RELIEF OF PAIN BY SUBCUTANEOUS ELECTRICAL STIMULATION AFTER OCULAR SURGERY

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Pain after ocular surgery is a common occurrence. Medication with various mild analgesic drugs is the accepted, and usually, effective way to alleviate postoperative pain. However, ocular surgical procedures associated with highly increased intraocular pressure, such as cyclocryotherapy, circular buckling for retinal detachment, or evisceration, may cause severe and persistent pain that is not relieved even by the more potent analgesics. Postoperative administration of retrobulbar alcohol in seeing eyes has been recommended in order to prevent unnecessary suffering.[1]

Electrical stimulation of painful areas has been advocated as a new form of therapy in various pain syndromes,[2-4] postoperative pain being one of the conditions treated successfully by this method from the early stages of its use.[5-10] The electrical treatment was applied either through externally placed electrodes, that is, transcutaneous electrical stimulation, or by means of implanted subcutaneous wire electrodes, that is, subcutaneous electrical stimulation. In patients who had undergone thoracic,[5,6] abdominal,[7,8] orthopedic,[9] or gynecologic[10] operations, the application of transcutaneous electrical stimulation or subcutaneous electrical stimulation was successful in ameliorating postoperative pain. Some patients even preferred electrical stiumulation therapy instead of treatment with analgesic drugs.

In opthalmologic immediate postoperative pain relief, however, electrical stimulation has not been used. We present the results obtained with subcutaneous electrical stimulation applied to patients who had been subjected to various surgical ocular procedures.

SUBJECTS AND METHODS

Twenty-five patients (12 females and 13 males, aged 17 to 71 years) who underwent ocular surgery were treated by electrical stimulation for postoperative pain relief. Twenty-one patients received subcutaneous electrical stimulation by means of implanted steel wire electrodes. In four patients, who suffered from persistent late postoperative pain, transcutaneous electrical stimulation was administered by way of externally placed silicone rubber electrodes. The surgical procedures consisted of cyclocryopexy in 12 patients, cataract in six, retinal detachment in six, and vitrectomy in one patient (Table). In 19 of the 21 patients who received subcutaneous electrical stimulation, sterile wires were introduced in the area adjacent to the supraorbital and infraorbital nerves at the end of the surgical procedures and while the patient was still under local or general anesthesia (Figs. 1 and 2). The other two patients complained of severe pain in the eye three to 14 days after surgery and subcutaneous electrical stimulation was introduced at this late postoperative stage.

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TABLE

PERTINENT DATA OF THE PATIENTS AND RESULTS OF ELECTRICAL STIMULATION*

Patient No., Age (yrs), Sex	Surgical Treatment	Anesthesia	Type of ES	Duration (days)	Results	Remarks
1, 46, M	Retinal detachment	Local	SES	2	Very good	Reoperation
2, 48, F	Cataract	Local	SES	2	Very good	—
3, 64, M	Cataract	Local	SES	2	Good	—
4, 70, M	Vitrectomy	Local	SES	1	Good	—
5, 71, F	Retinal detachment	General	SES	2	Very good	Reoperation
6, 71, F	Retinal detachment	Local	SES	3	Very good	Reoperation
7, 63, M	Cataract	Local	SES	3	Very good	Allergic to drugs
8, 71, F	Cyclocryopexy	Local	SES	1	Very good	Retrobulbar alcohol block in previous surgery
9, 40, F	Cyclocryopexy	Local	SES	1	Good	—
10, 52, M	Cyclocryopexy	Local	SES	—	—	Reoperation; patient opposed—treatment interrupted
11, 58, F	Retinal detachment	General	SES	2	Good	Reoperation
12, 14, F	Cyclocryopexy	General	SES	1	Fair	Reoperation
13, 70, F	Cyclocryopexy	Local	SES	1	Good	—
14, 46, M	Cyclocryopexy	Local	SES	2	Very good	—
15, 65, M	Cyclocryopexy	Local	SES	1	Very good	—
16, 25, F	Cyclocryopexy	Local	SES	1	Very good	—
17, 53, F	Cyclocryopexy	Local	SES	1	Fair	Severe ischemic heart disease
18, 51, M	Cyclocryopexy	Local	SES	1	Good	
19, 61, F	Cyclocryopexy	General	SES	—	—	Patient opposed—treatment interrupted
20, 45, M	Retinal detachment	†	SES	2	Good	Reoperation
21, 70, M	Cataract	†	SES	1	No effect	Pain relieved by subsequent retrobulbar alcohol block
22, 65, F	Retinal detachment	†	TES	5	Good	—
23, 42, M	Retinal detachment	†	TES	7	Good	
24, 74, M	Cataract and bulbous keratopathy	†	TES	7	Good	—
25, 51, M	Cataract	†	TES	3	Fair	—

*ES designates electrical stimulation; SES, subcutaneous electrical stimulation; and TES, transcutaneous electrical stimulation.

