CONTINUOUS SUXAMETHONIUM INFUSION FOR MICROLARYNGEAL SURGERY

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SUMMARY
The suxamethonium infusion requirements to maintain a 100% neuromuscular block in patients undergoing microlaryngeal surgery were determined. Anaesthesia was maintained with halothane and the neuromuscular block monitored with a peripheral nerve stimulator delivering train-of-four stimuli. Suxamethonium requirements varied directly with time in a linear manner and the onset and recovery time of the block increased with time. No difficulties in recovery were observed when the duration of infusion was less than 1 h, even when the nature of the block had altered to the non-depolarizing type. A good correlation was observed between neuromuscular block as indicated by peripheral nerve stimulation and laryngeal muscle paralysis.

Suxamethonium provides suitable conditions for laryngoscopy (Ali and Savarese, 1976) and for microlaryngeal surgery (Rajagopolan, Foster-Smith and Ramachandran, 1972; Vourc'h, Tannieres and Freche, 1979). In particular, sudden patient movement is minimized, resulting in greater safety when instruments such as the carbon dioxide laser are used. The necessity for absolute immobility has been stressed previously (Snow et al., 1974; Vourc'h, Tannieres and Freche, 1979).

Continuous suxamethonium infusion has been described on many occasions (Foldes et al., 1952; Churchill-Davidson, Christie and Wise, 1960; Carden and Vest, 1974; Konchigen and Shaker, 1974; Lee, Barnes and Katz, 1978). However, neuromuscular block has not been monitored continuously throughout the entire surgical procedure. Previous studies, involving a lesser degree of neuromuscular blockade, have established that there is poor correlation between the observed twitch response in the hand, and laryngeal paralysis (Bennet, Giesel and Dalai, 1973) or paralysis of the abdominal muscles during abdominal surgery (Crul et al., 1966); 95% twitch depression of the hand muscle response was associated with incomplete cord paralysis (Donlon, Ali and Savarese, 1974).

A study was undertaken to determine the suxamethonium infusion requirements to maintain neuromuscular blockade of 100% twitch suppression and to determine if the use of the peripheral nerve stimulator afforded good control of the block.

METHODS
Sixteen consecutive patients aged 32–71 yr, undergoing elective microlaryngeal surgery for non-malignant conditions were studied. Patients with malignant disease, liver disease and neurological disease were excluded. An appropriate Kleinsscher suspension laryngoscope was used in all operations, and in eight a carbon dioxide laser was used.

Standardized preoperative medication of morphine 5–15 mg and hyoscine was used. Anaesthesia was induced with sodium thiopentone 3–5 mg kg⁻¹, after the i.v. injection of atropine 0.5 mg and pancuronium 1 mg.

The ulnar nerve was stimulated at the wrist using surface electrodes and a Myotest train-of-four nerve stimulator (Biometer, Odense, Denmark) in the continuous mode. The necessary supramaximal stimulus was determined for each patient with the hand optimally positioned. Tetanic stimulation was never used. Train-of-four stimulation aided visual estimation of the evoked thumb response by providing potentially, four distinct movements.

Tracheal intubation using a Portex 5-mm endotracheal tube was facilitated by suxamethonium chloride 1 mg kg⁻¹. Anaesthesia was maintained with halothane 0.5–1% and 33% oxygen in nitrous oxide; the lungs were ventilated mechanically by an AGA pneumatic ventilator.
delivering a tidal volume of 10 ml kg⁻¹, at a frequency of 12 b.p.m.

On reappearance of thumb movement, an i.v. infusion of suxamethonium chloride 2 mg ml⁻¹ in 5% dextrose was commenced in the arm opposite to that stimulated. The rate of infusion was regulated to abolish the observed twitch response. Barely visible twitch movement in the hand is reported to indicate 95—98% twitch depression (Lee, 1975a; Ali and Savarese, 1976). If signs of block recovery were absent after 5 min, the infusion rate was reduced. Any patient who had not demonstrated recovery within the next 5 min would have been excluded from the study; however, this did not prove to be necessary. By these means it was hoped to maintain a 100% block without gross error in dosage.

On completion of surgery, the infusion was discontinued and halothane withdrawn. Lignocaine was used to anaesthetize the larynx under direct vision. The tracheal tube was removed when it was judged clinically appropriate and when there was no evidence of any significant residual block (Murphy et al., 1975).

RESULTS
The duration of surgery was 18—70 min (mean 34 min). The total dose of suxamethonium infused varied between 0.5 and 6.9 mg kg⁻¹ (mean 2.8), being given over a period of 8—60 min (mean 28). Ten patients received more than 3 mg kg⁻¹. The dose of suxamethonium required to maintain 100% paralysis was found to be linear with respect to time (fig. 1). Using a least-squares regression line constructed from the data, the dose requirement was found to conform to 0.1 mg kg⁻¹ min⁻¹, with 95% confidence limits of 0.06—0.14 mg kg⁻¹ min⁻¹.

