A NEW MANDIBULAR BLOCK TECHNIQUE
USING EXTRA-ORAL AND INTRA-
ORAL LANDMARKS

by

G.A.E. GOW-GATES

A Thesis

UNIVERSITY
O SYDNEY
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for the
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Sydney. N.S.W. 1983
DEDICATION

To my wife, Beulah who has given this research and my life greater meaning.
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G. G-G.
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"In Medicine, objections against new developments are generally only the spontaneous reaction of the individual's inborn dogmatism against that which tends to force on him a different conception of the facts from the one to which he was used."

Leriche, R. (1)
INTRODUCTION

In man, perception of pain is a subjective experience that can only be ascertained by the individual experiencing the sensation, and by direct physical examination and questioning by the investigator.

The aetiology of pain has been of great concern to clinicians for generations. As Adams and Walshe stated, \(^{(2)}\) "Physiologists and Psychologists have shown that all persons have a uniform sensation threshold, (the lowest stimulus value at which the sensation of pain is reported) but an extremely variable pain tolerance, (the level at which subjects refuse to tolerate more pain).

It is also known that a number of factors are capable of influencing pain tolerance, including cultural training, past experience, attention (distraction) suggestion and anxiety.

It is frequently assumed that patients have a constant pain threshold, yet within the same individual the experience of pain varies considerably, depending on the psychological state, his immediate expectations, and the responses of those around him."

The Gow-Gates Mandibular Block Technique \(^{(3,4,5)}\) is a new concept to intercept sensory conduction in the mandible.

All oral branches of the mandibular nerve are blocked by depositing an adequate volume of anaesthetic solution in only one position away from the proximity of nerve membranes.

The integration of the extra-oral and the intra-oral landmarks provide the correct orientation of the needle to the injection site. Used correctly no trismus occurs and the incidence of vascular penetration is reduced.
PART A

REVIEW OF LITERATURE
of MANDIBULAR ANAESTHESIA.
The Genesis of Pain Control in the Mandible.

The first approach to the use of the needle and syringe as armamentarium for local anaesthesia, was made by a French physician, Dr. Claude Bernard, who in 1869 injected morphine as a preliminary narcotic before the administration of ether or chloroform.

However the real birth of local anaesthetic solutions dates to the discovery of the analgesic effects of cocaine by a Viennese physician, Dr. Carl Koller in 1884. He was experimenting without success with morphine and other substances, and he was attracted by his associate, Dr. Sigmund Freud, the famous psychoanalyst, who was trying to break the addiction of a colleague to morphine, to the numbing effects of cocaine on the tongue. This gave him the idea that it might anaesthetize the eye, a discovery which he announced on September 15, 1884 at the German Ophthalmological Society at Heidelberg. The impact of this knowledge occurred in 1885 when J. Leonard Corning first demonstrated that a nerve trunk could be blocked with cocaine. In the same year Hallstead injected cocaine at the mandibular foramen introducing the inferior alveolar block injection. History records that Dr. Raymond took a patient suffering with mandibular pain to Hallstead to have a tooth extracted. Thirteen minims of 4% cocaine were injected at the lingual, Fig. 1, and seven minutes later there was almost complete anaesthesia of the right side of the tongue. The tooth was then extracted, and it is to be noted that profound anaesthesia was not claimed.

Hallstead and Hall later demonstrated beyond question that a nerve trunk could be blocked at any point along its course, thereby producing an abolition of sensory impulses. It was indeed remarkable that although their discovery laid the foundation of the Art of Local Anaesthesia, the concept of depositing the anaesthetic solution
in close proximity to the nerve membrane so influenced the attitude of dentists that for almost a century there remained a reluctance to explore the relatively higher avascular region of the pterygo-mandibular space above the lingula neurovascular bundle.

Hall, Hallstead's associate, may have been the first clinician to report the block of the inferior alveolar nerve, and despite American and Canadian investigators publishing some 60 papers on the subject, it was not until Dr. Guido Fischer was brought to America in 1914 to teach the inferior alveolar block that it was projected and recognised as an important method of pain control.\(^{(7)}\)

For whatever the reasons, the technique did not gain great popularity and the majority of dentists were simply using the sub-periosteal or sub-mucous injections with little application of the inferior alveolar block injection. This was observed by Smith who stated\(^{(8)}\) "The fundamental basis of nerve blocking is not only a thorough knowledge of nervous anatomy, but also of the surrounding anatomic structures".

Despite anatomical descriptions being made available, dentists still appeared to be diffident with acceptance of the inferior alveolar block as it continued to remain dormant until Cooke-Waites in 1927 organized a professional division to teach dentists the technique.\(^{(7)}\) Within a few years more than 15,000 dentists had attended the clinics, so that the American Dental Schools initiated the universal teaching of the inferior alveolar block injection.

These historical events were synchronized with the recognition of the Practice of Dentistry as a separate profession. It is recorded that William T. Gies suggested in Columbia University, that the practice of dentistry should not be considered as a speciality of Medicine but rather as a special division of Health Services.\(^{(9)}\)

This new status undoubtedly provided amongst other things a great impetus in what has become a continuing search for the ideal anaesthetic solution possessing the
quality of stability, low local and systemic toxicity and high potency. However the technique and concept of the administration of the inferior alveolar block is basically what it was when first discovered, although minor modifications have been introduced to improve its effectiveness.

Some of the procedures recommended included the indirect method for inserting the needle by palpating the internal oblique line, then slightly withdrawing it before altering its direction more medially before re-advancing the needle to the injection site. Other methods adopted a direct thrust of the needle, either to vary the depth of penetration of the needle at the neural or more posterior position in the neurovascular bundle. However the injection site remained at the immediate region of the lingula with modifications of technique being numerous, as well as conflicting, created confusion.

The problems related to the technique are reflected by many clinicians reverting to various additional infiltration techniques to supplement its use in order to overcome the failure rate which may be in excess of 25%.

In contrast greater progress has been made in the synthesis of anaesthetic solutions which are continuing to be made available to the dental profession.

In 1900 Braun mixed an extract of the adrenals of animals with a cocaine solution and injected the mixture into his forearm.

He realized at once that a new era for local anaesthesia had arrived, and in 1903 he published his ingenious experiments with a cocaine-epinephrine solution.7

A further discovery included the advantages of preservatives such as Sodium Bisulfite to prevent the oxidation of epinephrine, and methylparaben, a bacteriostatic agent, have all contributed to supporting the statement that "Pain Control through the administration of local anaesthetic techniques remains the single most important factor in dental practice, and indeed the administration of local anaesthetic drugs are probably the single most utilized method of pain control in
in dentistry today."(10)

Chronologically, procaine, an ester-type anaesthetic solution was prepared by Alfred Einhorn in 1904-1905,(15) followed by the amides; lidocaine prepared by Nils Lofgren in 1943(15); prilocaine prepared by Lofgren and Tegner in 1953(15); and mepivocaine prepared by A. F. Ekenstom in 1957(15), were some of those local anaesthetic solutions attaining prominence in dentistry and other related Health Fields.
ANATOMY OF THE PTERYGO-MANDIBULAR SPACE.

All oral branches of the mandibular nerve pass through the pyrimidal shaped pterygo-mandibular space. This region is bounded laterally by the ramus and sigmoid fascia; medially by the medial pterygoid muscle as it inclines infero-laterally, and slightly posteriorly to insert in the ramus below the mylo-hyoid groove; superiorly by the lateral pterygoid muscle forming its roof.

The medial wall of the pterygo-mandibular space is completed by the interpterygoid fascia which is significant in limiting the spread of the anaesthetic solution deposited in the 'space'.

The maxillary artery enters the 'space' through the interpterygoid fascia and initially lies in close relation to the neck of the condyle, and as it winds upwards to the pterygo-maxillary fissure may either be superficial or deep to the lateral pterygoid muscle. Several branches which pass through the space comprise the middle meningeal artery ascending deep to the lateral pterygoid muscle; the posterior deep temporal artery passing up between the sigmoid fascia and the lateral pterygoid muscle and the inferior alveolar artery descending to the mandibular foramen where it comes into posterior relation with the inferior alveolar nerve. A lingual branch may be given off from either the maxillary or the inferior alveolar arteries to accompany the lingual nerve, whilst other small branches include the masseter artery.

The pterygoid plexus of veins surrounds the inferior head of the lateral pterygoid muscle and is confluent with a plexus of veins surround the capsule of the temporomandibular joint.

A large vein may drain the plexus and join the inferior alveolar vein or veins in close proximity to the ramus below the inferior border of the lateral pterygoid muscle. The resultant maxillary vein passes backwards inferior to the maxillary artery, and after receiving
other tributaries perforates the interpterygoid fascia and joins the superficial temporal vein in the parotid gland to form the retromandibular vein.

The lingual and inferior alveolar nerves separate from each other on the deep side of the lateral pterygoid muscle and emerge into the pterygo-mandibular space on the lateral surface of the medial pterygoid muscle.

The lingual nerve having joined within the chorda tympani, runs forwards and downwards in front of the lingula to become flattened between the medial pterygoid muscle and internal surface of the ramus en route to the floor of the mouth.

The inferior alveolar nerve lies posterior to the lingual nerve and gives off the mylo-hyoid nerve approximately 5mm above the mandibular foramen.

The auriculo-temporal nerve is in close relation deep to the lateral pterygoid muscle and in close relation to the neck of the condyle as it passes posteriorly into the parotid gland.

The buccal nerve passes between the two heads of the lateral pterygoid muscle as it passes towards the deep portion of the temporalis muscle. The buccal nerve subsequently emerges from beneath the temporo-buccinator band to pass forwards on the buccinator muscle.

The medial pterygoid muscle abuts the superior constrictor of the pharynx on its medial side, but the two structures are separated above by a pharyngeal artery and a number of veins.

The entrance into the pterygo-mandibular space is approximately 2.2mm wide, and the depth of the 'space' at the level of the coronoid notch parallel to the occlusal plane, is approximately 28mm long and 3mm wide. The cross sectional area at this level is thus 92.45 sqmm(12).

The convergence of the inferior alveolar nerve and artery with veins at the lingula forms a neurovascular bundle. Its overall length is 8mm and its breadth about 2.2mm wide; the cross sectional area is thus approximately 17.6 sqmm. Just one fifth of the cross sectional area of the pterygo-mandibular space is occupied by the
inferior alveolar neurovascular bundle.\(^{(12)}\)

A photo micrograph of a dissection by Watson\(^{(3)}\), Fig.2, shows the neurovascular bundle which lies in an antero-medial position and closely abutting the medial pterygoid muscle. The vascular part is in a postero-lateral position and is closer to the mandibular ramus than the neural part. \(^{\uparrow}\)

The distance from the entrance to the neural part of the bundle is 18mm and to the vascular part 20mm.\(^{(12)}\)

The distance to the lingual nerve is 6.7mm.\(^{(12)}\)
ARMAMENTARIUM

Since the discovery of the hypodermic syringe, the all metal and the Luer lock type syringes have been displaced by the breech-loading metallic cartridge type.

The needle is attached to the barrel of the syringe by the screw hub; the end of the needle then penetrates the barrel of the syringe and pierces the rubber diaphragm of the cartridge of anaesthetic solution.

The aspirating tip of harpoon attached to the piston is used to penetrate the thick rubber or silicone stopper at the end of the cartridge. When negative pressure is exerted on the thumb ring by the administrator blood will enter the needle lumen and cartridge if the needle tip rests within a blood vessel and if the needle gauge is of adequate size. Positive pressure applied to the thumb ring will force the anaesthetic solution into the needle lumen and thus into the patient's tissue.

