The penetrative effect of the Helica T. C. In Vivo

Summary
The Helica T.C. caused tissue injury in a highly localised manner, sparing adjacent structures damage from excessive heat dissipation. The intensity of damage was predictable with safe and effective use. The foot pedal and dial settings gave precise delivery of beam energies and the indicator flame permitted a precise application to the tissues.

ASSESSMENT OF THE HELICA T.C. IN VIVO: EFFECT OF DURATION OF EXPOSURE AND POWER SETTING ON TISSUE INJURY.

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Introduction

The Helica thermal coagulator is a helium beam whose clinical applicability is currently being assessed. It works by combining helium gas with a low AC electric current which passes along a single insulated probe. The instrument is guided by an indicator flame of about 20 degrees centigrade. However as the probe approaches tissue, coagulation is activated and the directional flame changes to a fine jet reaching a temperature of around 800 degrees centigrade. Its advantage over other forms of coagulation equipment is that it uses very low power levels (in the range of 2 to 35 watts). This may permit the Helica T.C. to cauterise soft tissue selectively and so reduce the risk of damaging neighbouring healthy tissue.
At present one of the main areas of clinical assessment of Helica T.C. has been in gynaecological laparoscopic surgery in the management of endometriosis and in situations where achieving haematosis is difficult. As a consequence, Helica T.C. has gained acceptance in a number of centres. However, no formal assessment has been undertaken of its efficacy, through the range of power settings and exposure durations, on tissue in vivo.

Aim

The aim of this study was to assess, macroscopically and microscopically, the degree of acute damage caused to rat tissue in vivo, following the application of Helica T.C. The probe was assessed through a range of exposure durations and power settings. Since most clinical experience to date has been in the treatment of endometriosis, we chose to assess the abdominal and small intestinal walls from the serosal sides.

Methods

Adult male Wistar rats (180-220 g body weight) were anaesthetised with an intraperitoneal injection of sodium pentobarbitone (60mg/kg) and maintained throughout the experiments by interval intraperitoneal injections (15-30mg/kg) as necessary. Animals were kept at 37 degrees centigrade using an overhead lamp. The abdomen was opened through a midline incision which was extended a little to the right and left at the xiphisternum and pelvis so as to free two large flaps of abdominal wall with an intact blood supply. Each flap was then pinned to a cork mat and the viscera was retracted, so exposing a sheet of parietal peritoneum of the abdominal wall. An earth plate was placed under the rat. The probe tip was placed 2mm above the parietal peritoneum, perpendicular to the tissue and a used: four of these were at low power, one at medium (12W) and one at high power (33W). The four low power settings were 1/10, 3/10, 6/10 and 10/10 on the dial, the former representing the minimum settings (<2W) and the latter the

maximum setting (<6W). Submucosal injections of ink were made to identify the points where the beam had been applied.

At the end of the experiment the rats were killed by an overdose of pentobarbitone and the sampled abdominal wall placed in formalin prior to histological assessment. In a parallel group of experiments the coagulator beam was applied through the same power setting range to the serosal aspect of small intestine. The tissues were paraffin-fixed and stained with haematoxylin and eosin. A single blinded histopathologist reviewed the slides to assess the tissue injury.

Analysis

The extent of the defect in the tissue caused by the coagulator probe was measured macroscopically. The histological appearances were described and tissue necrosis and blood vessel damage were assessed semi-quantitatively. Tissue necrosis was graded 1 (minimal damage), 2 (moderate tissue necrosis with <3mm penetration) or 3 (severe injury with>3mm penetration). Blood vessel damage was expressed as 1 (congestion) or 2 (thrombosis). Findings were correlated with energy delivery by the probe.

Materials

The Helica T.C. was supplied by Helica Instruments Ltd, Block 6, Research & Development Park, Heriot Watt University, Riccarton, Edinburgh, EH14 4AS.

Results

Macroscopic appearances:

The coagulator-induced lesions ranged from transient blanching which spontaneously resolved, at the lowest power settings, through to ulcers>10mm in diameter after 6 seconds or more exposure at medium and high powers. The highest power setting was sufficient to perforate the small intestinal wall.

