THIOPENTONNE 20 mg kg⁻¹, KETAMINE 8 mg kg⁻¹ AND MINAXOLONE 2 mg kg⁻¹ WERE ADMINISTERED TO FASTING GREYHOUND DOGS. MECHANICAL AND ELECTRICAL ACTIVITIES FROM STOMACH, DUODENUM, JEJUNUM AND ILEUM WERE RECORDED USING STRAIN GAUGE FORCE TRANSDUCERS AND IMPLANTED BIPOLAR ELECTRODES. THIOPENTONNE AND MINAXOLONE CAUSED INTENSE ACTIVITY IN THE DUODENUM AND JEJUNUM (PHASE I AND PHASE II OF THE INTERDIGESTIVE CYCLE), BUT NOT THE STOMACH OR ILEUM. THE ACTIVITY FOLLOWING INJECTION OF THIOPENTONE OR MINAXOLONE WAS PREVENTED BY PREMEDICATION WITH EITHER ATROPINE 0.05 mg kg⁻¹ OR PENTOLINIUM 0.2 mg kg⁻¹. KETAMINE HAD NO INFLUENCE ON GASTROINTESTINAL ACTIVITY OR THE RESPONSE TO THIOPENTONE OR MINAXOLONE. NONE OF THESE DRUGS ALTERED THE BASAL ELECTRICAL RHYTHM OF THE INTESTINE.


WE HAVE EXAMINED THE EFFECT OF ANAESTHETIC AGENTS ON THE ELECTRICAL AND MECHANICAL ACTIVITIES OF THE CANINE SMALL INTESTINE.

METHODS

NINE GREYHOUNDS UNDERGOING LAPAROTOMY WERE ANAESTHETIZED WITH THIOPENTONE 20 mg kg⁻¹, NITROUS OXIDE IN OXYGEN AND 2% HALOTHANE. TWO SILVER/SILVER CHLORIDE BIPOLAR ELECTRODES WERE SUTURED TO THE DUODENUM APPROXIMATELY 10 cm APART AND A THIRD ELECTRODE WAS SUTURED TO THE PROXIMAL JEJUNUM. IN FOUR DOGS AN ELECTRODE WAS ALSO SUTURED TO THE PROXIMAL ILEUM AND TO THE ANTRUM. METAL FOIL STRAIN GAUGES WERE CONSTRUCTED USING THE TECHNIQUE DESCRIBED BY BASS AND WILEY (1972). THESE WERE SUTURED TO THE ANTRUM OF THE STOMACH AND TO THE DUODENUM AND JEJUNUM IN A T CONFIGURATION ALIGNED TO RECORD LONGITUDINAL AND TRANSVERSE MUSCLE ACTIVITY. TEFLOON-COATED WIRE WAS USED TO CONNECT THE ELECTRODES AND THE STRAIN GAUGES TO TWO MULTIPIN CONNECTORS. THE CONNECTORS WERE CEMENTED INTO TWO STAINLESS STEEL CAPSULES SUTURED INTO THE ANTERIOR ABDOMINAL WALL ON EITHER SIDE OF THE MIDLINE.

A GRASS MODEL 7, EIGHT-CHANNEL PEN RECORDER (GRASS INSTRUMENTS) WAS USED TO AMPLIFY THE
mechanical and electrical signals and for real-time monitoring of these signals. Activity was recorded simultaneously on magnetic tape and processed subsequently using an FM seven-channel instrumentation tape recorder (Store 7 D, Racal Thermionics). All data was recorded at a tape speed of 24 mm s$^{-1}$ onto 12.5-mm tape which gave a frequency response of 313 Hz d.c. All recordings were subjected to digital computer analysis. The recordings were replayed at eight times real time using a spike processor (Digitimer D 139) incorporating a high pass filter which rejected frequencies of less than 130 Hz and a low pass filter which rejected frequencies greater than 14 Hz in order to separate the BER from the fast spike activity. The electrical signals were led to the input of the analog-to-digital convertor of a PDP 11/10 computer (Digital Electronic Corporation). All the data were sampled at preset 250-ms intervals. The data from multiple sampling intervals were summated over preset periods (analysis intervals 10 s) and presented as a series of plots of mechanical and electrical activity against time. The mechanical activity was quantified in terms of maximum amplitude of the strain gauge deflection in both the longitudinal and transverse planes and expressed in arbitrary computer units. This enabled quantitative comparisons to be made between experiments using different animals at different times.

A computer subroutine was used to subject the slow wave activity (BER) and mechanical data to a Fast Fourier transform analysis (FFT).

Each animal was fasted for 12 h before the study. Fasting activity was observed until the activity front (phase III) of a migrating myoelectrical complex (MMC) (Szurszewski, 1969; Carlson, Bedi and Code, 1972; Marik and Code, 1975) has passed the duodenal recording sites. Ten minutes after passage of MMC, i.v. atropine, pentolinium or the anaesthetic agent was administered. Five minutes after atropine or pentolinium the anaesthetic agent was administered.