The needle used is either of the sharp stilleto type or the more ovoid Huber type(7), and a 25 gauge diameter preferred to the 27 gauge diameter for mandibular regional block techniques(13). The Huber type is also preferred as it reduces the incidence of vascular penetration(7). The needle's length for mandibular block injections varies from 25mm to 28mm.

The improvement in the development of the hypodermic syringe was demonstrated by Adams and Mount(14) using an Astra* plastic self adjusting disposable syringe fitted with a 27 gauge needle demonstrated positive aspirations of 17% in contrast to 3.6% demonstrated by Harris in 1957 using a Luer Lock syringe. Table I.

* Astra Pharmecuticals, North Ryde, Sydney.
LOCAL ANAESTHETIC SOLUTIONS

Many varieties of local anaesthetic agents have been synthetized and made available to the dental profession since the discovery that cocaine possessed analgesic properties.\(^{(6)}\)

The anesthetic solutions are classified as either esters or amides and some of the more frequently used are presented in chronological order with pertinent information.\(^{(15)}\)

1. Procaine, ester.
   Chemical formula: 2-Diethyl aminoethyl 4-amino-benzoate hydrochloride.
   Prepared by: Alfred Einhorn, 1904-1905.\(^{(15)}\)
   Potency: 1(Procaine=1)
   Toxicity: 1(Procaine=1)
   Metabolism: Hydrolyzed rapidly in plasma by plasma pseudocholinesterase.
   Excretion: 1. 2% unchanged in urine.
   2. 90% para-aminobenzoic acid.
   3. 8% diethylaminoethanol.
   Vasodilating properties; Produces greatest vaso dilatation of all currently employed local anaesthetic solutions.
   \(P_k: 9.1\).
   Onset of action: 3 to 5 minutes.
   Ideal concentration: 2 to 4%
   Topical anaesthetic action: No.

2. Lidocaine, amide.
   Chemical formula: 2-Diethylamono- \(\cdot 2',6'\) acetoxylidide hydrochloride
   Prepared by: Nils Lofgren, 1943.\(^{(15)}\)
   Introduced: 1948.
   Potency: 2) today, lidocaine is used as a standard.
   Toxicity: 2) of comparison for all local anaesthetic solutions.
Metabolism, in liver, by microsomal fixed-function oxidases, to monoglycine and zylidide; zylidide is a local anaesthetic and is potentially toxic.

Excretion, Via kidneys

- 10% lidocaine
- 80% various metabolites

Vasodilating properties; Considerably less than procaine; however, more vasodilating than prilocaine

$P_{Ka}$: 7.9

Onset of action; Rapid, 2 to 3 minutes

Ideal concentration: 2%

Anaesthetic half-life: 90 minutes

Topical anaesthetic action: Yes.

3. **Mepivacaine; An' Amide**

Chemical formula: 1-Methyl-2',6'-pipecloxylidide hydrochloride

Prepared by: A.F. Ekenstam, 1957(15)

Introduced: 1960, 2% with vasoconstrictor

1961, 3% without vasoconstrictor

Potency: 2(procaine=1)

Toxicity: 1.5 to 2(procaine=2)

Metabolism, In liver, by microsomal fixed-function oxidases, hydroxylation and N-demethylation play important roles in metabolism of mepivacaine.

Excretion: Approximately 1% to 16% of anaesthetic dose is excreted unchanged in the urine.

Vasodilating properties: Mepivacaine demonstrated only very slight vasodilating properties. Some studies have shown that mepivacaine possesses vasodilating properties, but this is not a consistent finding. Of all local anaesthetics available, only cocaine consistently produces vasoconstriction. Duration of pulpal anaesthesia of mepivacaine without vasoconstrictor is approximately 20 to 40 minutes. Lidocaine without a
vasoconstrictor lasts 5 minutes; procaine without a vasoconstrictor lasts up to 2 minutes.

$P_{ka}$; 7.6

Onset of action: Rapid; 1 to 2 minutes

Ideal concentration: 3\% without vasoconstrictor

Anaesthetic half-life; Similar to lidocaine approximately 90 minutes

Topical anaesthetic action: No

Maximum dosage 3\% without vasoconstrictor: 3mg/lb.

Maximum dosage 2\% with vasoconstrictor: 3mg/lb.

4. Prilocaine:

An amide

Chemical formula: 2-Propylamino-o-propionotoluidine hydrochloride


Potency: 2(procaine=1)

Toxicity: 1(procaine-1); 40\% less toxic than lidocaine.

Metabolism: Differs significantly from that of lidocain and mepivacaine. Prilocaine undergoes metabolism in both liver and the kidneys. Ortho-toluidine and L-N-N-propylamine are metabolites of prilocaine. Ortho-toluidine can induce the formation of methaemoglobin, producing methaemoglobinemia if large doses are administered. A dose in excess of 400 mg is needed to produce significant methaemoglobin levels in the blood. This dosage produces a methaemoglobin level of 1\%.

Methaemoglobin levels of less than 20\% usually do not produce clinical signs or symptoms, which are grayish or slate blue cyanosis of lips, mucous membranes, and nail beds and infrequently respiratory and circulatory distress. Methaemoglobinemia is rapidly reversed by administration of 1 to 2mg/kg body weight of methylene blue solution intravenously over 1-5 minute period. Prilocaine is metabolized more rapidly than lidocaine; thus the levels of prilocaine in the blood are lower.
Excretion: Prilocaine and its metabolites are excreted primarily through the kidneys. Vasodilating properties, Prilocaine is a vasodilating agent. It produces greater vasodilation than does mepivacaine but less than lidocaine and significantly less than procaine. 

$\text{pK}_a$: 7.9

Onset of action; slower than that of lidocaine; 2 to 4 minutes

Ideal concentration: 4%

Anaesthetic half-life: Shorter than either lidocaine or mepivacaine

Topical anaesthetic action: No

Maximum dosage: 4% with or without vasoconstrictor 3.6 mg/lb.
CARE OF THE ANAESTHETIC SOLUTION

All reasonable precautions should be observed by the manufacturers to prevent contamination of the solution, by individually packing the cartridges in hygienic containers.

It is known however, that contamination of the solution can occur during transportation from the manufacturer or during storage prior to use, or in handling by auxiliary personnel.

Lilley stated (16) that immersion in alcohol (with or without subsequent flaming) chlorhexidine or glutaraldehyde is not totally effective in preventing contamination and involves the possibility of further risks to the patient, due to the penetration through the diaphragm technique. Application of a gas flame to the diaphragm for 5 seconds has been shown to be a completely reliable technique devoid of apparent deleterious effects upon the contents and without affording additional risks to the patient. On the basis of these findings it would appear reasonable recommending that flaming for 5 seconds should be routine procedure.

Cooley stated (17) that there are two potential problems associated with freezing the solutions;
1. The solution may become contaminated should the rubber plunger become unseated and be partially pushed out of the cartridge allowing air and micro-organisms to enter.
2. The second problem that may occur when air enters the cartridge is due to the deleterious effect of oxygen on epinephrine. Although Sodium bisulfite in concentrations of 0.5 to 0.1% is added to the anaesthetic solution to prevent oxidation, excess oxygen into the cartridge however will neutralize this protective mechanism and lower its pH.

De Jong (18) claimed that local anaesthetic solutions without epinephrine have a pH of 6 to 7 and are readily buffered by tissue fluids to the prevailing pH of approximately 7.3.
A study by Petersen and Klein (19) to determine whether warming the local anaesthetic solution to body temperature (37°C) produce less pain than that injected at room temperature (21°C) concluded that neither was onset of anaesthesia accelerated nor was there any benefit by warming the solution to body temperature prior to the injection.
MANDIBULAR BLOCK AND INFILTRATION TECHNIQUES.

The Inferior Alveolar Block.

The purpose of this technique is to select a position for depositing the anaesthetic solution proximal to the affected area, along the nerve trunk and provide anaesthesia in the bone and teeth as well as the oral soft tissues of the mandible.

The most suitable position appeared to be at the Lingula(16). Intra orally the points of reference are the apex of the buccal pad which coincides with the coronoid notch, the pterygo-mandibular raphe, the internal oblique line, and the occlusal surfaces of the mandibular teeth. The index finger is placed on the occlusal surfaces of the molar teeth and rests in the pterygo-temporal depression. Bisecting the finger nail as it corresponds to the apex of the buccal pad represents the height for inserting the needle. There are many methods and techniques for this injection, with advocates for a curved needle, although the most popular is the straight needle. Some preferred three positions of the needle in contrast to those using the direct approach, whilst devious ways have been introduced to determine the antero-posterior and super-inferior position of the mandibular foramen. Nevertheless as the injection site is in the neuro-vascular bundle it is difficult to avoid complications arising from the involvement of neural and vascular as well as muscular tissue. The technique is unreliable as the clinician is unable to determine, by tactile sense, the ideal position for depositing the solution.

The Mental Block.

The aim of this technique is anaesthetize a segment in the mucobuccal fold between the apices of the lower teeth. The needle is advanced slowly to a depth of approximately 5 to 6mm until the level of the mental foramen is reached. Penetration into the foramen is not necessary.
After an aspiration test proves negative 0.5 to 1ml of the anaesthetic solution is deposited very slowly.

**Infiltration techniques.**

Prior to the universal acceptance of the inferior alveolar block, infiltration techniques were more frequently used for controlling pain in the mandible. Their aim was to anaesthetize the peripheral filaments under pressure into and around a circumscribed area and avoiding injection into inflammatory conditions.

There are several subdivisions, sub periosteal, supra periosteal, intra-osseous and periodontal injections.

1. **Sub-periosteal technique** aims at depositing the anaesthetic solution beneath the periosteum by inserting the needle between the gingival margin and the apex of the tooth at right angles to the alveolar plate in order to penetrate the periosteum. The needle is then placed parallel to the alveolar plate, with its bevel towards the bone and then advanced towards the apex of the tooth beneath the periosteum. About 1ml of the solution is injected, repeating the procedure on the lingual side.

2. **The Supraperiosteal** or sub-mucous technique as its name implies aims at depositing the solution above the periosteum to avoid 'tearing' the periosteum, and reducing the incidence of post-operative complications.

3. **Intra-osseous technique.** The aim in blocking sensory filaments within the alveolar bone is to perforate the cortical layer of bone with either a small round bur, or Beutelrock drill, and in the opening provided to deposit 1cc of the anesthetic solution.

4. **Peridental technique.** The purpose of this technique is primarily to effectively provide pulpal anaesthesia, in particular to molar teeth which have remained sensitive despite the administration of the inferior alveolar block injection. The needle is placed in the gingival sulcus along the medial root of the tooth and advanced until resistance is encountered and a small volume of anaesthetic solution is deposited.
In the early 1980s the Peri-press* and Ligmajet** syringes were introduced into Australia as a new concept for the injection of the local anaesthetic-solution. The solution is injected under pressure. Profound anaesthesia is attained in single mandibular teeth without the need for an inferior alveolar injection, and not anaesthetizing the lower lip or tongue.

Of the various techniques listed the inferior alveolar technique attempts to anaesthetise the whole of one side of the mandible.

However the inferior alveolar technique does not produce total anaesthesia in all cases.

Various reasons have been given to explain the difficulty of predicting anaesthesia in the mandible with the injection site at the lingula.

