EFFECTS OF KETAMINE AND THREE OTHER ANAESTHETICS ON SPINAL REFLEXES AND INHIBITIONS IN THE CAT

D. LODGE AND N. A. ANIS

SUMMARY

The effects of ketamine, alphaxalone/alphadolone, methohexitone and di-isopropylphenol have been compared on synaptic excitations and inhibitions in the spinal cord of decerebrate or pentobarbitone-anaesthetized cats. Ketamine selectively and reversibly decreased polysynaptic reflexes over a wide dose range. With the other three anaesthetic drugs decreases in reflex activity were accompanied by increases in the prolonged inhibition of reflexes, and in the amplitude and time course of dorsal root potentials. It was concluded that ketamine decreases synaptic transmission at terminals of excitatory interneurones, whereas the other three anaesthetics enhance synaptic inhibitions mediated by y-aminobutyric acid. Such specific effects of anaesthetics on particular synaptic processes do not support a unitary hypotheses of anaesthesia.

Anaesthesia induced with ketamine and related dissociative anaesthetics has characteristics not seen with other classes of general anaesthetic agents (Domino, Chodoff and Corssen, 1965; Richards, 1980; White, Way and Trevor, 1982). This unique combination of properties includes profound analgesia, dissociation of cortical and limbic electroencephalograph (EEG) patterns, and psychotomimetic episodes during the recovery period. Despite several neurophysiological investigations into the action of ketamine, the site and mechanism of action remain uncertain (see White, Way and Trevor, 1982). Most investigators have not compared the effects of ketamine with those of other anaesthetics concurrently in the same preparation. Such a comparison would appear to be important in any assessment of the unique aspects of the pharmacological profile of ketamine.

As part of a study on the interaction between general anaesthetics and putative central neurotransmitters, we have compared the actions of ketamine with those of representatives of three other classes of injectable anaesthetic on monosynaptic and polysynaptic spinal reflexes, short and long duration inhibitions and dorsal root potentials. We report the effects of dissociative, steroid, barbiturate and phenolic anaesthetics on such evoked events and suggest a possible explanation for some of the properties of ketamine. Preliminary communications of parts of this work have been published previously (Anis, Burton and Lodge, 1982a,b; Lodge and Anis, 1982).

MATERIALS AND METHODS

Experiments were performed on 14 cats (2.4–3.8 kg) which were anaesthetized initially with either alphaxalone/alphadolone (n = 7; Saffan; Glaxo) 18 mg kg⁻¹ i.m. or with pentobarbitone (n = 7; Sagatal; May & Baker) 35 mg kg⁻¹ i.p., and supplemented i.v. as necessary to maintain adequate surgical anaesthesia. A radial vein, a carotid artery and the trachea were cannulated.

The alphaxalone-anaesthetized cats were then decerebrated by removal of the nervous tissue rostral to a mid-collicular section of the brainstem. Muscle paralysis was provided by gallamine and the cats' lungs were ventilated artificially to maintain an end-tidal carbon dioxide concentration of 4%. Arterial pressure was monitored throughout and the circulation was supported by the infusion of crystalloid (glucose/saline) and colloid solutions i.v.

In all cats, the lumbar spinal cord was exposed via a dorsal laminectomy and was sectioned at the thoraco-lumbar junction. Ventral roots (VR) L5 to S2 and a small fascicle of dorsal root (DR) L7 were sectioned and prepared for recording. The following hind limb nerves were exposed and prepared for stimulation: posterior biceps–semitendinosus (PBST), sural, gastrocnemius–soleus (GS), flexor digitorum longus, plantaris, tibial and common, deep and superficial, peroneal (Per) nerves.

Recording and stimulating electrodes were pairs of silver wires connected to appropriate amplifiers and pulse generators. Thresholds of afferent nerves were estimated by observing the lowest stimulus...
strength required to elicit a potential recorded from a silver ball placed on the appropriate dorsal root. The stimulus strengths used to elicit reflexes, inhibitions, etc., were expressed as multiples of this threshold (T). Dorsal root volleys were monitored intermittently throughout the experiments to monitor changes in afferent nerve excitability.

Monosynaptic reflexes recorded in VR L7 or S1 were evoked by stimulation of low threshold (<1.8T) muscle afferents, in some cases conditioned by a <1.3T stimulus to the same nerve. Such reflexes were assumed to be monosynaptic (MS) since they had stable central latencies of less than 1 ms.

