference.

Microcirculation. Morphological investigation of the skin capillaries showed that the number of perfused capillaries increased significantly after ESES. Skin capillary diameter did not change after treatment R.B.C. velocity in capillaries already perfused before ESES increased from 0.054 mm/s to 0.762 mm/s (p 0.001) after treatment. The appearance time of sodium-fluorescein decreased in all patients (p 0.001).

Discussion. Intravital skin capillary microscopy was shown to be a noninvasive method to evaluate microcirculatory changes induced by ESES. The significant increase in skin capillary density and R.B.C. velocity explain the observed clinical improvement and ulcer healing. Although the patients in this study were all in the last phase before amputation, seven patients reported subjective improvement while in three patients amputation was necessary as yet. Similar beneficial effects were also reported by Augustinson and coworkers. The mechanism by which spinal cord stimulation exerts pain relief is still unclear. Pain is a symptom of tissue damage caused by stimulation of A-delta and C fibres. Melzack and Wall propose that pain is determined by the interaction of stimuli transmission to the cells of substantia gelatinosa, the dorsal column fibres and the first transmission cells with dorsal horn. The idea of dorsal root electrical stimulation is based on blockade of painstimuli. Consequently pain relief may release the reflex vasoconstriction that is known to occur in response to pain. Hilton and Marshall described vasodilatation in the Cat gastroenemius muscle following dorsal root stimulation and postulated that this effect is due to antidromic stimulation of small diameter fibres. They found an interaction with prostaglandines release in muscles.

In conclusion Epidural Spinal Electrical Stimulation (ESES) caused effective pain relief and improved wound healing in patients with severe limb ischaemia which could be objectivated by improved skin nutritional bloodflow. Further prospective clinical and physiological studies are necessary in order to clarify the indication and to investigate the mechanisms involved.