Bremer(21) demonstrated that no known landmark in common use, consistently determined the correct height for depositing the anaesthetic solution above the lingula of the mandible. Moreover the use of the apex of the buccal pad, the coronoid notch, or resting the index finger of the occlusal plane of the mandibular teeth and bisecting the width of its nail to assess the height for the insertion of the needle, are not reliable landmarks for determining the needle pathway. He stated that using the intra-oral landmarks referred to and inserting the needle parallel to the occlusal plane, would place it below the lingula in at least 5% of the injections.

His measurements were carried out on 400 mandibles and found that the height ranged from 1 to 19mm. Table 2. The heights of various planes passing through the lingula and parallel to the occlusal plane are shown in Fig.3. Accordingly inserting the needle 3mm above and parallel to the occlusal plane would be placed above the lingula in 42% and below it in 5% of the cases.

Nevin claimed(22) that inadequate mandibular anaesthesia may be due to supplementary innervation of the mandible from the mylo-hyoid, buccal, lingual or facial.* Oral Tronics, West Germany.
** Ima, West Germany.
nerves. These nerve fibres innervating the mandible were identified anatomically.\(^{(22)}\)

Frommer considered\(^{(23)}\) that the mylo-hyoid nerve contributes to incomplete anaesthesia, and his study involved an analysis of the functional components of the nerves from human cadavers, of fibre size, and frequency distributions. He claimed that there is a reduction of small calibre fibre size between the proximal and the distal regions which supports the hypothesis of mylo-hyoid participation in posterior teeth innervation.

Rood suggested\(^{(24)}\) that nerve fibres in addition to the inferior alveolar nerve can be associated with supplying sensation to pulps of mandibular teeth. He stated that incisor teeth have indicated the greatest proportion of failures to achieve anaesthesia and this is commonly believed to be due to overlap of right and left inferior alveolar nerves.

Rood also considered\(^{(25)}\) that the buccal, posterior superior, and auriculo-temporal nerves may contribute to incomplete anaesthesia following the injection at the lingula.

Sutton demonstrated\(^{(26)}\) small branches of nerves entering the body and ramus of the mandible providing supplementary innervation and contributing to incomplete anaesthesia.

Reynolds demonstrated\(^{(27)}\) a branch from the auriculo-temporal nerve entering the mandibular foramen either singly or incorporated within the sheath of the inferior alveolar nerve. Fig 4. He also demonstrated a branch from the lingual nerve entering small foramina in the bicuspid region on the medial side of the body of the mandible.

Angleman supported\(^{(28)}\) the concept of branches from the buccal, mylo-hyoid, lingual nerves as supplementing innervation of the mandible. He also considered that an enlarged posterior alveolar superior nerve may assume the distribution and function of the long buccal nerve.

Adatia shared\(^{(29)}\) the belief that the cervical plexus does not contribute to incomplete anaesthesia, and that anatomical and clinical evidence appears to support the
conclusion that the innervation of the mandibular central incisor is by way of the intra-mandibular branches arising from ipsilateral source, unlike the mucoperiosteum and probably some of the superficial bone.

Grover claimed (30) that bifurcation of the mandibular nerve, which is rarely mentioned in the literature, may be a cause of inadequate anaesthesia in a small percentage of cases.

Rood considered (31) that local anaesthetic solutions affecting the trunk of the inferior alveolar nerve produce changes in the sensory supply to the lip and teeth over a similar period. The apparent early onset of lip anaesthesia is due to the lack of appreciation of early changes in pulpal sensory depression.

Sicher stated (32) that the inferior alveolar injection is one of the most frequently used local anaesthetic techniques in dentistry, as well as being the most unreliable and unpredictable when depositing the anaesthetic solution at the lingula.

The investing layers of fascia are not absolute but relative barriers dividing the pterygo-mandibular space from adjacent spaces. The loose connective tissue which fills the pterygo-mandibular space is subjected to stress and may be condensed to form strands of denser connective tissue further dividing the space, and as a result affecting the diffusion of the injected solution. Such condensation of loose connective tissue frequently develops where blood vessels, such as the maxillary artery passes through the connective tissues.

The pterygo-mandibular space is a potentiably distendable region containing approximately 2 mm³ of loose connective tissue (12). When fluid is injected into a tissue space, there may be a rise in pressure depending upon the rate at which the fluid enters compared with its diffusion from the compartment.

Rood stated (33) that pressures ranging from 14.5 to 460.0 mm of Hg were created within the pterygo-mandibular space when depositing the anaesthetic solution at the lingula at the rate of 18.3 seconds to inject 2.0 ml. It was observed
that faster rates of the injection produced the greatest pressure rises. It was considered that the rate for administering 1ml of a 2% lignocaine solution with 1.80,000 adrenaline be no less than 30 seconds to induce satisfactory anaesthesia without causing a rise in pressure.

Murphy and Grundy referred\(^{(12)}\) to the many modifications introduced to improve the effectiveness of the inferior alveolar block as being conflicting.

The neural part of the lingula\(^{\prime}\) neurovascular bundle lies in an antero-medial position closely abutting the medial pterygoid muscle, and consists of four fasciculi imbedded in the surrounding perineurium.

The vascular part of the bundle is in a postero-lateral position and is closer to the ramus than the neural part. He claimed that the distance from the entrance into pterygo-mandibular space to the neural part is 18mm and 20mm to the vascular part of the neurovascular bundle.

Watson showed\(^{(3)}\) Fig 2. The relatively large single inferior alveolar artery surrounded by a plexus of veins.

Harvey considered\(^{(34)}\) that the narrowest width of the ramus to be an important plane from which vertical and horizontal criteria may be obtained to establish the position of the mandibular foramen. This concept was clearly supported by evidence from dissections and clinical observations. He further stated that there are 11 points of entrance of the needle, 6 horizontal bearings, 6 vertical bearings, 11 depths of penetration of the needle, 9 positions of the foramen and 12 target areas. These are conflicting and confusing, and as well as being obscure do not resolve anatomical variations affecting needle placement and consequently the clinician is not provided with reliable criteria for determining the correct position to deposit the anaesthetic solution.

Jorgansen and Hayden stated\(^{(35)}\) that a plane through the deepest point on the anterior border of the ramus parallel to the occlusal plane, is not a reliable guide for the placement of the needle above the lingula. They
claimed that the distance from the lingula to the internal oblique line is the same, plus or minus 1mm irrespective of the width of the ramus or the age of the individual; that it is of infinite importance to appreciate the variation of normal anatomy; that it is futile to predetermine the penetration of the needle for all mandibles, and that the occlusal plane of the molar teeth is a more reliable landmark.

Shields supported the view that none of the accepted landmarks used in the conventional inferior alveolar block technique are completely reliable and do not resolve those instances in which the lingula presents an obstruction to the needle. He suggested extra and intra-oral landmarks to estimate the height and depth of needle penetration.

Menke and Gowgiel considered the penetration of the needle from the oral mucosa to the neurovascular bundle and preferred the less flexible short needle as a precautionary measure to prevent penetrating too deeply.

Bernes and Sadove injected a radio-opaque anaesthetic solution at the level of the lingula, and found that the needle could be some distance from the inferior alveolar nerve and induce anaesthesia.

Galbreath and Eklund injected 2% lignocaine with 1:100,000 concentration of adrenaline combined with Urogaffin 60 at the lingula. Diffusion of the solution was determined by radiographs which indicated that the solution followed the line of least resistance by whatever fascial planes were encountered and that its course could not accurately be predetermined. The likelihood of obtaining anaesthesia was increased by placing the needle near the mandibular foramen.

Peterson stated that the spread of the local anaesthetic solution is an important component of anaesthetic effectiveness. His study involved the pattern of spread through the pterygo-mandibular space correlated with anaesthetic effects. He injected 2% mepivacaine with 1:200,000 adrenaline mixed with five different radio-opaque
media. In order to quantitate the distribution of the injected solution, the dimensions of the spread were measured in two planes. It was noticed that immediately after the injection there was a slow dispersion of the injected solution, and it appeared that confining the spread to the area between the anterior and posterior borders of the ramus provided more favourable results. In cases of partial or complete failure of anaesthesia two general patterns of distribution were noticed, the more common being spread in a vertical direction (length greater than width) behind the ramus, i.e. in the parapharyngeal space. This type of spread found in seven cases, is clearly due to inserting the needle too deep in relation to the width of the ramus. Loss of the solution into adjacent spaces reduces the volume and concentration of the anaesthetic necessary to cover an adequate segment of the nerve membrane to intercept sensory transmission.

De Jong considered\(^{(18)}\) that at least 6mm and preferably 10mm of the nerve membrane should be exposed to prevent transmembrane influx of sodium ions.

Fox\(^{(41)}\) investigated the effect of diffusion in relation to the effectiveness of the block by depositing the solution with fast or slow methods. Lidocaine with and without epinephrine, as well as mepivacaine with and without levonordefrin were incorporated with contrast medium in the ratio of 2cc to 1cc were administered. Lateral and anter-posterior cephalometric radiographs traced the diffusion of the solution.

It was observed that dispersion of the solution ascended towards the condylar neck, forming a triangular shape down the anterior border of the ramus of the mandible and corresponding to anatomic fascial planes.\(^{(41)}\) Slow injection of the anaesthetic solution appeared to be a less traumatic experience and more consistent in effectiveness than the fast method, although when either technique rendered excellent anaesthesia it appeared radiographically that the entire pterygo-mandibular space was filled with solution.
Complications arising from administering the inferior alveolar block have been reported. Traeger considered\(^{(42)}\) the high incidence of haematoma formation is more frequent than is generally realized and often gives rise to ecchymosis in the pharangeal area. The effusion of blood diluting the concentration of the solution may be a possible cause of incomplete anaesthesia as well as contributing to post-operative pain.

Cannell referred\(^{(43)}\) to circulating plasma levels of 1.9/μg/ml from the injection of 160mg of plain lignocaine at the lingula. As it is claimed that confusion, twitching and other manifestations of toxicity occurs at levels in excess of 2.7/μg/ml, and excess of 10/μg/ml causing cortical seizure, it is obvious that techniques should be selected that minimize multiple and supplementary injections. Similarly techniques with unpredictable results should not be employed.

Toxicity from elevated blood levels of the anaesthetic solution may be minimized by the addition of epinephrine, but its absorption into the circulation when deposited in highly vascular areas may affect the cardio-vascular system.

Aldrette stated\(^{(44)}\) that as the primary purpose of local anaesthetic injections was to deposit the solution in proximity to the nerve membrane inadvertent intravascular injections may occur. In an attempt to explain why some adverse reactions might occur as a result of local anaesthesia, he obtained data from Rhesus monkeys by haemodynamic and electrocephalo-graphic studies, indicating that carotid blood flow is reversible.

Results showed that even small amounts of local anaesthetic agents when injected inadvertently into a branch of the external carotid artery, may enter the cerebral circulation, most likely through a retrograde flow into the common and then into the internal carotid arteries. Some toxic neurological manifestations could
be explained by this mechanism.\textsuperscript{(44)}

Watson and Coleman stated\textsuperscript{(45)} that it is difficult to impale arteries when passing unrestricted through loose areolar tissue due to their muscular coats. However as the inferior alveolar artery is tightly held in the mandibular foramen it is not so readily pushed aside and is easily impaled.

