Microprocessor-controlled scanning micromanipulator for carbon dioxide laser surgery

Technical note

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A microprocessor-controlled scanning device for use in carbon dioxide laser surgery is described. This device increases the speed of dissection, allows the surgeon to keep both hands in the operative field, and thereby decreases the fatigue associated with manual control of the micromanipulator used in a surgical laser system.

KEY WORDS • carbon dioxide surgical laser • scanning micromanipulator • laser surgery • instrumentation

The carbon dioxide laser has been established as a useful tool in neurological surgery. It may be used as a free-hand instrument, or in conjunction with the operating microscope. As a microsurgical device, the movement and placement of the laser beam is controlled via a mechanical joystick manipulator. Operative limitations associated with the current application of laser include: 1) the requirement of one of the surgeon's hands to direct the laser beam; 2) operator fatigue; and 3) a lack of precise control. This paper presents a microprocessor-controlled scanning device that we have used clinically which eliminates the problems just mentioned.

Materials and Methods

The Model 771 Microscan micromanipulator* is an electromechanical version of the micromanipulators currently in use with a variety of surgical laser systems. It consists of a micromanipulator unit with a continuously variable focal spot size, attached to a remote control panel and joystick via a sterilizable electrical cord (Fig. 1).

The area of tissue to be ablated is selected by the surgeon and outlined using the helium-neon aiming beam and the joystick on the control panel. The coordinates of this area are then stored in the microprocessor memory and may be verified by having the device retrace the previously selected area. If the surgeon is satisfied with the area selected, he may proceed with laser operation. If not, the above process is repeated until a satisfactory tracing is obtained (Fig. 2).

When the foot switch is depressed, the selected area of operative field is scanned first in the horizontal direction, from left to right, and then in the vertical direction, from top to bottom (Fig. 3). At the end of the vertical scan, the device extinguishes the laser and closes the shutter for 2 seconds before beginning the next horizontal scanning sequence. The area to be scanned is controlled by the surgeon with an accuracy varying from 4.0 mm when working in the largest area, to 0.25 mm when the smallest area setting is used. The surgeon likewise controls the scan speed, focal spot diameter, and laser power, and can stop both the laser and the scanning action at any time by simply releasing the foot switch.

Another option is the manual control of the beam, such as is currently available with conventional micromanipulators. The surgeon may switch to manual con-
Microprocessor-controlled scanning micromanipulator

Fig. 1. Control panel of the microprocessor scanning device.

Fig. 2. Flow diagram of operation of the device.

Fig. 3. Diagram showing the scanning sequence in the operative field.

trol of the laser beam by simply depressing a single button. Automatic scanning may be resumed when desired, with the scan beginning at the same point where it was previously discontinued.

The microprocessor circuitry includes a number of safety features to reduce the possibility of an accidental prolonged exposure of tissue to the laser beam. These include a circuit that closes the shutter and extinguishes the laser should the scan stop for more than 1 second, as well as the ability to view the area to be scanned with only the helium-neon guide beam.

Discussion

The thermal effects that occur as a result of the absorption of laser light by tissue are controlled by manipulating the power density and radiant exposure variables. Since power density is determined by power per unit, the range of power densities achievable is comparable with both those micromanipulators already available and the microprocessor-controlled scanner reported here. Radiant exposure is power density in watts/sq cm multiplied by time in seconds. With the conventional micromanipulators, damage in adjacent tissue is reduced primarily by either decreasing the power density or by using a pulsed burst of laser energy. The microprocessor-controlled scanner introduces the capability of swift accurate scanning to the extent that damage in adjacent tissues is minimized even with the use of a continuous beam.

One of the greatest advantages associated with the use of this device is the ability of the surgeon to use both hands in the operative field for suctioning or dissection, instead of having to use one hand solely for the control of the micromanipulator. Furthermore, microprocessor control and speed increases the precision of the laser dissection, and decreases the fatigue experienced by the surgeon by eliminating the repetitive movements of the manual micromanipulator.

We have used the microprocessor-controlled scanning micromanipulator clinically for removing a tumor by carbon dioxide laser surgery. The use of this new device provides the advantages of: 1) allowing the surgeon to keep both hands in the operative field; 2) increasing the speed of dissection by allowing the use of a continuous beam and minimizing the damage to surrounding tissues; and 3) decreasing the fatigue associated with the manual micromanipulator now in use.

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