Polysynaptic (PS) reflexes recorded in VR L7 or S1 were evoked by stimulation of higher threshold afferents from muscle, cutaneous or mixed nerves. Such reflexes were of variable latency, amplitude and configuration and, on repetitive stimulation at frequencies greater than 2 Hz, were decreased in amplitude.

For short latency inhibitions of MS reflexes, stimulation of low threshold afferents from an antagonist muscle was used to condition the MS reflexes with an interval of 5–10 ms.

Prolonged inhibitions were evoked by short tetanic (three pulses at 300 Hz) stimulation of higher threshold muscle or cutaneous nerves, or both, at least 35 ms before the MS reflex. Dorsal root potentials (DRP) were elicited by this same or a similar conditioning stimulus and recorded from the DR L7 fascicle.

The evoked potentials were recorded using standard neurophysiological amplifiers (bandwidth DC or 0.2 Hz to 300 KHz) and displayed continuously on an oscilloscope. Measurements of the amplitude and time course of the evoked potentials were made for averages of 8–64 events plotted on a pen recorder. The following drugs were tested following their i.v. injection: (1) Ketamine (supplied as the hydrochloride. Warner-Lambert U.K. Ltd). (2) Alphaxalone/alphadolone (abbreviated to Alphax in figures; supplied by Glaxo Ltd). (3) Methohexitone (supplied by Eli Lilly & Co. Ltd). (4) Di-isopropylphenol (abbreviated to diprophex in figures; supplied by I.C.I. Ltd).

In two cats in this series, extracellular recordings were also made from spinal Renshaw cells using multibarrel glass microelectrodes to compare the effect of ketamine on the synaptic excitation in response to ventral root (VR) stimulation with that to dorsal root (DR) or afferent nerve stimulation. Techniques for this type of experiment have been described fully elsewhere (Curtis and Ryall, 1966; Anis et al., 1983).

### RESULTS

In all, 42 tests of the effects of anaesthetics on evoked potentials were performed. In some instances, the apparent effects of anaesthetics did not show signs of recovery in a 3-h period after administration and these results were discarded. Fluctuations of evoked potentials with time and unrelated to drug injection are often a problem with this type of experiment where stable recordings are required for several hours. This was a particular problem with

---

**TABLE I. Summary of major changes observed following i.v. administration of four short acting anaesthetic agents**

<table>
<thead>
<tr>
<th>Drug (i.v.)</th>
<th>Monosynaptic reflexes</th>
<th>Polysynaptic reflexes</th>
<th>Short latency inhibitions</th>
<th>Prolonged inhibitions</th>
<th>Dorsal root potentials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ketamine 2.5–10 mg kg⁻¹</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Alphaxalone/alphadolone 2–6 mg kg⁻¹</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Methohexitone 2.5–10 mg kg⁻¹</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Di-isopropylphenol 2.5–10 mg kg⁻¹</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
decerebrate preparations and explains the use of pentobarbitone-anaesthetized animals in some of the investigations. The effects of the anaesthetics were qualitatively similar in both types of preparation.

**Ketamine**

The consistent feature of ketamine was the decrease in PS reflexes with only minor changes in other variables (table 1). This occurred at doses well below the 15–20 mg kg\(^{-1}\) required for surgical anaesthesia in the cat (Glen, 1973). Thus, ketamine 2.5–10 mg kg\(^{-1}\), reduced PS reflexes by 50–95%, MS reflexes by less than 10%, had no effect on DRP amplitude and increased the time course of DRP by less than 10%. There were no clear effects on inhibitions of MS reflexes at these doses. Even with higher doses of ketamine (10–25 mg kg\(^{-1}\)) similar to those required for anaesthesia, in only two of seven tests were prolonged inhibitions or DRP, or both, reversibly enhanced and then by less than 20%. Recovery from these effects of ketamine was usually complete within 1 h following doses less than 5 mg kg\(^{-1}\) whereas 2 h or more was required for recovery from doses in excess of 10 mg kg\(^{-1}\).