The pterygo-manibular space is contiguous with adjacent spaces and complications may arise through over penetration or incorrect angulation of the needle when depositing the anaesthetic solution.\textsuperscript{(46)}

Campbell described\textsuperscript{(46)} the signs of Horner's syndrome as flushing and rash on the face, increased vascularity in the conjunctiva affecting membranes resulting in 'stuffy nose', ptosis of the eyelid, pupillary constriction and increased skin temperature over the affected part. A side effect is a temporary blocking of the recurrent laryngeal nerve, affecting all extrinsic muscles of the vocal chord and the larynx, resulting in a suffocating sensation.

Other complications arising from misdirecting the inferior alveolar block injection into the parotid gland and involving the facial nerve, Bell's Palsy, as well as trismus by injecting into the medial pterygoid muscle which frequently occurs are well reported in the literature.\textsuperscript{(12)}

The advantage of selecting an injection site away from nerve membranes cannot be overstated to prevent paraesthesia arising from traumatizing the inferior alveolar nerve.

Inflammatory conditions occasionally contribute to failure of local anaesthesia. Najjar claimed\textsuperscript{(47)} that neurodegenerative changes along the inflamed nerve distant from the inflammatory site, and the presence of amino acids which may be the product of lyosomal enzymes activity, appear to be the cause of failure to prevent transmembrane influx of sodium ions. It appears that the degree of anaesthesia depends primarily upon the concentration of the solution permeating the nerve fibre. Since the initial
contact of the local anaesthetic is at the sheath membrane it is at this level the morphological alterations, such as neurodegenerative changes of the axon, or the presence of inflammatory mediators must play an important role. The effect of inflammation on the nerve fibres appears to be mediated by proteolytic enzymes, as biochemical studies from his investigation, revealed the presence of amino acids which were not present in the control group.
DISCUSSION

The literature reveals that the inferior alveolar technique presents many problems in achieving pain control in the mandible. This is indicated by Shazer\(^{(48)}\) who poses the question, "Is the inferior alveolar block obsolete?"

Criticism of this technique is based on unpredictable results from its use and the false premise that pulpal anaesthesia is consistently attained by depositing the anaesthetic solution at the lingula. The inability to achieve pulpal anaesthesia at times was recognized by Elliott\(^{(49)}\) who suggested a test to distinguish between pressure and pain. The test consisted of exerting pressure of increasing intensity on the tooth with the extracting forceps for 3 seconds, followed by a sudden release of the pressure, thus providing a sudden stimulus. If the patient moves or 'jumps' the response indicated inadequate anaesthesia. As the failure rate may be as high as 29% it is obvious that there must be agreement with Shazer and this is indicated by so many clinicians reverting to basic outmoded techniques such as infiltration techniques, intra osseous, periodontal, as well as more complicated methods as intra venous sedation or nitrous oxide inhalation techniques.

Causes of incomplete anaesthesia.

Following the inferior alveolar block these may be due to:

1. Inadvertent injection into the lumen of blood vessels as indicated by aspiration studies.
   Table 1.
2. Misdirecting the needle into adjacent spaces.
3. Inadequate volume and concentration of the solution injected.
4. The clinician is not provided with the tactile sensation for determining an ideal injection site.
5. Depositing the anaesthetic solution in close proximity to the nerve membranes accelerates the absorption into the surrounding blood vessels.
which accompany nerves.

6. Intra oral landmarks are unreliable criteria in determining the position of the mandibular foramen.

7. Radiographic studies indicate that diffusion of the anaesthetic solution injected at the lingula cannot be predetermined.

8. Supplementary innervation.

9. The presence of inflammation affecting the nerve membrane.
CONCLUSION.

It is obvious that depositing local anaesthetic solutions near nerve membranes within the lingula neurovascular bundle are associated with local and systemic complications.

Stone stated"the inferior alveolar block is known to be associated with post operative trismus quite frequently. It involves the penetration of muscle and the deposition of anaesthetic solution into a highly vascular space, and a small amount of haemorrhage may result in mild discomfort when the anaesthesia wears off. However if the pterygoid plexus is entered, or if a small vein is lacerated or punctured by the needle, a larger haematoma in the infratemporal fossa may result".

Sicuteri et al claimed that several pathological situations induce a release and concentration of vasoneuroactive substances, as ischaemia provokes a local activation of kinins and serotonin, which is the most powerful vasoconstrictor in man, besides being able to sensitize the human nociceptors to other pain producing substances such as bradykinin. During ischaemia the action of VNS* becomes intense and long lasting because of the slowing down of arterial blood flow.

It is strange that the higher region of the pterygomandibular 'space' was not more intensely explored to determine whether a relatively safe needle pathway above the neurovascular bundle existed and avoid penetration into the medial pterygoid muscle and would be a significant advancement in mandibular local anaesthesia. Furthermore the existence of a less vascular injection site may permit the use of local anaesthetic solution without vasoconstrictors and eliminate ischaemia.

* VasoNeuroactive Substances
PART B

NEW MANDIBULAR BLOCK
TECHNIQUE USING INTRA-ORAL
AND EXTRA-ORAL LANDMARKS.
DEVELOPMENT AND ESTABLISHMENT OF THE GOW-GATES MANDIBULAR BLOCK TECHNIQUE.

The experience of the author acquired in a busy clinical practice from 1935, provided strong convictions that sensory transmission in the mandible could not be consistently intercepted at the lingula.

Many references have appeared in dental journals implying that the dental health of the community was adversely affected by an unfavourable image of dentistry based on unpleasant painful dental treatments. In particular this referred to the unreliable inferior alveolar block injection.

At first the author attempted to rectify this image, by adopting nitrous oxide to control pain, but with this method it was difficult to always provide the preparation, premedication and post-operative care to a standard mandatory to the patients welfare.

It was not unusual in emergency situations to be compelled to act as clinician/anaesthetist and supported by partially trained assistants. It was also noticed that for various reasons too many patients were demanding nitrous oxide inhalation for even the most trivial dental treatments.

As a clinician's responsibility is to provide procedures considered in the best interests of the patient's well being, such was the impact from these experiences that they contributed to initiating the research into the pterygo-mandibular "space", for locating a more reliable injection site.

It seemed that this could be achieved by selecting a more proximal position along the nerve trunk in the higher region of the "space" near the branching of the posterior division of the mandibular nerve, provided the solution was deposited in close approximation to nerve membranes. However it soon became apparent by complications arising from involvement of the vascular system that the
medial upper region of the pterygo-mandibular space was most unfavourable for depositing local anaesthetic solution and was to be avoided.

Procaine with 1:50,000 adrenaline was the anaesthetic solution commonly used for the inferior alveolar block injections at that time. It was noticed that an unusual number of patients were affected by syncope (more frequently in summer months with high humidity) after the injection. In an attempt to avoid having to adopt life saving protocal procedures, the supine position of the patient was adopted before and during the administration of the injection. This was partially successful by the maintenance of adequate cerebral blood levels, although it was noticed however, that the effectiveness of the block was not improved. The position of the patient however assisted in changing the direction of the needle to the more lateral side of the pterygo-mandibular space.

It was noticed that a needle pathway directed laterally above the neurovascular bundle to the anterior surface of the condyle was a more favourable injection site. The tactile sensation of palpatiing bone, preventing further penetration of the needle, stimulated further consideration to developing criteria to determine the topography of the blood vessels and the inferior alveolar nerve. The supine position facilitated the identification of various intra oral and extra oral landmarks which are recognised as being basic and simple in the administration of the Gow-Gates Mandibular Block Technique. (3) Fig 5.

These were events which induced the author to publish the technique in 1973, and in the following year accepted an invitation to present it to a panel of American Educators in Massachusetts not far from where Hallstead had demonstrated the inferior alveolar block technique. (7)
The seminar was a Workshop sponsored by Astra Pharmaceuticals Inc.* to consider the "Challenge to the Teaching of Local Anaesthesia to Dentists and Dental Students." (52)

History was repeated as the invitation to the author was similar to that extended to Dr. Guido Fischer in 1914, both invitations being related to describing regional mandibular block anaesthesia.

The American Dental profession did not immediately accept the inferior alveolar block as described by Dr. Fischer as it remained dormant until 1927. (7)

The advantage of involving dental schools for exposing new techniques was demonstrated by the author’s participation in the Workshop in Local Anaesthesia (52) 1974-1979 and presenting the Gow-Gates Mandibular Block to Dental Educators from the 57 American Dental Schools.

As a result many studies were carried out to assess its effectiveness (53,54,55,56,57,58,59) by clinical, anatomical and other procedures to study its diffusion.

In contrast to the result of the visit by Dr. Fischer, the acceptance of the Gow-Gates Block was spontaneous and has been introduced in the curriculum in pain control techniques being exposed to dentists, undergraduates and hygienists.

Its impact on the American Dental Profession is illustrated by Panuska who stated (66) "that it is a new concept and technique, that can give a statistically better result, be less painful, and reduce the number of injections from three to one".

* Astra Pharmaceuticals Products Inc. Mass. U.S.A.
THE GOW-GATES MANDIBULAR BLOCK INJECTION

The Advantages.

The advantages of the lateral side of the anterior surface of the condyle as the injection site for mandibular anaesthesia were first described in 1973\(^{(3)}\).

These are:-

1. A teachable safe and simple technique.\(^{(60)}\)
2. Reliable extra oral and intra oral landmarks.
3. Predictable method for achieving anaesthesia.
4. Blockage of all oral sensory branches of both divisions of the mandibular nerve.
5. No vasoconstrictors are required.
7. Tactile position for locating target area.
8. Penetration into adjacent spaces avoided.
10. Injection site relatively avascular.
11. Injection above the neurovascular bundle at the lingula.
12. Injection into the medial pterygoid muscle avoided.
13. Painless needle pathway.\(^{(55)}\)
15. Reduction in tissue pressure.
16. Injection at nerve membrane avoided.
17. Plexus of nerves blocked.
18. No trisms.
19. No local tissue complications.
20. Reduction in systemic toxicity.
21. No paraesthesia.
22. Reduction in the incidence of vascular penetration.

The Landmarks.

The landmarks for the injection are:- Fig. 5.

Intra oral,

The medial side of the deep tendon of the temporalis muscle corresponding to the apex of the intertragic notch, or to the buccal cusp of the maxillary molar
teeth. Fig 5.

Extra Oral,

(a) The apex of the intertragic notch.
(b) The lower border of the tragus. or
(c) The external auditory meatus.

The target area is the lateral side of the anterior surface of the condyle, which will be referred to as the condylar neck.

Imaginary reference planes are used to simplify the insertion of the needle. These are:- Fig 6.

1. The Alpha plane. This extends from the lower border of the tragus through the corner of the mouth to a similar position on the opposite side. This gives the vertical direction of the needle.

2. The Beta plane. This is the angulation of the ear to the sagittal plane and gives the lateral direction of the needle. Co-ordination of both planes provides the correct orientation to the injection site.

3. The Gamma plane. This extends from the puncture point of the needle to a similar position on the opposite side. It corresponds to the intersection of the Alpha plane with the medial surface of the deep tendon of the temporalis muscle. The mouth must be kept open as wide as possible when the syringe is placed in the opposite corner of the mouth.

4. The Delta plane. This extends from the lateral side of the anterior surface of the condyle to the opposite side. The distance between the Gamma
and Delta planes represents the penetration of the needle being approximately 25 to 27mm.