Microscopic appearances:

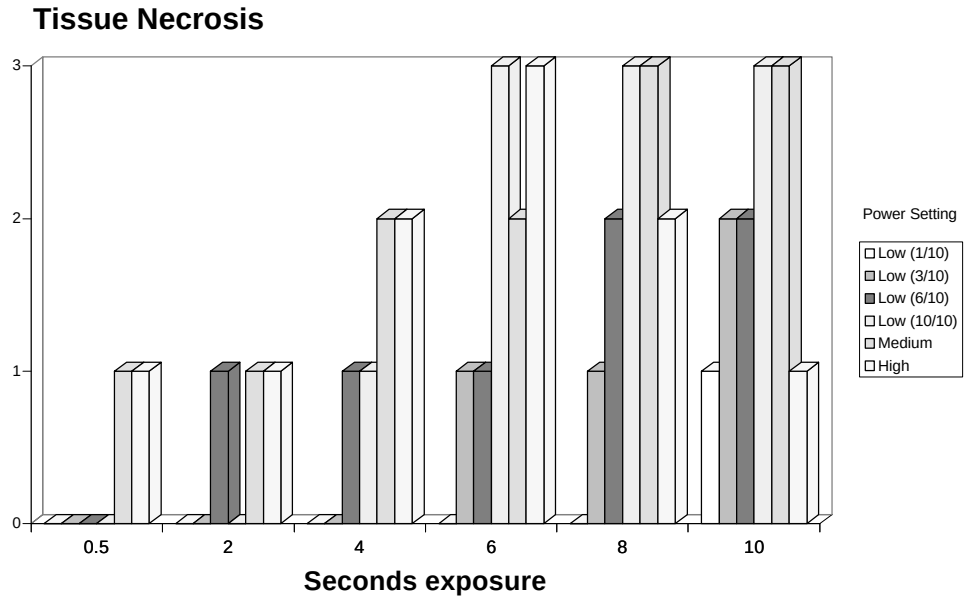


Figure 1: Effect of the Helica T.C. on rat abdominal wall expressed as grades of tissue necrosis. Grade 1= minimal injury: grade 2= moderate injury, <3mm penetration ; grade 3= severe injury, <3mm penetration. The beam was applied at differing power settings and exposure durations.

The low power settings, 1/10 and 3/10 resulted in minimal identifiable injury. Examination of the coagulator-induced lesions revealed disruption of the serosa with a varying degree of tissue

necrosis of the underlying muscle. The tissue damage appeared highly localised and was accompanied by congestion or thrombosis in adjacent veins. Occasionally haemorrhage or thrombosis of a vasa nervorum was identified.

As expected, the severity of tissue necrosis and intravascular thrombosis became more marked both with increasing exposure and increasing power settings (figs. 1 and 2).