Figure 1 illustrates the selective reduction by ketamine 2.5 mg kg\(^{-1}\) of the PS reflex in a pentobarbitone-anaesthetized cat. The PS reflex following peroneal nerve stimulation was almost abolished, whereas there was no decrease in the MS reflexes. Ketamine 2.5 mg kg\(^{-1}\), diprophene 5 mg kg\(^{-1}\), and alphaxalone 3 mg kg\(^{-1}\) each produced different effects on the PS reflex in a pentobarbitone-anaesthetized cat. Ketamine selectively reduced the PS reflex, whereas diprophene reduced the MS reflex, almost abolished the PS reflex, and increased the DRP in both amplitude and duration. Alphaxalone increased the DRP, and the PS reflex was reduced.

---

**Fig. 1.** Effects of ketamine, di-isopropylphenol and alphaxalone on monosynaptic and polysynaptic reflexes, and dorsal root potentials in a pentobarbitone-anaesthetized cat. Each set of three recordings shows from left to right a MS reflex (PBST), recorded in VR S1 in response to a 1.6T stimulus to the posterior biceps and semitendinosus nerve, a mixed MS and PS reflex (PER) recorded in VR S1 in response to a 5T stimulus to the peroneal nerve, and a DRP recorded in a small fascicle of DR L7 in response to three stimuli at 300 Hz delivered to the peroneal nerve (5T). Each record is the sum of 16 responses. The left hand columns of records show the selective reduction by ketamine 2.5 mg kg\(^{-1}\) i.v., on the PS (late) component of the PER reflex. Almost full recovery was observed 65 min later. The centre set of records shows the effect of di-isopropylphenol (diprophene) 5 mg kg\(^{-1}\), which reduced the MS reflex, almost abolished the PS reflex, and increased the DRP in both amplitude and duration. Recovery is illustrated 145 min later. The right hand set of records shows the effect of alphaxalone (alphax) 3 mg kg\(^{-1}\). In this case the DRP is considerably prolonged and the PS reflex is reduced. Recovery was observed 42 min later. The vertical calibration bar represents 500 µV for the PBST reflex, 200 µV for the PER reflex and 500 µV for the DRP. The horizontal time calibration bar is 2.5 ms for the PBST reflex, 12.5 ms for the PER reflex and 125 ms for the DRP.
reflex, and no enhancement of the DRP. Recovery was complete 1 h later. The full time course in another example of these effects is illustrated in figure 2. In this decerebrate cat, ketamine 10 mg kg\(^{-1}\) decreased the PS reflex with no clear effects on either the MS reflex or the DRP. In this test, there was an apparent increase in the prolonged inhibition, but no substantial recovery of this effect was observed over the next 90 min, during which time the PS reflex returned to near control value.

**Alphaxalone/alphadolone**

This steroid anaesthetic consistently enhanced prolonged inhibitions and DRP, effects which were usually accompanied by decreased PS, and less frequently MS, reflexes with little or no change in the short latency inhibition (table I). Thus, in 13 tests alphaxalone 2−6 mg kg\(^{-1}\) increased the amplitude of the prolonged inhibitions by 100−500%, the half-decay time of DRP by 50−150%, and decreased the amplitude of PS reflexes by 66−90%. Recovery, from these various effects of alphaxalone which were dose-dependent, was usually complete within 60−90 min.

In figure 1, the effects of alphaxalone on these evoked potentials in a pentobarbitone-anaesthetized cat can be seen. Injection of 3 mg kg\(^{-1}\) i.v. decreased the PS reflex and increased the time course of the DRP with, at this dose, little effect on the MS reflex. At about one-half the anaesthetic

---

**Fig. 2.** Comparison of the effects of ketamine with those of alphaxalone and methohexitone on reflexes, inhibitions and DRP recorded from the lumbar spinal roots of a decerebrate cat. • — • = Amplitude of MS reflex recorded from VR L7 following stimulation of the gastrocnemius nerve (GS) at 1.5T. This reflex had a central latency of 1.15 ms. ○ — ○ = Amplitude of a PS reflex evoked and recorded as above. The central latency of this reflex was 3.5−4.0 ms. • — • = Percentage inhibition of the GS MS reflex by a conditioning stimulus (2.5T) delivered to the deep peroneal (DP) nerve 5 ms before the test stimulus. This short latency inhibition is largely unaffected by all three anaesthetics. ▽ — ▽ = Percentage inhibition of the GS MS reflex by a short train (three at 300 Hz) of stimuli (3T) delivered to the PBST nerve 50 ms before the test stimulus. ■ — ■ = Half-decay time of the negative DRP recorded in a DR L7 fascicle following stimulation to the PBST nerve as described above. △ — △ = Amplitude of the DRP evoked and recorded above. All measurements were taken from a sum of 16 tests repeated at 2-s intervals. Ketamine 10 mg kg\(^{-1}\) i.v., at the time indicated by the arrow, decreased the PS reflex selectivity whereas alphaxalone 6 mg kg\(^{-1}\) and methohexitone 10 mg kg\(^{-1}\) enhanced the DRP in both duration and amplitude.
dose for cats, alphaxalone 6 mg kg\(^{-1}\) decreased both MS and PS reflexes (fig. 2) by about 50%, although the effect on the MS reflex was relatively short lasting. The accompanying increase of the prolonged inhibition from 20% to 100% and of the DRP amplitude and time course by 30% and 95%, respectively, contrasted with the lack of effect on the short duration inhibition. About 75 min was required for these effects of alphaxalone to be reversed.