A simple method of carrying out the technique by using the external auditory meatus as a landmark is to have the patient insert the little finger in the external auditory meatus, and as the syringe is held in the opposite corner of the mouth it is advanced very slowly, in the direction of the centre of the finger, until bone is palpated. Fig 8.
Clinical Procedure

The patient is placed in a supine position in the chair, the head extended and the chin kept high so that the intertragic notch has an upward inclination.

The mouth is opened as wide as possible, and associated with the stretching of the tissues, lifts the base of the tongue from the posterior pharyngeal wall avoiding airway obstruction. These positions are built in safeguards which assist the patient in the prevention of syncope and other complications arising from the injection.

Covino (61) stated that in general "the convulsive threshold is inversely related to the arterial pCO₂ level. An increase in pCO₂ is associated with a reduction in the dosage and blood level of local anaesthetic agent required to induce seizures, whereas a decrease in pCO₂ requires a greater amount of local analgesic drug to be administered in order to produce convulsive activity."

In addition to preventing airway obstruction the wide open mouth position permits the mandible to rotate on a horizontal axis passing through the condyles, (31) and associated with the lateral pterygoid muscles pulling the condyles downwards and forwards, transforms the ramus from an oblique into a more perpendicular position. This is reflected with the target area on the anterior surface of the condyle presenting a broader and more upright region to the needle pathway, as well as being brought forward to the same frontal plane as foramen ovale.

The patient's head is slightly inclined towards the clinician, to enable him to correlate the puncture point with the external landmarks thus giving the correct orientation of the needle.

The operator may be either seated or standing, although the standing position is preferred as it simplifies the alignment of the needle with the imaginary reference planes.
If the injection is for the right side of the patient, the syringe is held in the right hand between the thumb and forefinger, whilst the forefinger of the left hand is free to either distend the cheek or to place it over the incisal surfaces of the lower teeth to maintain the wide open mouth position, which is most important as the needle is advanced to the condylar neck.

The syring is placed in the opposite corner of the mouth to the side being anaesthetised (over the canine or bicuspide teeth) with the needle placed as close as possible to the medial surface of the deep tendon of the temporalis muscle and corresponding to the height of the apex of the intertragic notch.

The needle is maintained in the Alpha plane, Fig 9 & 10 and is then aligned with the Beta plane, Fig 7. It is slowly inserted until bone is palpated at the condylar neck. Penetration of the needle MUST NOT exceed 28mm and if the target area is not located the needle must be withdrawn and the landmarks reassessed. Table 3.

When the mouth is opened the condyles are positioned on the articular eminence Fig 11, and both the masseter and the temporals muscles 'bulge' medially, Fig 9. The needle penetrates the buccinator muscle entering the pterygo-mandibular space being some distance from and above the internal oblique line. The entrance into the 'space' is a narrow cleft, (Fig 12) triangular in shape, broader towards the maxilla, and its medial side represented by the pterygo-mandibular raphe and medial pterygoid muscle.

The needle pathway in the upper and broader region of the 'space' is above the neurovascular bundle, the crest of the coronoid process and the maxillary artery, Fig 13 & 14. It is lateral to the middle meningeal artery and since it is below the masseter artery (57) it is important to have the needle aligned with the Alpha plane as it is advanced to the target area.
No anaesthetic solution should be deposited as the needle is advanced very slowly towards the lateral side of the anterior surface of the condyle. The tactile sensation of contacting the bone at a depth of 25 to 27mm is indicative that the needle is where it rightly belongs. Table 3.

The needle should be slightly withdrawn, the re-inserted and repeated two or three times, to disengage and small blood vessels that may have become impaled.

An aspiration test carried out and then the anaesthetic solution is deposited-VERY SLOWLY against the bone at the injection site.

This position for depositing the anaesthetic solution is just below the insertion of the lateral pterygoid muscle, and is relatively avascular. There are some small blood vessels in a region of loose fatty tissue, and its advantages in relation to the lingula as an injection site, is obvious by comparing its histology, (Fig 15) to that of lingula, (Fig 2.).

Since this technique selects an injection site at least 11mm from the inferior alveolar nerve and approximately 22mm from the buccal nerves, volume and concentration of the anaesthetic is most important.

2.2ml of 4% prilocaine or 3% carbocaine, and increased to 3ml for apprehensive patients is recommended providing the dosage complies with that based on ml of drug/kg weight of the patient to avoid adverse reactions.

Epinephrine is not necessary as a vasoconstrictor and its elimination further reduces the toxicity of local anaesthesia.
ANATOMY

The invariable success of this technique in anaesthetizing the buccal nerve, with all other oral sensory branches of the posterior division of the mandibular nerve revolves around:

1. The extreme forward position of the condyle in the wide open mouth position. The point of the needle at the injection site is thus much closer to the mandibular nerve than anatomy texts or dissection specimens would suggest.

2. The buccal nerve arises from the anterior division of the mandibular nerve above the neck of the condyle, being separated by the lateral pterygoid muscle. Standard text books are necessarily preoccupied with the 'anatomic position', the mandibular position in which the condyle rests in the glenoid fossa.

When the anaesthetic solution is deposited at the neck of the condyle, it diffuses downwards by gravity to bathe:-

a) the inferior alveolar, lingual and buccal nerves.

b) the point of the needle at the target area is hooded by the lower head of the lateral pterygoid muscle, tending to direct the anaesthetic solution inferiorly.

c) posterior diffusion of the solution is prevented by the anterior surface of the condyle.

Medial diffusion of the solution is prevented by the restricting influence of the interpterygoid fascia and assists in the drug diffusing predominantly in the sagittal plane as far anteriorly as the buccinator muscle as demonstrated by Gregg & DeJean (59) Fig. 15.

The histology of the injection site in the coronal plane in loose fatty areolar tissue, is relatively avascular. (3) The advantage of selecting this injection site removed from neural membranes is illustrated by comparing its histology (Fig 16) with that at the lingula, (Fig 2.) As a result, the incidence of vascular penetration
is reduced as well as the absorption of the drug into the circulation.\(^{3,55,60}\)

The close proximity of the needle pathway to various arteries stresses the importance of the imaginary reference planes to guide the needle to the injection site above the maxillary artery to reach the target area below the insertion of the lateral pterygoid muscle. Fig 14. The origin and course of the masseter artery is extremely variable\(^{56}\) and the needle passes inferiorly. Vascular complications are avoided by aligning the needle to the Alpha plane and aspirating the tissues before depositing the solution.

Reported absence of detectable haemorrhage from the administration of this technique may be attributed to the relatively resilience and robustness of arteries than of veins, and the difficulty of impaling those arteries whose freedom to move is not restricted.\(^{45}\) In contrast the not uncommon rupture of the postero-superior alveolar artery with the maxillary block is probably due to the tortuous configuration of this artery together with its inelastic periosteal investment, making this vessel especially vulnerable in attempting block anaesthesia. These circumstances do not apply to the meningeal arteries who are less restricted and if it is actually ruptured the restricting boundaries of the fascia and musculature no doubt operate to prevent excessive extravasation of the blood.

This technique has the advantage of not requiring a separate injection for the buccal nerve. The invariable depth at which the buccal nerve is approached with the standard buccal injection when supplementing the inferior alveolar block technique may result in some penetration of the temporalis muscle or its tendon. In this region the temporalis muscle is normally quite tough and tense, and penetration by the needle often produces subsequent tenderness in the muscle.

The traditional inferior alveolar block requires the depositon of the local anaesthetic solution at
varying distances in three injection sites in close approximation to the inferior alveolar, lingual and buccal nerve trunks.

As the ratio of volume to surface area in a cylinder becomes greater with increasing diameter, it follows that larger nerve fibres require larger volumes and concentration of an anaesthetic solution to penetrate into the central core bundles to avoid a breakdown of the block.\(^{(18)}\)

Minimal contact of the solution with the nerve membrane and reduction in the solution injected by absorption may result in an inadequate concentration available to complete intercepting sensory transmission.

The 'flooding' of the pterygo-mandibular space and the covering of the mandibular nerve is an entirely new concept for providing anaesthesia in the mandible. This method complies with the concept that at least 6 to 10mm of a nerve membrane should be exposed to the solution to potentiate the block.\(^{(18)}\)
EXPERIMENTAL PROCEDURE AND RESULTS

A series of studies were set up to investigate the effectiveness, mode of activity and side reactions when depositing the anaesthetic solution at the new position of the bone of the neck of the condyle, and to compare those factors with the traditional deposition of anaesthetic solution at the lingula.

In addition it was intended to observe whether mandibular anaesthesia was profound with one injection site.

The author with the help of an associate, administered the new mandibular block. Experienced clinicians carried out the injections at the lingula in the control studies which will be referred to as the traditional method to distinguish it from the experimental or new block using the neck of the condyle as the injection site.

Study 1.

Since rapidity of onset is a major consideration in clinical practice, this study investigated the initial onset time of the new block by the criteria usually adopted; i.e. to ask the patient to report the first signs of changed sensation in the lower lip. Two types of anaesthetic solutions were used.

Part A.

Anaesthetic solution: 2.2ml of 3% prilocaine with epinephrine 1:300,000.

55 Patients aged 9 to 67 years were used for this part of the study. Zero time was defined as the moment when the plunger of the syringe was first pressed after the routine aspiration test. Initial onset time was defined as the moment when the subject was able to detect any change of feeling in the lower lip.
Results.

The mean initial onset time was 143.3 seconds (minimum 119.0 seconds; maximum 151.5 seconds). This initial onset time is approximately double that of 71.1 seconds attained by Freeman (64) who used 83 patients ages 7 to 60 years employing the traditional inferior alveolar block with the same volume of the same solution. Similarly Bomba (65) used the same traditional block technique, and subject to the same conditions and criteria achieved an average initial onset time of 71.4 seconds on a sample of 60 patients aged 8 to 36 years (Table 4.).

At first sight it appeared that the traditional block had a more rapid onset of action than the new mandibular block. It was noticed, however, that this new method indicated a centrifugal pattern of spread; i.e. the numbness spread from proximal areas of nerve distribution (3rd Molar region) to more distal areas (lip region). On the other hand the mode of spread of the traditional block followed a centripetal pattern, where the numbness spread progressively from the more distal areas (lip region) to the more proximal (3rd Molar region) Fig 17.

Part B.

It had been observed clinically that the incidence of positive aspirations at the base of the neck of the condyle were significantly lower than when injecting the anaesthetic solution at the lingula. Patients also commented on the longer duration of anaesthesia when using the new target area.

It was thought that vasoconstrictors may be unnecessary particularly if using a higher concentration of 4% prilocaine which itself had indicated vasoconstrictor properties (69).

Anaesthetic Solution: 2.2ml of 4% prilocaine without vasoconstrictor.

100 patients aged 7 to 61 years were used for this part of the study. The criteria were those used in Part A.
Results.

The mean initial onset time was 135.6 seconds (minimum 117.0 seconds; maximum 141.0 seconds). This indicated a slightly lower initial onset time but clearly showed that vasoconstrictors were not necessary when using the new block technique. (Table 4)

Study II.

As a result of the observation of the opposite direction of spread between the traditional and new techniques noticed in Study I it was decided that this study be carried out to record the distribution of anaesthesia along the inferior alveolar, lingual and buccal nerves.

Part A.

The direction of spread of anaesthesia using the new mandibular block technique.

Anaesthetic Solution: 2.2ml of 3% Prilocaine with 1:100,000 epinephrine.

18 patients aged 11 to 67 years were used for this part of this study.