†Treatment with ES was instituted in the late postoperative period.

Treatment was given immediately after surgery with a portable battery-operated nerve stimulator to which the electrode wires were attached. The apparatus has a frequency of 80 Hz, a pulse duration of 0.4 msec and generates asymmetric square pulses. It is also equipped with a second type of preset electrical stimulation (the modulation current output) (Fig. 3). When the modulation current is turned on, the duration of the pulse waves increases continually and gradually from 0.4 to 0.6 msec during a total period of 0.2 msec, after which it automatically reverts to the 0.4 msec pulse duration, to restart the whole cycle. This will result in an automatic average increase of the current intensity by approximately 25%. The basic initial electrical stimulation produces a delicate feeling of tingling and the modulation current is perceived as a pulsating type of

Fig. 1 (Ticho, Olshwang, and Magora). Patient with implanted wire electrodes in the area of the supraorbital and infraorbital nerves.

Fig. 2 (Ticho, Olshwang, and Magora). Patient connected to the nerve stimulator.

coarse vibration deep in the eye and its surrounding area. The intensity and type of current stimulation is adjusted by the patient himself during the period of treatment that lasts from one to three days, sometimes continuing around the clock. In the patients with late postoperative pain, electrical stimulation was continued and treatment lasted up to seven days.

Each patient was checked periodically throughout the course of treatment with regard to his general condition, analgesic needs, and stimulator performance.

Results

The effect of electrical stimulation was assessed according to the subjective feeling of pain of the patient and his need for analgesic drugs. The results were defined as follows: "very good" when the patient was free of pain and no drugs were required, "good" when pain was moderate and sedatives or mild analgesic drugs sufficed, and "fair" when the pain persisted despite electrical stimulation and analgesic medication, but the patient refused to interrupt the stimulation. In the 19 patients in whom treatment with subcutaneous electrical stimulation was started immediately upon termination of surgery, results were "very good" in nine, "good" in six, and "fair" in two patients. Two patients were apprehensive and refused electrical stimulation treatment after a short trial (Table). Of the six patients with late or chronic postoperative pain, the results were "good" in four, "fair" in one, and had no effect in the last patient. In seven patients who had undergone previous ocular surgery, subcutaneous electrical stimulation treatment compared favorably with earli-

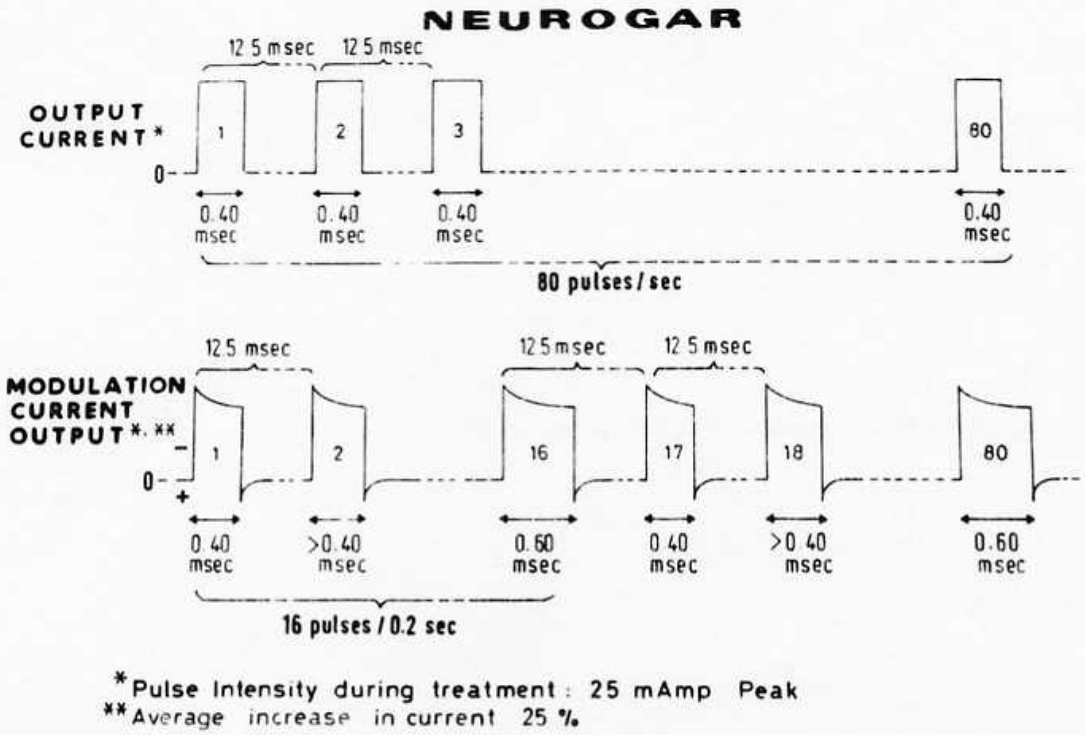

Fig. 3 (Ticho, Olshwang, and Magora). The current output of the electrical nerve stimulator.