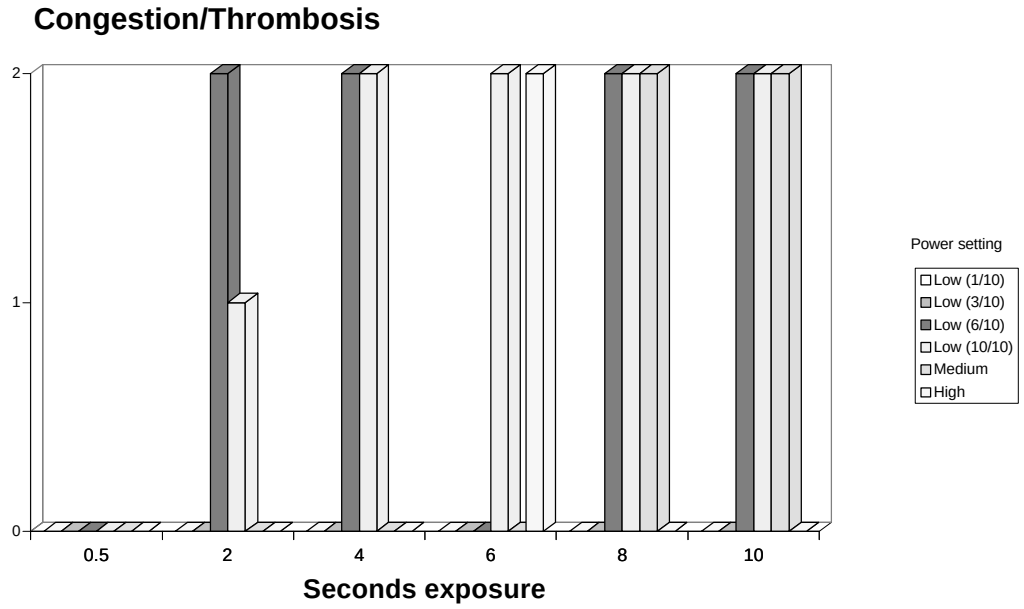
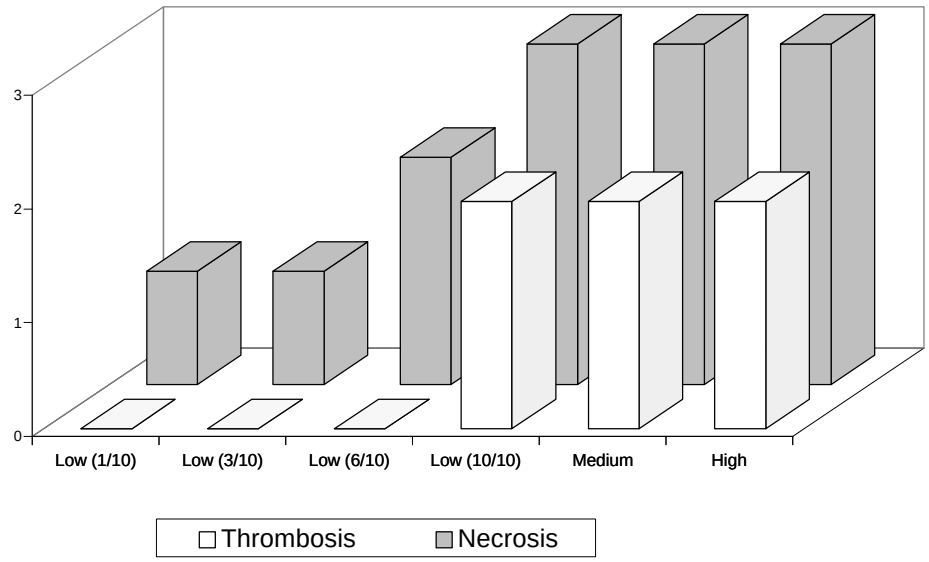


Figure 2: Effect of the Helica T.C. on rat abdominal wall expressed as vascular injury. Grade 1= venular congestion; drade 2= thrombosis. The beam was applied at different power settings and exposure durations.

Small intestinal findings matched thoes of the abdominal wall (Fig. 3).



Fugure 3: Effect of the Helica T.C. on rat small intestine expressed as tissue necrosis and vascular injury.
As assessment of energy delivery by the coagulator suggested that at the low power settings, a combination of exposure time and power setting sufficient to deliver approximately 35 joules or more resulted in grade 2 tissue necrosis (fig. 4). Grade 3 tissue necrosis was seen only at

maximum low power, medium or high power settings at least 6 seconds exposure to the coagulator beam. At these power settings, however, exposure duration rather than total energy delivery appeared more effective in causing tissue necrosis. (Fig. 5).