Soft tissue anaesthesia was tested by gentle pressure with a very sharp probe in the molar, mental foramen and incisor regions. Alveolar bone anaesthesia was tested by applying a light impact to the molar, canine and central incisor teeth with a mouth mirror handle. The onset of anaesthesia was assessed when the patient first noticed any change of sensation in the lower lip. Zero time was the moment the plunger of the syringe was first pressed after the aspiration test.

Results.

In all cases anaesthesia was recorded firstly in the molar region, then the mental foramen/canine region and then the lower incisor region. This was observed in both probing and tapping tests. (Table 5.)
In order to put this observation to a severe clinical test patients were selected who required operative treatment in the lower molars. Prior to administering the new block, it was ascertained, by means of cold thermal tests, that the patients had normally sensitive teeth.

Before any sign of anaesthesia was reported in the lower lip, the cavity preparations for the patients were outlined with a high speed drill, and in no case was pain indicated by the patients.

The cases were selected as the cavities were extensive, and were in first molar teeth in mesial and distal surfaces as well as in gingival positions in the teeth.

This was a dramatic demonstration of the centrifugal pattern of spread, although it is unlikely that such tests could be routinely performed without provoking some pain.

Additional observations were made in that degree of changed sensation of the lower lip varied from slight to very high (Table 6)

**Part B.**

The direction of spread of anaesthesia using the traditional technique.

Anaesthetic solution: 2.2ml of 3% Prilocaine with 1:100,000 epinephrine.

The anaesthetic was administered by an experienced clinician who routinely used the traditional block technique.

15 patients aged 9 to 58 years were used. The criteria were those used in Part A.

**Results.**

In most cases the first signs of anaesthesia appeared in the lip. In some of the cases anaesthesia of the mucosa occurred in the mental foramen region before any detectable numbness of the alveolar bone in the molar region occurred.

The average time between anaesthesia of the lip/mental foramen to the first signs of numbness in the molar alveolar bone was 130 seconds (201-71) which confirms the centripetal
mode of spread when using the traditional block technique (Table 5.)

However, it should be emphasized that to reproduce this particular pattern of onset, care should be taken to ensure that the anaesthetic solution is deposited at the lingula. Depositing the solution in a position intermediate between the traditional block at the lingula and the new block at the base of the neck of the condyle results in an unpredictable pattern of onset even though anaesthesia may be clinically effective.

It is acknowledged that in this intermediate area, which is highly vascular, there will be difficulty in avoiding blood vessels which will affect the diffusion of the solution.

Study III.

The original description of the new mandibular block technique advised withdrawing the needle slightly after encountering bone in the target area, and, after performing an aspiration test, to deposit the anaesthetic solution 1mm from the bone. The reason for this was that some patients experienced slight transient discomfort.

The objective of this study was to compare the effects between depositing the solution 1mm away from the bone in contrast to the injection against the bone.

Anaesthetic solution: 2.2ml of 3% prilocaine with felypressin.

12 patients aged 9 to 46 years, who required bilateral blocks were used for this study.

Right and left sides were alternated to preclude any asymmetric bias in the technique.

Results.

In all cases clinically satisfactory anaesthesia was obtained on both sides of the mandible. In all twelve patients there was no report of discomfort when the anaesthetic solution was deposited 1mm away from the bone.

Nine patients reported no discomfort when the
anaesthetic solution was deposited against the bone but that there was a deeper feeling of anaesthesia on this side than on the side where the anaesthetic solution was deposited 1mm away from the bone. Three patients were unable to make any distinction in depth of anaesthesia between right and left sides.

Study IV.

This study was undertaken to investigate the hypothesis that the new technique is clinically more reliable in producing excellent local anaesthesia with a single injection than the conventional mandibular block technique. 304 patients aged 14 to 59 years were used in this study.

The trial was designed to use five groups: two experimental and three control. One experimental and two control groups each received 2.2ml of 3% prilocaine with 1:300,000 adrenaline. The remaining two groups, one experimental and one control, each received 2.2ml of 3% prilocaine with felypressin (Octapressin, Astra). The respective experimental and control groups are summarised in Table 7. Two control groups were included as a precaution against the possibility that a single operator may not have been a representative exponent of the conventional technique.

In the control groups, a single operator was responsible for a single group, but the three groups had separate operators. The operators used the traditional block technique.

The experimental and control groups comprised patients attending typical urban practices. No subject received premedication prior to the injection.

The grade of anaesthesia, assessed by the method used by Dobbs and De Vier, was noted according to how the patient reacted to the dental procedure performed at that appointment.
The Dobbs and De Vier system of grading depth of anaesthesia based on clinical criteria is:

Grade A -- completely satisfactory anaesthesia.
Grade B -- the subject feels some slight pain but does not require reinforcement.
Grade C -- feeble anaesthesia, another injection required.

**Results.**

The results are summarised in Tables 8 and 9.

Grade A anaesthesia was present in significantly more subjects in the experimental groups than in the respective control groups.

No significant difference was detected by the success rates of the three control operators using the traditional mandibular nerve block procedure.

In the experimental groups a high proportion of the subjects were tested for a response to a sharp probe in the regions of distribution of buccal and lingual nerves. These tests, and the freedom from pain during the actual operative procedures, confirmed that buccal and lingual nerves are consistently anaesthetised along with the inferior alveolar. Not one subject in any of the two experimental groups provided any evidence that a supplementary injection was needed.

Within the two experimental groups, a total of 27 third molars and 2 central incisors received treatment. All 29 of these subjects clearly had Grade A anaesthesia. The nine third molars which required extraction were tested by sinking a high-speed burr into the pulp without any reaction from the patient. Each central incisor required a cavity preparation and both of these were noticeably close to the pulp.

**Study V.**

The purpose of this study was to test the effectiveness of the new technique using an anaesthetic solution without vasoconstrictor.

Anaesthetic solution: 3ml of 4% prilocaine plain.
90 patients aged 14 to 62 years, requiring either endodontic, restorative or surgical treatment, varying from lower molar to incisor regions were used in this study. The anaesthetic solution was deposited against bone. An electrical pulp tester was used to monitor the spread of anaesthesia along the distribution of the inferior alveolar nerve. Anaesthesia for buccal and lingual nerves was tested using a sharp probe.

In all patients the planned treatment was carried out to completion.

Results.

Grade A(5) anaesthesia was obtained in all cases. Not one subject provided any evidence that a supplementary injection was needed. The increased volume of 3.0ml of anaesthetic solution showed a lightly lower onset time than the 2.2ml of similar anaesthetic solution used in Study I (B). (Table 10)

The results of the pulp tester demonstrated the progressive centrifugal onset pattern of anaesthesia along the inferior alveolar nerve (Fig.18), and complied with the concept of De Jong(18) that the proximal areas (molar) are supplied from the mantle bundles of the nerve trunk and the distal areas (incisor) are supplied by the fibres from the central core bundles of the nerve trunk. (Fig 19).

Even though vasoconstrictors were not used, excellent anaesthesia was maintained in all cases during the treatment required. The duration of anaesthesia was not less than 2 hours which was the longest time required for the treatment of any of the patients used in the study.

These tests, the relaxed composure of the patients and freedom from pain during the actual treatment procedures, confirmed that the buccal and lingual nerves were consistently anaesthetised along with the inferior alveolar nerve. The increased volume and increased
concentration of the anaesthetic solution potentiated the new mandibular block.
REVIEW OF THE LITERATURE IN RELATION TO THE GOW-GATES MANDIBULAR BLOCK

Since 1973 the literature has indicated increasing confidence in mandibular regional block anaesthesia using the condyle region as the injection site. Malamed(53) and others(54,55,56,57,58,59,62) who have investigated the Gow-Gates technique for injecting anaesthetic solutions in the vicinity of the condyle, in clinical and anatomical studies agree, that this method represents the first new approach to intra oral regional mandibular anaesthesia for many years.

The Malamed study(53) investigated the Gow-Gates technique over five years involving dentists, undergraduates and hygienists as operators.

The study involved 4275 patients of which 2068 (48.4%) received the Gow-Gates technique as the primary injection, and 2107 (51.6%) to whom the technique was administered after failure with the traditional inferior alveolar block.

Clinical anaesthesia was obtained in 97.25% using 1.8m. of lignocaine with epinephrine; 5.35% experienced clinical discomfort; 117 patients required re-injections.

In contrast, the traditional block resulted in incomplete anaesthesia ranging from 4.9% to 29%; the buccal nerve was 62% with positive aspiration rate of 1.9% (81 of 4275) which is in agreement with our studies indicating 1.6% involving 3000 injections. (Table 1.)

The traditional block demonstrated positive aspiration when injecting at the lingula as being 17%(14). This emphasizes the advantage of the condyle as a more favourable injection site. Table 1.

Levy(54) initiated a split mouth study on 26 patients who required the bi-lateral removal of lower third molars. Both the Gow-Gates and the traditional blocks were used simultaneously on either side of the mandible. Dosage of anaesthetic solution was 3ml of 4% prilocaine without vasoconstrictor.
The results indicated 96% Grade A anaesthesia for the Gow-Gates technique and only 65% anaesthesia for the traditional block technique. (54)

Levy considered that the poor performance of the traditional mandibular block may be related to the study's split mouth design, as it is possible that the adequacy of the block is valid only when compared with a more adequate block on the same patient at the same time. His explanation for block failure and positive aspirations in two patients was considered to be due to the use of a 5ml syringe in failing to deposit the solution against the bone. He stated that "it reinforces the most important principle of this method, that no solution should be deposited until the needle is placed against the bone of the condyle".

The comparison of 96% and 65% Grade A anaesthesia between the Gow-Gates and the traditional block techniques, draws attention on the reasons advanced for several decades, why anaesthesia cannot be predicted consistently when the solution is deposited at the lingula. It now emphasizes that there are advantages provided by adopting a higher needle pathway above the high vascularity of the neurovascular bundle situated at the lingula.

Yamada and Jastak (55) compared the Gow-Gates and the traditional inferior alveolar block techniques in children whose ages ranged from 4 to 6 years. No premedication was given, the dosage being 1.8ml of lignocaine with 1:100,000 adrenaline being injected in each child.

With the Gow-Gates technique bone was encountered at 18 to 22mm in younger children, and at a greater depth in adolescents. The needle was withdrawn 1 to 2mm from the bone before the injection. The anaesthetic solution was deposited over a period of 20 seconds.

The conventional method used by Yamada and Jastak (55) in this study complied with that described by Sicher (32), where 1.5ml anaesthetic solution was deposited adjacent to the inferior alveolar nerve, and the remaining 0.3ml deposited in the muco-buccal fold distal to the most
posterior mandibular tooth. This was done to anaesthetize the buccal nerve. The same volume of anaesthetic solution was used in both techniques.

Clinically excellent Grade A anaesthesia was obtained in all patients using the Gow-Gates technique. By contrast the traditional block achieved 73% Grade A, 9% Grade B, and 18% Grade C anaesthesia. A pain free injection was executed in 63% of the Gow-Gates, but only 9% of the conventional group. Speed of onset of anaesthesia were not significantly different between the Gow-Gates and conventional patient groups.

It was stated that this study tends to confirm Sanders' statement that the Gow-Gates technique is more reliable and less painful for children than is the traditional mandibular block.

Coleman and Smith reviewed and analysed the anatomy of mandibular anaesthesia according to the Gow-Gates technique. They agreed the generally held concept that the anaesthetic solution should be deposited in close approximation to the inferior alveolar, lingual and buccal nerves for successful anaesthesia does not appear to be a requirement for providing mandibular anaesthesia.

