TABLE 1. Relationship between Direction of the Bevel of the Epidural Needle and Anesthetic Spread in the Epidural Space

Age Groups (yr)	Upper Level of Anesthesia (Thoracic Dermatome)		Probability
	Cephalad Direction	Caudad Direction	
20–39	8.6 ± 0.4 (25)	9.2 ± 0.5 (25)	0.19
40–59	5.2 ± 0.4 (25)	6.2 ± 0.4 (25)	<0.05
60–79	4.4 ± 0.5 (25)	5.9 ± 0.4 (25)	<0.02

Values are means ± SEM. The number of patients in parentheses.

ential spread of the solution in a direction of the bevel of the epidural needle.

The small but significant influence of the direction of the epidural needle bevel on epidural anesthetic spread in older patients has, we believe, little clinical importance compared to some of the variables mentioned, *i.e.*, technical factors, physical characteristics of the patient, and intrinsic anatomic factors.[4-6] Because of the involvement of these many variables in epidural anesthetic spread, the epidural anesthesia becomes very unpredictable and the epidural catheter is, therefore, often inserted in patients of our institution to insure not only the duration of the anesthesia, but also an adequate level of the anesthesia.

In conclusion, local anesthetic injected into the epidural space had a preferential spread to the direction of the epidural needle bevel only in patients older than 40 years of age. However, because the difference is less than two segments, the direction of the bevel is of little significance clinically.

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An Unusual Occurrence of Total Anesthesia Machine Failure during Administration of an Anesthetic

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Separate needle valves and flow columns for nitrous oxide and oxygen are standard equipment on conventional anesthesia machines. Recently, a new type of gas flow control with separate adjustments for concentration and for total flow has been introduced. The intended purpose of this innovation is to prevent delivery of hypoxic mixtures by making a 70–30% mix of nitrous oxide–oxygen, the lowest oxygen concentration that can be dialed. We describe a case in which the use of such a system, (Monitored Dial Mixer)‡ (fig. 1) was involved with failure of the anesthesia machine to deliver fresh gas when a critical component of the device malfunctioned during administration of an anesthetic.

REPORT OF A CASE

An 86-kg, 61-year-old man was scheduled for supraglottic laryngectomy and radical neck dissection because of cancer of the larynx. His past history included two prior myocardial infarctions and a cardiac arrest. He previously had removal of a left ventricular aneurysm and had also had coronary artery bypass grafts. He was taking propranolol, persantin, and cimetidine, but had been progressing well since bypass

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‡ Manufactured by Fraser-Sweatman, Inc.

surgery. Preoperative medications consisted of 50 mg hydroxyzine, po, 10 mg morphine sulfate, im, and 0.2 mg glycopyrrolate im. A tracheostomy was performed with local anesthesia. The tracheostomy tube was attached to a Bain circuit with a total flow of 12 l/min of 50% nitrous oxide and oxygen. Increments of fentanyl to a total of 0.5 mg, iv, were administered and halothane added at an inspired concentration of 0.5%. Ventilation was controlled and within a few minutes total flow was reduced to 6 l with 50% nitrous oxide and oxygen maintained. One hour later, and long after the last change in flows, the fresh gas output of the machine totally ceased. This was realized immediately due to deflation of the rebreathing bag and the fall of both flow column balls. The machine settings had not changed nor was it disconnected from the central gas supply. The standby tanks on the machine were turned on and although full, did not restore machine gas output. Oxygen could still be delivered, however, by the oxygen flush valve. A portable O_2 tank and bag combination was used to control ventilation until a second anesthesia machine could be substituted. The patient suffered no untoward effect from this sequence and surgery and anesthesia finished without further incident. Postoperative examination of the M.D.M. machine showed that the flow control valve had malfunctioned probably due to progressive damage by multiple earlier attempts to overclose the valve. Over closing the valve appears likely among individuals inexperienced with the characteristic of this type of machine which allows at times some flow to exist for 15–30 seconds after the valve had been rotated clockwise to its stop.

FIG. 1. Assembled "Flow Control Valve" of the Fraser-Sweatman "Monitored Dial Mixer."

DISCUSSION

The Fraser-Sweatman M.D.M. machine is nearly unique in using a regulator-type device to act as a control on total machine output. Regulators are an integral part of every conventional anesthesia machine performing the vital function of reducing high tank pressure to low working pressures. With a single exception,[1] we have found no reports of regulator failure which seriously compromised the output of a working anesthesia machine. In general however, one of the most feared complications

