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PRELIMINARY COMMUNICATIONS

Induction Cardiac Pacing: A New Approach

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Summary

A new approach to induction cardiac pacing using a "skin tunnel" transformer has been developed and used in a patient. Initial results are encouraging. If the system proves reliable in the long term it may have important applications in the delivery of power to implanted artificial organs.

Introduction

Permanent electrical pacing of the heart is firmly established as the treatment of choice in certain cardiac conditions, principally symptomatic complete heart block. Full utilization of this method of therapy in developing countries, however, has been impossible because of the very high cost of the permanent pacemaker.

In seeking a less expensive alternative we have devised and used a cheap permanent pacemaker using the induction principle. The problem, inherent in any induction-type pacemaker so far described, of maintenance of good approximation of primary and secondary coils has been overcome by using a "skin tunnel" transformer. Such a device has not been used previously in man and its successful utilization, reported here, may have important implications concerning the transfer of power from outside the body to implanted artificial organs.

Principle of Method

A diagram of the system is shown in fig. 1. The induction element is the skin tunnel transformer as described by Andren *et al.* (1968). In this technique an implanted coil is brought out

in a tunnel of skin and thus can be coupled to the primary coil with a ring of ferrite material. By using a radio frequency impulse in our system the external coil has been reduced to one turn of stranded copper wire and the internal coil to three turns of insulated Elgiloy spring-coiled wire.* The latter is continuous at one end with the pacing electrode in the heart, and at the other with a stainless-steel capsule which acts as the indifferent electrode and also contains the only implanted electrical components, four diodes (only one is necessary but four are used for redundancy) to rectify the A.C. impulse.

FIG. 1—Diagram of system using "skin tunnel" transformer.

Clinical Trial and Results

After successful animal experiments (McArthur *et al.*, 1972 a; McArthur *et al.*, 1972 b) the system was offered to a patient with complete heart block who could not afford a totally implanted system. An endocardial pacing lead was placed in the apex of the right ventricle using the saphenous vein approach (Sloman *et al.*, 1970). Under general anaesthesia a skin tube was formed in the inguinal fossa region using standard plastic surgery techniques. Inside the tube were incorporated three loops of the insulated Elgiloy wire, the deep portions of the loops being placed under the external oblique muscle. The capsule was placed in the rectus sheath. When the tube had healed a ferroxcube toroid,† previously scored and broken in half, was re-assembled round it and the loop of wire from the external unit passed through. (In fact, two loops were used for redundancy; see fig. 2.) The external generator, which will be described elsewhere, and which has two independent pacing circuits for safety, was worn in a leather case on a belt (fig. 3).

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FIG. 2—Close-up view of "skin tunnel" transformer in patient. (For scale, toroid has external diameter of 4 cm.)

FIG. 3—Total external component of system.

The patient has had the system for six months. The original capsule had to be replaced because of an insulation fault. Otherwise the system has continued to function well.

Discussion

In devising a pacing system suitable for use in developing countries the main considerations were safety and low cost. An induction system seemed most promising as the external generator could be built from locally available components at low cost, and by building in redundancy wherever possible a high degree of safety could be achieved. Nevertheless, the problem of having to use adhesive plaster to fix the primary coil closely over the secondary coil appeared a major one for warm countries, where perspiration would tend to loosen the adhesive. This problem appears to have been overcome by using the skin tunnel transformer. In addition this system allows very efficient transfer of energy and, therefore, low battery drain.

It remains to be seen just how robust the skin tube of such a system will prove to be. If satisfactory it may have wide possibilities in the delivery of power to implanted artificial organs.

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MEDICAL MEMORANDA

Postpartum Purpura Fulminans: Successful Management with Streptokinase

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Purpura fulminans is an acute condition characterized by extensive bleeding into the skin, resulting in haemorrhagic bullae with large areas of skin necrosis and gangrene of extremities. The bleeding leads to severe anaemia and the untreated condition is usually fatal (Henoch, 1887).

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We present a case of postpartum purpura fulminans associated with bilateral deep vein thrombosis. Successful management was achieved only by using streptokinase in addition to heparin.

Case Report

The patient, a 19-year-old primigravida, was delivered of a normal male child by lower segment caesarean section. The pregnancy had been uneventful apart from a failed forceps delivery due to fetomaternal disproportion.

There was nothing significant in the past medical history and in particular there had been no previous thrombotic episode.

On the ninth postpartum day she became pyrexial (temperature, 38.5°C) and the next day developed right sided pleuritic pain. Radiography at the time showed changes consistent with collapse and consolidation at the right lower zone. There was no clinical evidence of deep vein thrombosis and she was treated with ampicillin 250 mg six-hourly.

The next day she noticed pain and tenderness in the right calf which was slightly swollen. A deep vein thrombosis was diagnosed clinically and anticoagulation begun with heparin, then phenindione. Adequate anticoagulation with phenindione as judged by prothrombin time was readily achieved but there was no change in her condition until eight days after the onset, when the calf circumference rapidly increased. This was thought to be due to intramuscular haemorrhage. Phenindione was, therefore, discontinued and she was given vitamin