**Methohexitone**

The consistent effects of this barbiturate anaesthetic were enhancement in both amplitude and duration of prolonged inhibitions and of dorsal root potentials (table I). This enhancement of these inhibitory events, like that seen with alphaxalone, was often accompanied by a diminution of PS, and occasionally of MS, reflexes, but short duration inhibitions were not usually affected. Thus, methohexitone 10 mg kg\(^{-1}\) (which is approximately the dose for induction of anaesthesia in cats) increased the amplitude of prolonged inhibitions by 70–250%, the half decay time of DRP by 25–100% and decreased the amplitude of PS reflexes by about 45%. Recovery of each of these parameters from the dose-dependent effects of methohexitone followed a similar time course, usually requiring 30–90 min for full reversal.

An example of the enhancement of prolonged inhibition is provided in figure 3. In this decerebrate cat, methohexitone 10 mg kg\(^{-1}\) reversibly increased the inhibition of a MS reflex by a stimulus delivered 45 ms previously to the PBST nerve from 61 to 95%, with no clear effect on either the unconditioned MS reflex or the short duration inhibition. In comparison, on these same reflexes and inhibitions, ketamine was virtually without effect save for an irreversible decrease in the MS reflex. Results from another cat (fig. 2) show graphically the magnitude and the time course of the effect of methohexitone on reflexes, inhibitions and DRP. In this example, neither the MS or PS reflexes nor the short duration inhibition, were obviously affected, although the prolonged inhibition was increased from about 35 to 95%, and the DRP amplitude and half decay time were increased by 35% and 100%, respectively. In this experiment, the effects of methohexitone had disappeared 75–80 min after its injection.

**Di-isopropylphenol**

The effects of this new anaesthetic, for which the anaesthetic dose in cats is 5–10 mg kg\(^{-1}\), were examined on six occasions with similar effects in all tests, the PS reflex was reduced to a greater extent than the MS reflex and DRP were enhanced in both amplitude and time course (table I).

An example of the effect of di-isopropylphenol is shown in figure 1. In a dose of 5 mg kg\(^{-1}\), this anaesthetic almost abolished the PS reflex and reduced the MS by about 45% and there were approximately 10% and 30% increases, respectively, in the amplitude and time course of the DRP. Full recovery from these effects required 145 min. A previous dose of 2.5 mg kg\(^{-1}\) had decreased only the PS reflex, whereas a subsequent dose of 10 mg kg\(^{-1}\) had greater effects both in decreasing MS reflexes and in enhancing DRP.

![Figure 3](http://bja.oxfordjournals.org/) Effect of ketamine and methohexitone on unconditioned and conditioned MS reflexes. Each set of three records consists of, from left to right, an unconditioned MS reflex (amplitude, mV) recorded in VR L7 following a 1.5T stimulus to the GS nerve, the same reflex but conditioned by a single 3T stimulus to the PBST nerve 5 ms before the GS stimulus and the same reflex conditioned by three stimuli at 300 Hz (3T) to the PBST nerve 45 ms before the GS stimulus. The figures alongside the two conditioned reflexes denote the decrease in amplitude expressed as a percentage of the control reflex. Ketamine (left hand column) had little effect on the magnitude of the short and long latency inhibitions, whereas methohexitone (right hand column) selectively enhanced the prolonged inhibition. Recovery from this effect of methohexitone was observed some 68 min later.
Thus, in terms of comparative effects on reflexes and on DRP, di-isopropylphenol was intermediate between, on the one hand, ketamine which selectively reduced PS reflexes and, on the other, methohexitone and alphaxalone which appeared to have their major action on DRP. This relationship can be observed by reference to figure 1.