From their dissections they considered the success of the Gow-Gates technique to be due to several anatomic structures and/or biophysical forces; that probably the diffusion is aided by gravity, by the condylar neck restricting the diffusion of the drug posteriorly and by the lateral pterygoid muscle directing the drug inferiorly.

They considered that the incidence of positive aspirations (1.9%) reported by Malamed supported the anatomic observation that sizeable blood vessels at the site of the mandibular neck are a rare anatomic occurrence; that aberrant branches to the mandibular teeth and periodontium arising from major branches of the mandibular trunk high within the pterygo-mandibular space could also be bathed by the nerve blocking drug deposited at the mandibular neck; and that those nerves would probably
escape the drug when it is deposited at the mandibular foramen.

Coleman and Smith (57) also stated that anatomic evidence does not support the view that the drug injected at the mandibular neck could reach the mandibular trunk at the origin of the buccal nerve.

Robertson (58), Malamed (53) and Levy (54) in three separate studies of the Gow-Gates technique used 1.8ml, 1.8ml and 3.0ml of anaesthetic solution and achieved 62%, 68% and 77% anaesthesia respectively in the buccal nerve. It is obvious that increasing the volume of the anaesthetic is an important factor in blocking the buccal nerve. However it is noted that more than 60% of the injections using 1.8ml of anaesthetic solution provide buccal nerve anaesthesia, and that this result is not related to the chair position of the patient.

De Jean and Gregg (59) designed an anatomical study based on the Gow-Gates technique.

Three fresh cadaver heads were used. The mouths were opened in the widest vertical dimension, and a hypodermic needle was inserted to the target area prescribed by the Gow-Gates technique. India ink was then deposited at this target area. With the jaw held open at this widest dimension, the heads were frozen. Sarcosote sections were cut in the plane of the needle. Fig 15 and approximately one centimetre lower Fig 20.

The specimens showed that the dye (India ink) diffused through the pterygo-mandibular space to the inferior alveolar, lingual and buccal nerves. Although no attempt was made to compare the diffusion of suspended carbon particles to local anaesthetic molecules, De Jean and Gregg further stated that it was certainly fair to assume that the local anaesthetic solution would diffuse as readily as India Ink (perhaps even more readily).

The dye apparently diffused down, around, and back up alongside the lower belly of the lateral pterygoid muscle to the inferior alveolar and lingual nerves at the
higher level where they are in close proximity. Their conclusions were that the Gow-Gates technique is effective because diffusion of local anaesthetic solution through the pterygo-mandibular space bathes the nerve trunks as they pass medial and inferior to the lower belly of the lateral pterygoid muscle and as they pass lateral to the medial pterygoid muscle.
DISCUSSION

It has been claimed in this thesis that the Gow-Gates mandibular block technique is a predictable method for providing pulpal anaesthesia in the mandible.

It is associated with an insignificant failure rate\(^{(3)}\) and confirmed by the experience of American Dental Educators, gained from its exposure to undergraduates and dentists since its adoption in 1974.

Their results are based on dosage of 1.8ml, and it is the author's experience that whilst there is barely any statistical difference by the increase to 2.2ml, that the extra 0.4ml increases the depth of anaesthesia obtained irrespective of which anaesthetic solution is used. It is also recommended that 3.3ml of 4% plain prilocaine be adopted as the dose of anaesthetic solution for apprehensive patients or those with acute inflammatory conditions. The importance of increased volume by clinical observation of the author in using this technique since 1947, is confirmed by Schilli\(^{(65)}\) who refers to the reduction in the concentration of the solution as it diffuses away from the primary injection site. This also is highlighted by the attainment of 62% adequate anaesthesia in the buccal nerve using 1.8ml\(^{(54)}\) as to be expected since the buccal nerve at the temporalis muscle is in excess of 20mm from the injection site at the condylar neck.

It has been anatomically verified that diffusion of the anaesthetic solution after injecting 3.3ml of 4% prilocaine without vasoconstrictor extends anteriorly as far as the buccinator muscle, as well as to the medial side of the lateral pterygoid muscle, and will 'flood' the pterygo-mandibular space.\(^{(59)}\)

This demonstrates the remarkable co-operation of nature that despite the injection site being so removed from the respective nerve membranes, a relatively avascular site with favourable fascial planes permits
the diffusion of the anaesthetic solution so that all oral branches of the sensory components of the mandibular nerve are exposed to the anaesthetic solution and that the deposition of anaesthetic solution against individual nerves in multiple injection sites is unnecessary.

This prevents a breakdown of the block which may occur by depositing the solution at the nerve membrane where an inadequate segment of the nerve may be exposed resulting in the impulses 'jumping' across the solution and leading to partial or complete breakdown of the block.\(^{(18)}\)

The effectiveness of the block will materially depend on the expertise to position the needle and deposit the solution at the condylar neck, and it is advocated that the rate of injecting the solution should not exceed \(1 \text{ml} \) in 30 seconds. No studies are available to indicate the increase in tissue pressure with the injection at this site, but it has been observed that less resistance is encountered than when the solution is deposited at the lingula, indicating the more potentiable distendable part of the pterygo-mandibular space.

This region between the vascular part of the lingula neurovascular bundle and the ramus contains fat\(^{(3)}\) extending to the injection site below the insertion of the lateral pterygoid muscle. A reduction in tissue pressure in a relatively avascular injecting site to that of lingula, minimizes any loss into the circulation, and maximizes the concentration of the solution at the nerve membrane thus potentiates the blocking of sensory transmission.

Infiltration techniques are not necessary to reinforce pulpal anaesthesia with the Gow-Gates Block. There has never been any worth while anatomical or physiological evidence to support a widespread belief in the existence of decussation of inferior alveolar fibres to innervate contra-lateral incisor pulps.\(^{(29)}\) This fallacy may have originated in the frequent failure of traditional
inferior alveolar block techniques to produce satisfactory anaesthesia of ipse-lateral incisors. It is not necessary to block contra-lateral inferior alveolar nerves to remove the pulps from lower incisor teeth with the adoption of the lateral side of the anterior surface of the condyle as the injection site. However 'time' as well as an adequate concentration and volume are important components to potentiate the adequacy of the new block.

A well recognized dental problem associated with the traditional block technique has been the failure to consistently provide pulpal analgesia in the third molar. This has not been the experience with the Gow-Gates block, as it is the first tooth in the segment exposed to the solution. Fig.18.

Reference was made by Najjar to the effect of inflammation on the nerve membrane, and it is advisable to premedicate the patient with antibiotics, as well as raising pain threshold with sedatives, in such cases.

Initial pain is a transient discomfort which is experienced by the patient when the anaesthetic solution is at first injected. Whereas 4.6% initial pain has been reported with the injection of 3% prilocaine with 1:300,000 epinephrine, this has not been observed when depositing the solution at the condylar neck. Yamada and Jastak claimed that there was an absence of initial pain even using epinephrine with the Gow-Gates block.

Possibly an explanation may be due to the reduction in the incidence of vascular penetration. It is required that the effusion of blood in the tissues result in the release of biogenic substances as serotonin being considered as the most powerful vasoconstrictor agent as well as a pain producing agent in a man. The proliferation of these vasoactive substances lies in the capillary bed and affect the sensory receptors.

The elimination of the vasoconstrictor from the anaesthetic solution contributes to the patient's comfort and reduces complications arising from the cardiovascular system.
The avoidance of the lingula neurovascular bundle also prevents trismus arising from the medial pterygoid muscle a common occurrence with the traditional block injection.

Though the incidence of hypersensitivity to local anaesthesia is low, there is the occasional patient who has a history of allergic response to the anaesthetic agent.

The dentist is confronted with the problem of ascertaining whether the reaction is due to:

1. An underlying systemic cause that could have intensified an adverse reaction.
2. Was the reaction truly an allergic reaction, or due to drug toxicity, or due to a syncopal episode.
3. Whether the analgesic is an ester or an amide.
4. Did the solution that was administered contain chemicals such as methylparaben.

Methylparaben, a preservative in the amide type of local anaesthetic solutions has been associated with some cases of allergic reactions, and as it is used in ointments, creams, lotions, dentifrices, the patient should be questioned on whether there is a history of sensitivity to their use. (66)

A feature of considerable importance is the sensation of solid resistance when the needle encounters the bony neck of the condyle after having passed smoothly through the fatty tissue above the neurovascular bundle. This is not the sensation of deflection often experienced when the needle meets bone at an acute angle at the lingula approach techniques, but a sudden halt to the previous unimpeded progress of the needle.

It is in this feature that the greatest safety factor of the Gow-Gates technique lies.

THE SOLUTION IS NOT INJECTED UNLESS THE NEEDLE POINT IS RESTING AGAINST THE BONY CONDYLAR NECK.

No case of facial paralysis or any similar phenomenon has been reported as a consequence of the Gow-Gates
technique, when carried out properly.

Numerous clinicians volunteered that the modest outlay of time and effort required to master this technique is amply rewarded by the confidence in having a safe and reliable method of controlling pain in the mandible.
SUMMARY

The advantages of the Gow-Gates Mandibular Block Technique are related to depositing an adequate volume of an anaesthetic solution in one position on the lateral side of the anterior surface of the condyle. This area being relatively avascular permits the use of 4% prilocaine without epinephrine, and whilst eliminating complications arising from epinephrine, still provides a longer duration of anaesthesia than the inferior alveolar block injection.

The higher regions of the pterygo-mandibular space above the neurovascular bundle is a relatively painless, safe anatomical pathway when using extra oral and intra oral landmarks.

The avoidance of involving the medial pterygoid muscle eliminates the major cause of trismus. The reduction in the incidence of positive aspirations is emphasized by the prevention of haematoma formation.

The clinician is provided with an injection site that permits the identification of knowing by tactile sensation that the needle is correctly placed and preventing the needle from advancing into the parotid gland.

This technique is a radical departure from the existing inferior alveolar block technique since there is no requirement to deposit the anaesthetic solution in the vicinity of neural tissue despite the injection site so far removed to the nerve trunks.

The evidence of centrifugal diffusion is in accord to the submissions of De Jong, and although it has been established that pain threshold is elevated before signs
of paraesthesia in the lip, it must be remembered that
time is an important component of the new technique,(18)
and that consideration must be given to time to permit
the diffusion of the anaesthetic solution to saturate
the entire nerve trunk.

The supine position of the patient equates the
effect of gravity on the circulation and assists in
preventing syncope.

The simplicity of mastering the technique has
been indication in American Dental Schools as it is
stated that "A new student in Local Anaesthesia does
not encounter the same difficulty as does the more
experienced administrator".
CONCLUSION.

The merit of a particular technique for pain control becomes apparent after repetitive studies based on subjective findings from unrelated clinical reports by independent investigators.

Studies of the author's experiences since 1947 have indicated the advantages of utilizing the higher regions of the pterygo-mandibular space above the neurovascular bundle.

The evolution of the technique, its subsequent investigation and evaluation by those with the clarity of mind and lack of bias, is again further evidence of man's search for Truth and Perfection.

The acceptance by American Educators of the technique, the exposure to undergraduates and graduates has demonstrated the advantages in overcoming local and systemic complications and a predictable method of providing pulpal and soft tissue anaesthesia in the mandible.
### TABLE 1.
RESULTS OF ASPIRATION TESTS.