RESULTS

Thiopentone (18 separate recordings, six dogs) 20 mg kg$^{-1}$ caused intense stimulation of mechanical and fast spike electrical activity ($P < 0.001$) in the duodenum (fig. 1). This activity occurred within 2 min of the injection, lasted for
several minutes (7.7 ± 0.6 SEM) and was propagated to the jejunum but not the ileum. Thiopentone did not stimulate the antrum nor alter the frequency of the basal electrical rhythm (BER) in the small intestine (fig. 2). The stimulation was abolished when thiopentone was preceded by either atropine 0.05 mg kg\(^{-1}\) or pentolinium 0.2 mg kg\(^{-1}\) (six separate recordings, three dogs) (table I). Ketamine 8 mg kg\(^{-1}\) had no effect on the resting interdigestive mechanical or electrical activity, but when thiopentone (six separate recordings, three dogs) was administered after ketamine, significant (\(P<0.001\)) stimulation of mechanical and fast spike electrical activity still occurred. Minaxolone 2 mg kg\(^{-1}\) also caused significant stimulation. The minaxolone injection was followed within 2 min by the onset of mechanical and fast spike activity (\(P<0.001\)) (three dogs, five separate recordings) but did not alter the BER. The fast spike electrical and mechanical activity following minaxolone did not occur after injection of atropine 0.05 mg kg\(^{-1}\) or pentolinium 0.2 mg kg\(^{-1}\) (three dogs, five separate recordings).

**DISCUSSION**

The interdigestive migrating myoelectrical activity consists of a burst of intense electrical spike activity (phase III) which migrates from the stomach to the ileum. This activity fades out at the ileocaecal junction and is replaced by a further burst of activity starting at the stomach. The intense activity persists for about 5 min at a single recording site and takes 110 min to travel to the small intestine (Szurszewski, 1969; Carlson, Bedi and Code, 1972). At a given recording site intense activity is preceded by a period of intermittent spiking activity (phase II) and followed by a period in which fast spike activity is absent (phase I). Therefore, the activity front (phase III) passes the duodenal recording site before it arrives at the jejunal recording site. Thus, the duodenal recording site may exhibit phase I activity and the jejunal recording site, simultaneously, phase II activity, while between these recording sites lies the phase III activity front.

Thiopentone stimulated intensely the canine duodenum and jejunum, but not the antrum or ileum when given as a bolus injection. The intensity of activity was similar to that seen during phase III of the migrating myoelectrical complex. Stimulation occurred within 2 min. In all the experiments the thiopentone was injected at a comparable time in the interdigestive cycle, during phase I in the duodenum and phase II in the jejunum. There was no evidence that thiopentone acted differently during the two phases. The degree of stimulation was similar at each recording site. There was, however, a delay between the onset of stimulation such that stimulation occurred initially in the duodenum and was propagated to the jejunum (fig. 1). There was no propagation to the ileum. The frequency of the duodenal and jejunal BER was not altered by thiopentone.

It has been suggested that thiopentone possesses a peripheral parasympathomimetic effect on bronchi (Adriani and Rovenstine, 1943), but in the intestine, the stimulation was inhibited not only by atropine but also by pentolinium, which suggests a central effect. Stimulation of intestinal motor activity is characteristically parasympathetic, whereas inhibition is sympathetic in origin. Therefore, it is of interest that ketamine, which has a sympathomimetic action, did not stimulate the...
small bowel but, on the other hand, did not decrease the effect of thiopentone. The effect of minaxolone, in spite of its quite different chemical structure, was comparable to that of thiopentone.

Gastrointestinal motility has been studied frequently in the anaesthetized animal but no allowance has been made for the action of the anaesthetic agents themselves, which may have altered the responses. Indeed, using anaesthetized dogs, thiopentone has been reported to have no important effect on motility or fast electrical activity in lighter planes of anaesthesia, but could cause a decrease in motility and fast electrical activity in deeper planes without modification of the slow complex (Holaday, Volk and Mandell, 1958).

The basal electrical rhythm is particularly important in that the mechanism responsible for these slow electrical components regulates the excitability of the contractile elements so that they are rendered alternately relatively excitabile and absolutely refractory (Holaday, Volk and Mandell, 1958).

Thus, an alteration in BER may influence the co-ordination of motor action into the effective activity of peristalsis and segmentation. An alteration in BER may be pertinent to the study of ileus following surgery and anaesthesia. Indeed, a number of studies using radiological or audiometric techniques (Farrar and Ingelfinger, 1955; McPhail et al., 1958; Baker and Dudley, 1961) have demonstrated rapidly occurring intestinal contractions after surgery. However, although intestinal contractions are present in the early period after operation, they produce few propulsive movements (Nachlas et al., 1972). It has been shown that the BER is always abnormal in the period immediately after operation and that, because BER plays an important role in the initiation and propagation of muscular contractions, it is the alteration in BER which is responsible for the lack of propulsive activity (Dauchel et al., 1976).