Synaptic excitation of Renshaw cells

Stable recordings were obtained from three Renshaw cells with which it was possible to test the action of ketamine on synaptic excitation following VR or afferent nerve/dorsal root (DR) stimulation. With all three cells, ketamine administered electrophoretically into the region of the Renshaw cell reversibly decreased afferent nerve-evoked excitation to a greater extent than VR-evoked excitation.

An example of this differential effect of ketamine is illustrated in figure 4. From these histograms, showing the occurrence of action potentials following VR and DR stimulation, it can be seen that the firing pattern to the two inputs is different. The VR-evoked excitation, which is decreased by acetylcholine antagonists (Curtis and Ryall, 1966), has a very short latency and an early peak in firing frequency. The DR-evoked excitation, on the other hand, was decreased by excitatory amino-acid antagonists (Lodge, Headley and Curtis, 1978) and has a long and variable latency which suggests a polysynaptic pathway. In order to compare the effects of ketamine on similar intensities of synaptic excitation, in each control histogram we arbitrarily delineated periods in which the number of spikes was the same for each input (fig. 4). Following the administration of ketamine the number of spikes in this period in the case of the polysynaptic DR-evoked excitation was decreased to a considerably greater extent than in the case of the cholinergic VR-evoked excitation.

DISCUSSION

The results show that there are clear differences between the four classes of short-acting anaesthetic. The enhancement of prolonged inhibitions and DRP thought to be mediated by the transmitter \( \gamma \)-amino-butyric acid (GABA) is an established feature of barbiturate anaesthesia (Eccles, Schmidt and Willis, 1963; Nicoll, 1975), and was observed in this study with methohexitone, alphaxalone and di-isopropylphenol, but was only weakly evident with ketamine. Although enhancement of the postsynaptic actions of the inhibitory transmitter, GABA, are
thought to underlie these effects of barbiturates (Lodge and Curtis, 1978; Barker and McBurney, 1979; Willow and Johnston, 1983), it is not known whether alphaxalone and di-isopropylphenol do this by a pre- or postsynaptic mode of action. Non-additive effects of steroid and barbiturate anaesthetics would suggest separate sites of action (Richards and White, 1981), but a more precise investigation of the mechanism of action of alphaxalone alphadolone and di-isopropylphenol is needed.

From our results it seems unlikely that enhancement of GABA-mediated inhibitions could make a major contribution to the anaesthetic action of ketamine. Prolonged inhibitions and DRP were not usually enhanced even at full anaesthetic doses of ketamine. However, there have been reports of the enhancement of the actions of exogenously administered GABA in vitro (Little, 1982) but not in vivo (Anis et al., 1983) and of GABA-mediated synaptic inhibitions in vitro (Scholfield, 1978) but not in vivo (Tang and Schroeder, 1973).

The reduction by ketamine of PS and not MS reflexes, seen also by Tang and Schroeder (1973) and by Chen and Chow (1975), in the absence of enhanced GABA-mediated inhibitions may help explain some of the characteristic aspects of dissociative anaesthesia. Indeed, the low doses of ketamine that result in reduced PS reflexes are compatible with the low doses that result in the analgesic and psychotomimetic effects of ketamine (White, Way and Trevor, 1982). The selective action on certain synaptic excitations suggests a differential effect of ketamine on the release of, or the postsynaptic actions of, the neurotransmitter mediating excitation in these pathways. Further support for such a view comes from our finding that ketamine reduced the DR-, but not the VR-, evoked excitation of Renshaw cells (Anis et al., 1983).

The identity of the transmitter at these excitatory synapses is not known, but the receptors appear to be preferentially activated by aspartic acid and in particular by N-methylaspartate (NMA). Hence, they have been designated "NMA receptors" (Watkins and Evans, 1981). Because NMA receptors are thought to be important in mediating PS reflexes and DR excitation of Renshaw cells (Watkins and Evans, 1981), and because ketamine blocks the postsynaptic excitatory action of NMA on spinal neurones (Anis et al., 1983) and does not reduce the release of excitatory amino acids in vitro (Minchin, 1981), we may conclude that ketamine is an antagonist of the natural excitatory transmitter, which may be aspartic acid or a closely related substance (Curtis and Johnston, 1974).