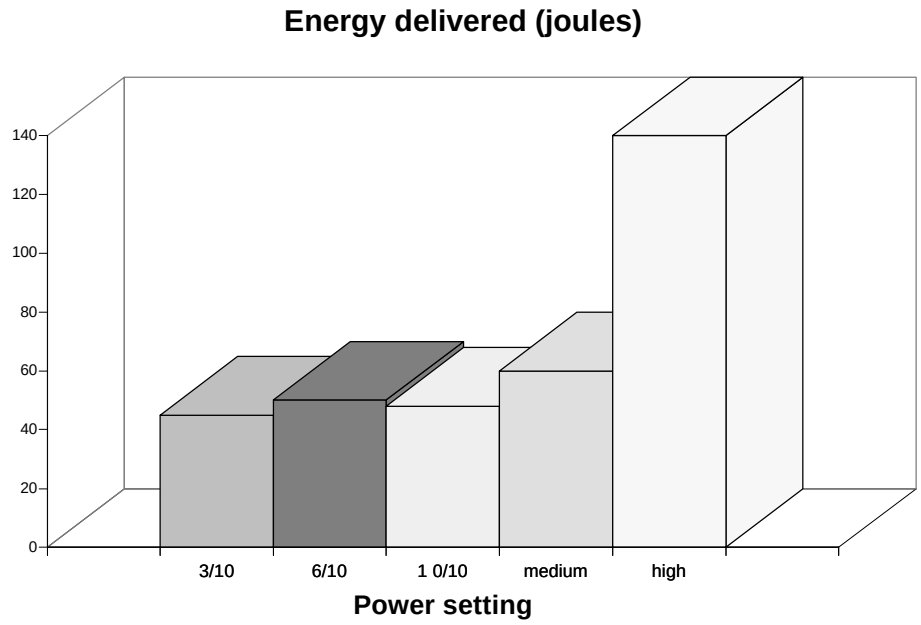


Figure 4: The amount of energy per power setting required to cause grade 2 or 3 tissue injury.

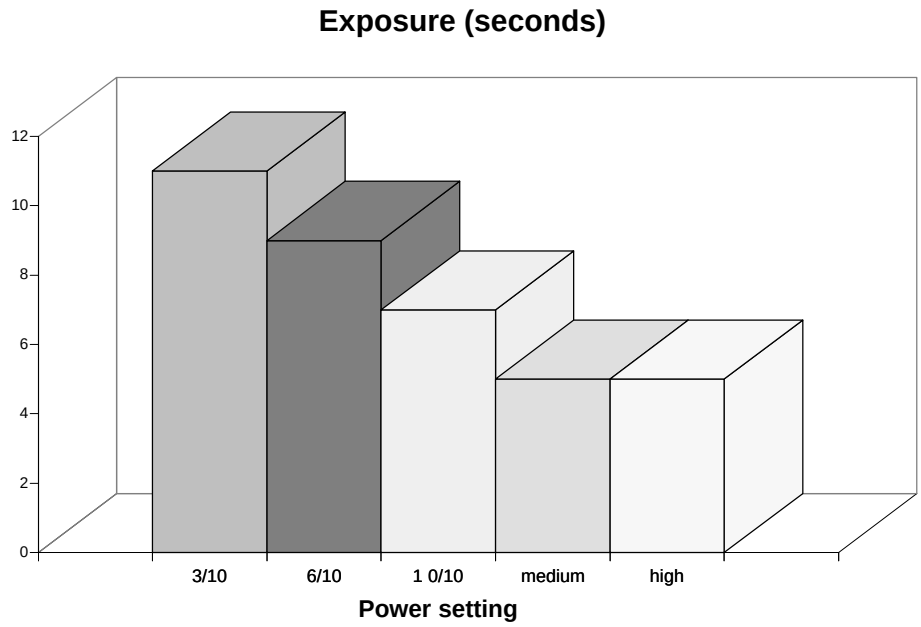


Figure 5: The exposure duration per power setting required to cause grade 2 or 3 tissue injury.

Discussion

We fount the Helica thermal coagulator to cause tissue injury in a highly localised manner. This may result from the relatively low energies required for efficacy of the coagulator. As a consequence, adjacent structures which might otherwise be damaged because of excessive heat dissipation are spared. The intensity of the injury was predictable, since macroscopic and

microscopic findings paralleled each other, and was dependent upon exposure duration and power setting. At low power settings a threshold of around 35 joules were required to cause significant tissue injury, whilst at higher power settings, exposure duration over 4 seconds tended to cause increasing tissue injury. The Helica thermal coagulator proved to be simple, safe and effective to use. The foot-pedal and dial settings allowed for the ready delivery of selected beam energies. Furthermore, the indicator flame permitted a precision of application to the tissues. In endometriotic disease, its spread of usage, predictability and efficacy at low energies permits extensive treatment to be carried out and has led to its acceptance in a number of centres. One can therefore envisage the use of the Helica T.C. being extended at this stage to open and laparoscopic surgery in a number of fields, as well as to endoscopic therapeutics. A formal evaluation of the range of indications of Helica T.C. as well as a comparison with established forms of cautery is now indicated.