er pain relief. One of the patients, who had received subcutaneous electrical stimulation postoperatively after previous ocular surgery, requested this mode of treatment after the surgical procedure.

Despite the continuous application of electrical stimulation, especially during the first 24 postoperative hours, the patients were able to move freely, because the implanted electrodes were well secured and bodily movement did not alter the electrical conductivity. However, in some instances, subcutaneous electrical stimulation was inadvertently interrupted because of sudden disconnection of the electrodes or exhaustion of the batteries. In these cases, pain often returned, but disappeared again after electrical stimulation had been re-established.

There were no complications associated with the electrical stimulation therapy such as skin burns, bleeding tendency, and the like. The electrode wires were removed easily upon completion of the treatment.

Discussion

Prolonged alleviation of pain was attributed by many investigators[11,12] to a peripheral physiologic effect caused by stimulation of the large fibers in the dorsal column in accordance with the "gate theory" put forward by Melzack and Wall.[13] Electrical stimulation is particularly suited for the treatment of postoperative ophthalmic pain as compared to other surgical procedures, because the circumscribed area of ocular pain is innervated mainly by two superficial nerves that afford easy access for therapy by stimulation. In addition to its electrical stimuli, electrical stimulation also exerts a mechanical effect, depending on the selection of the modulation current. This effect is particularly important after ocular surgery, because the patient is not allowed to massage, scratch, or apply pressure on the wound, in contrast to other types of surgery such as limb or abdominal operations. Although a placebo effect should not be excluded, Chapman,

Chen, and Bonica[14] have shown that the result of electrical stimulation treatment is not solely related to such a response. In the present series, direct placebo studies were not conducted; however, inadvertent interruption of the stimulation without the patient being aware of the break elicited pain sensations which, in all instances, were suppressed upon re-establishment of the stimulation. These observations strongly indicate that pain relief by means of electrical stimulation is the result of its physiologic effects.

Problems of electrical conductivity across the electrode skin interface often arise when externally placed electrodes are used. Localized concentration of current density and a spiking discharge causing unpleasant sensations may occur during sudden movement of the electrodes or changes in skin resistance caused by any other factor. In contrast, implanted electrodes are stable and bypass skin resistance; as a result, stimulation is uniform and pleasant, and current intensity necessarily minimal.

Insertion of the electrodes is a simple and painless procedure; it is performed under sterile conditions at the end of the operation while the patient is still anesthetized. Exact placement and maintenance of the electrodes near the supraorbital and infraorbital nerves is easily attained.

Pain after ocular surgery is, in general, not a major complaint. However, certain types of intervention or re-operation, together with the patient's personality, may render the early postoperative period difficult and extremely painful.

Treatment with electrical stimulation in a group of 25 patients completely abolished postoperative ophthalmic pain in nine patients and ameliorated the pain in 13. Intermittent or continuous application of electrical stimulation via subcutaneously implanted electrodes should be considered in the treatment of ocular pain in the immediate postoperative period in general and particularly in those surgical procedures in which postoperative pain is anticipated. Late postoperative ocular pain may be treated by either subcutaneous or transcutaneous electrical stimulation.

Summary

Electrical stimulation in the treatment of postoperative ophthalmologic pain was applied in 25 patients. In 21, stimulation was applied by means of subcutaneously implanted wires and in four patients the therapy was administered by externally placed electrodes. The subcutaneous electrodes were introduced near the supraorbital and infraorbital nerves at the end of the surgical procedures, and stimulation was immediately begun. Duration of treatment varied between one and three days.

The nerve stimulator is a portable, battery-operated apparatus. The implanted electrodes avoid skin resistance and are extremely stable, thus affording uniform current intensity that does not change during sudden movements. As a result, the stimuli are perceived as a pleasant sensation. Complete pain relief was attained in nine patients, and in 13 patients the pain was diminished. The therapy is appropriate and effective in postoperative ocular pain, because the pain is restricted to a limited area, innervated by superficial nerves that are easily accessible to electrical stimulation.

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