No relationship was observed between the duration of paralysis resulting from the initial dose of suxamethonium at induction and subsequent dosage requirements.

On discontinuing the infusion, a marked fade was observed in the train-of-four evoked twitch

![Fig. 1](http://bja.oxfordjournals.org/)

**Fig. 1.** Each patient's total suxamethonium requirements for the duration of the infusion. The time axis starts from observation of the first recovery twitch response after the initial induction dose of suxamethonium.
responses in eight patients; each had received at least 3 mg kg\(^{-1}\) of suxamethonium. The interval between stopping the infusion and tracheal extubation ranged from 3 to 16 min (mean 9). No significant airway or respiratory problems were encountered after operation. During surgery the observed thumb response provided a reliable indication of laryngeal movement. In the majority of patients the surgeon indicated resumption of minimal cord movement immediately before the return of thumb movement.

After a period of time, a difference in speed of onset of recovery and in attaining control of the block was noted. Initially there was a rapid recovery with a corresponding rapidity of control but, as the infusion continued, the converse was noted.

**DISCUSSION**

In contrast to previous studies (Crul et al., 1966; Bennet, Giesel and Dalal, 1973) good correlation was found between the observed twitch response and muscle paralysis at the site of operation.

A change in behaviour of the neuromuscular block was observed with no overall change in dose required. Several studies using a lesser degree of block or constant dose infusion have demonstrated the changing nature of the resulting neuromuscular block, with two steady-state periods, corresponding to type I and type II block, with a brief period of tachyphylaxis separating the two (Lee, 1975b; Lee, Barnes and Katz, 1978).

The use of train-of-four stimuli was supported by the finding that the majority of patients required a dose in excess of 3 mg kg\(^{-1}\), a dose found in previous studies to be associated with a well established Phase II block (Lee, 1975b; Lee, Barnes and Katz, 1978).

This study also demonstrated a satisfactory speed of recovery of the neuromuscular block when the infusion period was limited to 1 h as shown by Katz and Ryan (1969). The use of such an infusion was not associated with the occurrence of any undesirable clinical features in the patients studied.

**REFERENCES**


**PERFUSION CONTINUE DE SUXAMETHONIUM POUR LES INTERVENTIONS CHIRURGICALES MICROLARYNGIENNES**

RESUME

Nous avons déterminé les principes régissant la perfusion de suxamethonium pour entretenir un blocage neuromusculaire à 100% sur des patients subissant une intervention chirurgicale microlaryngienne. L’anesthésie a été entretenue à l’aide d’halothane et le blocage neuromusculaire a été surveillé à l’aide d’une dispositif électrique de stimulation du nerf périphérique produisant des stimulations par chaîne de quatre. Les exigences du suxaméthonium ont varié d’une manière linéaire directement avec le temps, et le temps compris entre le départ et la récupération du blocage a augmenté avec le temps. On n’a observé aucune difficulté dans la reprise de conscience
lorsque la durée de la perfusion a été inférieure à 1 h, même lorsque la nature du blocage s’était modifiée pour devenir du type non dépolarisant. On a constaté une bonne corrélation entre le blocage neuromusculaire, comme cela a été indiqué par la stimulation du nerf périphérique et la paralysie du muscle laryngien.

KONTINUIERLICHE SUXAMETHONIUMINFUSION BEI KEHLKOPFMIKROCHIRURGIE

ZUSAMMENFASSUNG

INFUSION CONTINUA DE SUXAMETONIO PARA LA MICROcirUJIA LARINGEAL

SUMARIO
Se determinaron los requisitos de la infusión de suxametonio para mantener un bloqueo neuromuscular del 100% en pacientes sometidos a microcirugía de la laringe. La anestesia se mantuvo con halotano y el bloqueo neuromuscular se vigiló con un estimulador de nervio periférico que entregaba estimulación en trenes de cuatro impulsos. Los requisitos de suxametonio variaron linealmente y de forma directa en el transcurso del tiempo, y el tiempo de inicio y de recuperación del bloqueo aumentaron con el tiempo. No se observaron dificultades en la recuperación cuando la duración de la infusión fue inferior a una hora, incluso cuando la naturaleza del bloqueo se alteró convirtiéndose en el tipo no despoliante. Se observó una buena correlación entre el bloqueo neuromuscular, tal y como se indicó por la estimulación del nervio periférico y por la parálisis del músculo laringeal.