It appears that the i.v. agents tested in this study do not alter BER and are unlikely to influence the occurrence of ileus.

However, thiopentone does cause intense but transient (7-min) stimulation of the duodenum and jejunum with profound muscular contractions within a few minutes of injection. If these findings are confirmed in human studies, they will lend support to the use of atropine premedication before induction of anaesthesia with thiopentone for surgery in the presence of intestinal obstruction or perforation and for patients who have had a recently constructed intestinal anastomosis. On the other hand, it is reassuring that the use of thiopentone is unlikely to lead to contraction of the stomach musculature with regurgitation of gastric contents.

REFERENCES


I.V. AGENTS AND GUT MOTILITY


EFFET DE CERTAINS AGENTS ANESTHESIANTS ADMINISTRES PAR VOIE INTRAVEINEUSE SUR LA MOTILITE GASTRO-INTESTINALE DES CHIENS

RESUME
On a administré à des lévriers à jeun 20 mg kg$^{-1}$ de thiopentone, 8 mg kg$^{-1}$ de kétamine et 2 mg kg$^{-1}$ de minaxolone.

On a enregistré les activités mécaniques et électriques de l’estomac, du duodénum, du jéjunum et de l’iléon à l’aide de transducteurs à jauge de déformations et d’électrodes bipolaires implantées. Le thiopentone et le minaxolone ont provoqué une activité intense dans le duodénum et le jéjunum (phase I et phase II du cycle interdigestif), mais pas dans l’estomac ou l’iléon. On a pu empêcher par des médications préopératoires, telles que de l’atropine à raison de 0,05 mg kg$^{-1}$, ou le pentolinium à raison de 0,2 mg kg$^{-1}$, l’activité se produisant après l’injection de thiopentone ou de minaxolone. Le kétamine n’a eu aucune influence sur l’activité gastro-intestinale ou sur la réaction au thiopentone ou au minaxolone. Aucun de ces médicaments n’a modifié le rythme électrique basal des intestins.

WIRKUNGEN EINIGER INTRAVENÖSER ANÄSTHESIEMITTEL AUF MAGENDARM-BEWEGLICHKEIT BEI HUNDEN

ZUSAMMENFASSUNG
Thiopenton 20 mg kg$^{-1}$, 8 mg kg$^{-1}$ Ketamin und 2 mg kg$^{-1}$ Minaxolon wurden an fastende Windhunde verabreicht.

Mechanische und elektrische Aktivitäten von Magen, Duodenum, Jejunum und Ileum wurden mittels Dehnungsmesser-Kraftwandlern und eingepflanzten bipolaren Elektroden aufgezeichnet. Thiopentone und Minaxolon bewirken intensive Aktivitäten im Duodenum und Jejunum (Phasen I und II des Verdauungszyklus), aber nicht im Magen oder im Ileum. Diese Aktivitäten konnten durch Vorbehandlung mit entweder 0,05 mg kg$^{-1}$ Atropin oder 0,2 mg kg$^{-1}$ Pentolinium verhindert werden. Ketamin hatte keine Wirkung auf die Magen darmaktivitäten oder auf die Reaktion auf Thiopentone oder Minaxolon. Keine der Drogen veränderte den elektrischen Grundrhythmus des Darms.

EFEITO DE CIERTOS AGENTES ANESTESICOS DE CARACTER INTRAVENOSO SOBRE LA MOBILIDAD GASTROINTESTINAL DE LOS CANINOS

SUMARIO
Se administraron 20 mg kg$^{-1}$ de tiopentona, 8 mg kg$^{-1}$ de ketamina y 2 mg kg$^{-1}$ de minaxolona a perros galgos en ayunas.

Se registraron las actividades mecánicas y eléctricas del estómago, duodeno, yeyuno e ileon, mediante transductores de fuerza del medidor de deformaciones y electrodos bipolares implantados. La tiopentona y la minaxolona ocasionaron una intensa actividad en el duodeno y en el yeyuno (fases I y II del ciclo interdigestivo), pero no en el estómago ni en el ileon. La actividad subsiguiente a la inyección de tiopentona o de minaxolona se impidió mediante la previa medicación con 0,05 mg kg$^{-1}$ de atropina o con 0,2 mg kg$^{-1}$ de pentolinión. La ketamina no ejerce influencia alguna sobre la actividad gastrointestinal ni sobre la respuesta de la tiopentona y minaxolona. Ninguna de estas drogas alteró el ritmo eléctrico basal de los intestinos.