Such NMA receptors are thought to be important in the mediation of synaptic events in other areas of the mammalian central nervous system (Watkins and Evans, 1981) including the cerebral cortex (Stone, 1979; Hicks and Guedes, 1983), where ketamine also blocks the action of NMA (Lodge and others, unpublished observations). Thus, antagonism by ketamine of the natural excitatory transmitter at these receptors is likely to contribute significantly to its spectrum of action. Psychotomimetic, analgesic and anaesthetic effects may be brought about by decreases in information transfer in appropriate pathways into, within and out of the cerebral cortex and other higher brain centres. The dissociation of cortical and limbic EEG patterns by ketamine and related drugs (Domino, 1964; Weingarten, 1972) is further evidence for disruption of these synaptic pathways.

Reduction of PS reflexes is also a feature of the action of di-isopropylphenol, with which there is less enhancement of DRP than with barbiturates. Therefore, it seems likely that some other mechanisms beside increased GABA-mediated inhibition contribute to the PS reflex reduction seen with this drug. Whether these mechanisms include reduced release or postsynaptic effectiveness, or both, of excitatory transmitter(s) will require further investigation.

The effects of the four anaesthetics studied on spinal reflexes do not support a unitary hypothesis of anaesthesia, but rather suggest that each anaesthetic has an individual spectrum of neurophysiological effects which contributes to its own particular anaesthetic properties.

ACKNOWLEDGEMENTS

We wish to thank Warner-Lambert, U.K. and I.C.I. for supplies of ketamine and di-isopropylphenol, respectively. This work was supported by an MRC Project Grant and by the University of London Central Research Fund.

REFERENCES


——— (1982b). Ketamine anaesthesia by N-
methyldaspartate and acetylcholine receptor blockade? Studies on cat and rat Renshaw cells. J. Physiol. (Lond.), 324, 74P.


EFFETS DE LA KETAMINE ET DE TROIS AUTRES AGENTS ANESTHESIQUES SUR LES REFLEXES ET LES INHIBITIONS MEDULLAIRES CHEZ LE CHAT

RESUME
Nous avons comparé les effets de la kétamine, de l'association alphaxalone-alfadolone, du méthohexitol et du diisopropylphenol sur les excitations et inhibitions synaptiques médullaires chez des chats décerébrés ou endormis au pentobarbital. La kétamine provoquait une diminution sélective et réversible des réflexes polysynaptiques et ce pour un large éventail de posologies. Avec les trois autres agents anesthésiques, les diminutions d'activité réflexe s'accompagnaient d'augmentations de l'inhibition prolongée des réflexes, et de l'amplitude et de la durée des potentiels de la racine postérieure. Nous en avons déduit que la kétamine diminuait la transmission synaptique à l'extrémité des interneurones excitatoires tandis que les trois autres anesthésiques augmentaient les inhibitions synaptiques dont le médiateur est l'acide gamma-aminobutyrique. De tels effets spécifiques des agents anesthésiques sur des processus synaptiques particuliers vont à l'encontre d'une théorie unitaire de l'anesthésie.

EFECTOS DE LA QUETAMINA Y DE TRES OTROS ANESTETICOS SOBRE LOS REFLEJOS ESPINALES Y LAS INHIBICIONES EN EL GATO

SUMARIO
Se llevaron a cabo comparaciones de los efectos de la quetamina, de la alfazalona/alfadolona, de la metohexitona y del diisopropilfenol sobre las excitaciones e inhibiciones sináticas en la cuerda espinal de gatos descerebrados o anestesiados con pentobarbitona. La quetamina hizo bajar selectivamente y de modo reversible los reflejos polisinápticos sobre una gama amplia de dosis. Con los tres otros anestésicos, las disminuciones en la actividad de reflejos se acompañaron de aumentos en la inhibición prolongada de los reflejos y en la amplitud y transcurso de tiempo de los potenciales de la raíz dorsal. Se concluyó que la quetamina hace bajar la transmisión sináptica a los terminales de los interneuronas excitatorias, mientras que los otros tres anestésicos realizan las inhibiciones sinápticas mediadas por el ácido γ-aminobutírico. Dichos efectos específicos de los anestésicos sobre procesos sinápticos particulares no apoyan las hipótesis unitarias de la anestesia.