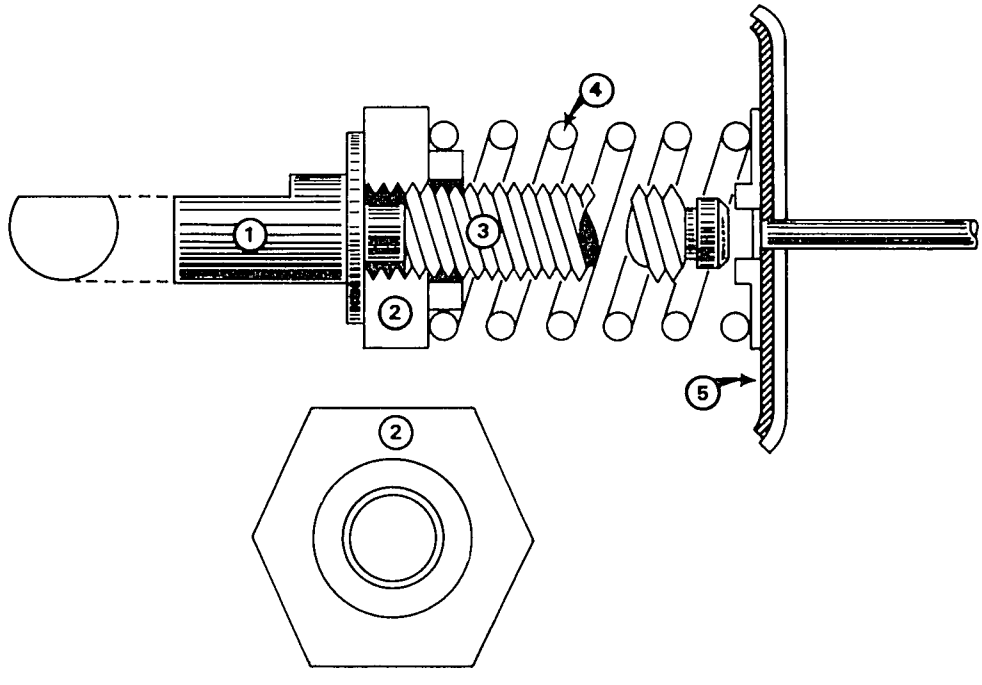

FIG. 2. Functional cutaway diagram of the flow control valve. 1) Knob Stem; 2) Nut originally of brass which moves along shaft; 3) Threaded shaft; 4) Valve spring; 5) Diaphragm. The nut is in the position which causes least spring tension (no flow). Rotating shaft counterclockwise from this position moves the nut down the shaft compressing the spring.

of general anesthesia is a mechanical failure on the low pressure side of the machine which causes delivery of an uncontrolled, hypoxic or unknown mixture to the patient. Implicated in the past in this potential catastrophe have been damaged needle valves,[2] cracked flow columns,[3] dirty or poorly maintained flow columns causing sticking of the floating indicators,[4] and incorrect substitution of flow columns.[5]

Manufacturers specification on the M.D.M. indicate that at normal gas delivery pressures of greater than 40 lbs per square inch for oxygen and nitrous oxide, the total flow control delivers flows of up to 20 l/min accurately. With the knob stopped down clockwise (reference point is facing the anesthesia machine), the nut seen in figure 2 is backed away from the diaphragm as far as possible and is in fact engaging at most two threads on the shaft. This is the point of minimum spring tension and the diaphragm position allows no gas flow. As the knob is rotated counterclockwise, the nut which can move in and out but not rotate in the housing surrounding it, rides down the shaft increasing spring tension. This in turn pushes on the diaphragm and increase in gas flow is proportional to this tension. Difficulty with this system can occur if the knob, in turning off flow, is forced beyond its natural stopping point, placing great stress on the last threads of the nut and the shaft. The original nut is brass and the shaft threads are stainless steel. Over time, the weaker nut thread breaks down under the constant spring tension. When it does so, this functionally disconnects the shaft from the nut, which is pushed off the shaft by the spring. Once the nut is pushed off the shaft by the spring, the spring is in its most relaxed position, the diaphragm is unpressurized and flow ceases. Turning the knob will not now cause any gas to flow. The solution to the problem, which repaired the machine and a second similar one which had not yet failed, was the fabrication and placement of a German Silver nut to replace the brass nut. Both machines have since been in use for hundreds of hours without any problems in the low-pressure circuits.

In summary a case is presented in which a mechanical breakdown in an unusual gas flow control, the M.D.M. of the Fraser-Sweatman Company, malfunctioned in such a manner as to stop all fresh gas flow during a general anesthetic. A description is given of the cause of the malfunction as well as the change necessary to prevent a recurrence of the same incident.

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A Simple Device for the Identification of the Epidural Space

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Epidural block is a useful technique which is associated with the hazard of an inadvertent dural puncture that may result in unpleasant and possibly serious complications.[1]

We describe an indicator which, in our experience, has proven reliable when attempting to identify the epidural space. This indicator has the additional advantage of being readily available in the operating room in a sterile and disposable form. No special preparation, sterilization or supply problems are involved.

Materials and Methods

The indicator is simply a segment of the standard clear plastic intravenous extension tubing. The extension tubing is cut at a distance of approximately six inches from the male leur end. The cut segment is filled with about one ml of the epidural anesthetic solution. The indicator

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