**Positive aspirations injecting at the lingula.**

<table>
<thead>
<tr>
<th>Author</th>
<th>Percentage</th>
<th>Cases</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harris (70)</td>
<td>3.6%</td>
<td>3085</td>
<td>1957</td>
</tr>
<tr>
<td>Forrest (71)</td>
<td>4.2%</td>
<td>577</td>
<td>1959</td>
</tr>
<tr>
<td>Schiano and Strambi (72)</td>
<td>11.0%</td>
<td>702</td>
<td>1964</td>
</tr>
<tr>
<td>Bartlett (73)</td>
<td>11.7%</td>
<td>944</td>
<td>1972</td>
</tr>
<tr>
<td>Corkery and Barrett (74)</td>
<td>16.8%</td>
<td>214</td>
<td>1973</td>
</tr>
<tr>
<td>Adams and Mount (63)</td>
<td>18.0%</td>
<td>94</td>
<td>1976</td>
</tr>
</tbody>
</table>

**Positive aspirations injecting at the condylar neck.**

<table>
<thead>
<tr>
<th>Author</th>
<th>Percentage</th>
<th>Cases</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gow-Gates *</td>
<td>1.6%</td>
<td>3000</td>
<td>1974</td>
</tr>
<tr>
<td>Panuska (56)</td>
<td>Nil</td>
<td>1201</td>
<td>1979</td>
</tr>
<tr>
<td>Malamed (15)</td>
<td>1.9%</td>
<td>4275</td>
<td>1980</td>
</tr>
</tbody>
</table>

* Unpublished.
TABLE 2.
VARIOUS Heights OF PLANES PARALLEL TO THE
OCCLUSAL PLANE ABOVE THE LINGULA. (21)

<table>
<thead>
<tr>
<th>Highest level Maximum in mm.</th>
<th>Cumulative number of cases</th>
<th>Per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>62</td>
<td>15.5</td>
</tr>
<tr>
<td>3</td>
<td>169</td>
<td>42.4</td>
</tr>
<tr>
<td>5</td>
<td>252</td>
<td>63.2</td>
</tr>
<tr>
<td>7</td>
<td>311</td>
<td>77.9</td>
</tr>
<tr>
<td>9</td>
<td>360</td>
<td>90.2</td>
</tr>
<tr>
<td>11</td>
<td>380</td>
<td>95.2</td>
</tr>
<tr>
<td>13</td>
<td>391</td>
<td>98.2</td>
</tr>
<tr>
<td>15</td>
<td>396</td>
<td>99.2</td>
</tr>
<tr>
<td>17</td>
<td>398</td>
<td>99.7</td>
</tr>
<tr>
<td>19</td>
<td>399</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Refer to Fig. 3 page 81.
**TABLE 3.**

DEPTH OF INSERTION OF NEEDLE FROM THE PUNCTURE POINT TO THE NECK OF THE CONDYLE*

<table>
<thead>
<tr>
<th>Depth of Penetration (mm)</th>
<th>No. of Cases</th>
<th>Percentages of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>1</td>
<td>0.09</td>
</tr>
<tr>
<td>20</td>
<td>14</td>
<td>1.26</td>
</tr>
<tr>
<td>21</td>
<td>13</td>
<td>1.16</td>
</tr>
<tr>
<td>22</td>
<td>12</td>
<td>1.08</td>
</tr>
<tr>
<td>23</td>
<td>53</td>
<td>4.77</td>
</tr>
<tr>
<td>24</td>
<td>175</td>
<td>15.74</td>
</tr>
<tr>
<td>25</td>
<td>398</td>
<td>35.79</td>
</tr>
<tr>
<td>26</td>
<td>262</td>
<td>23.56</td>
</tr>
<tr>
<td>27</td>
<td>129</td>
<td>11.60</td>
</tr>
<tr>
<td>28</td>
<td>48</td>
<td>4.32</td>
</tr>
<tr>
<td>29</td>
<td>7</td>
<td>0.63</td>
</tr>
</tbody>
</table>

|              | 1112        | 100%                 |

* Gow-Gates Mandibular Block
<table>
<thead>
<tr>
<th>Technique</th>
<th>No. of Patients</th>
<th>Ages</th>
<th>Anaesthetic Solution</th>
<th>Average Time #</th>
</tr>
</thead>
<tbody>
<tr>
<td>A New Block</td>
<td>55</td>
<td>9-67 yrs</td>
<td>2.2ml, 3% Prilocaine (1:300,000 Epinephrine)</td>
<td>143.3 secs.</td>
</tr>
<tr>
<td>B New Block</td>
<td>100</td>
<td>7-61 yrs</td>
<td>2.2ml, 4% Prilocaine</td>
<td>135.6 secs.</td>
</tr>
<tr>
<td>A Traditional(64) Block</td>
<td>83</td>
<td>7-60 yrs</td>
<td>2.2ml, 3% Prilocaine (1:300,000 Epinephrine)</td>
<td>71.1 secs.</td>
</tr>
<tr>
<td>A Traditional(65) Block</td>
<td>60</td>
<td>8-36 yrs</td>
<td>2.2ml, 3% Prilocaine (1:300,000 Epinephrine)</td>
<td>71.4 secs.</td>
</tr>
</tbody>
</table>

* Gow-Gates Mandibular Block
** Inferior Alveolar Block
# See pages No. 46,47.
<table>
<thead>
<tr>
<th></th>
<th>Molar</th>
<th>Canine/Mental Foramen</th>
<th>Incisor</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Block Technique*</td>
<td>126 secs.</td>
<td>135 secs.</td>
<td>143.4 secs.§</td>
</tr>
<tr>
<td>Traditional Technique**</td>
<td>201 secs.</td>
<td>126 secs.</td>
<td>71 secs.§</td>
</tr>
</tbody>
</table>

Average time in seconds from zero time for both probing and tapping tests.

Probing tests were carried out on the lingual gingival tissue for both techniques. It was noticed, however, that anaesthesia of the buccal gingival tissue also occurred when testing the new technique which was not the case with the traditional technique.

* Gow-Gates Mandibular Block
** Inferior Alveolar Block
§ See page 46 for range of onset time.
TABLE 6.  

- DEGREE OF CHANGED SENSATION 
- NEW BLOCK TECHNIQUE (Study II)*

<table>
<thead>
<tr>
<th>Changed Sensation</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>2</td>
</tr>
<tr>
<td>Moderate</td>
<td>7</td>
</tr>
<tr>
<td>High</td>
<td>6</td>
</tr>
<tr>
<td>Very High</td>
<td>3</td>
</tr>
</tbody>
</table>

* Gow-Gates Mandibular Block

§ Signs of tingling sensation of the lower lip.
<table>
<thead>
<tr>
<th>Anaesthetic solution</th>
<th>Volume</th>
<th>Number of Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Experimental groups</td>
</tr>
<tr>
<td>3% prilocaine with adrenaline 1:300,000</td>
<td>2.2ml</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3% prilocaine with felypressin§</td>
<td>2.2ml</td>
<td>63</td>
</tr>
</tbody>
</table>

* Gow-Gates Mandibular Block
** Inferior Alveolar Block
§ 0.003 Internat. Units per ml.
<table>
<thead>
<tr>
<th>Grade of Anaesthesia</th>
<th>Experimental Group*</th>
<th></th>
<th>Control Groups**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>A</td>
<td>56</td>
<td>98.2</td>
<td>49</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>1.8</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>57</td>
<td>100</td>
<td>60</td>
</tr>
</tbody>
</table>

* Gow-Gates Mandibular Block
** Inferior Alveolar Block
TABLE 9. -- Results of trial using 2.2ml of 3% prilocaine with felypressin.*(Study IV)

<table>
<thead>
<tr>
<th>Grade of Anaesthesia</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
</tr>
<tr>
<td>A</td>
<td>62</td>
<td>98.4</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>63</td>
<td>100</td>
</tr>
</tbody>
</table>

* 0.003 Internat. Units per ml.
TABLE 10.

ONSET: TIME (Comparison of volume of 4% Prilocaine anaesthetic solution using the new technique) (Study V)

<table>
<thead>
<tr>
<th>No. of Patients</th>
<th>Ages (Yrs)</th>
<th>Volume</th>
<th>Average Time(secs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study I B</td>
<td>100</td>
<td>7-61</td>
<td>2.2ml</td>
</tr>
<tr>
<td>Study V</td>
<td>90</td>
<td>14-62</td>
<td>3ml</td>
</tr>
</tbody>
</table>

NOTE No vasoconstrictor used.
ILLUSTRATIONS
FIG. 1. INJECTION SITE AT THE LINGULA.

Traditional inferior alveolar block techniques select the lingula and the neurovascular bundle for depositing the anaesthetic solution.
FIG. 2. HISTOLOGY OF TISSUES AT THE LINGULA. 
(by Watson\textsuperscript{3}).

The photo micro-graph shows the histology 1mm above the lingula in the horizontal plane. (antero-posterior section X30).

1. The inferior alveolar nerve.
2. The inferior alveolar artery.
4. Veins.
FIG. 3. HEIGHT OF PLANES DETERMINED BY BOTH TECHNIQUES.

The apex of the buccal pad is normally 10mm above the occlusal plane, and since the height of the lingula may be as high as 19mm, above the occlusal plane using the buccal pad as a landmark for the insertion of the needle, will place it below lingula in 4.8% of cases. (21)
FIG. 4. SUPPLEMENTARY INNERVATION OF THE MANDIBLE.
(Medial surface.)

Dissection by Reynolds\(^{(27)}\) demonstrating a branch from the auriculo-temporal nerve which may, or may not be incorporated within the sheath of the inferior alveolar nerve entering the mandibular foramen.
FIG. 5. EXTRA-ORAL AND INTRA-ORAL LANDMARKS.

The Extra-Oral Landmarks are the lower border of the tragus and the Alpha plane extending through both corners of the mouth. The syringe must be aligned with this plane. The apex of the intertragic notch determines the height for the insertion of the needle, as also the intersection of the Alpha plane with the medial side of the deep tendon of the temporalis muscle.

The Intra-Oral landmark is close to the tendon of the temporalis muscle and its co-ordination with the above extra oral landmarks and the Beta plane (Fig. 6) provides the correct orientation to the placement of the needle at the lateral side of the anterior surface of the condyle.
FIG. 6. REFERENCE PLANES USED GIVE CORRECT ORIENTATION OF THE NEEDLE.

1. Alpha plane extending from the external auditory meatus.
2. Beta plane extending from the surface of the tragus.
3. Delta plane extending through the condylar surfaces.
4. Gamma plane extending through the coronoid process.

The Alpha and Beta planes give the vertical and lateral direction of the needle respectively. The Gamma and Delta planes determine the penetration of the needle, and the tactile sensation of the needle impacting the bone on the Delta plane prevents misdirecting the needle and enables the clinician to realize that the needle is where it rightly belongs when integrated with the other landmarks.
FIG. 7. RELATIONSHIP OF THE BETA PLANE TO THE SAGITTAL PLANE.

Diagramatic demonstration of the Beta plane formed by the angulation of the tragus with the sagittal plane. This provides an arbitrary assessment of the ramus of the mandible and gives the correct lateral direction of the needle.
FIG. 8. EXTERNAL AUDITORY MEATUS AS THE EXTRA ORAL LANDMARK.

The patient's finger is placed in the external auditory meatus, the clinician holds the mouth opened as wide as possible with the finger, the syringe is held over the canine or bicuspid teeth and maintained in the Alpha plane as it is advanced slowly towards the centre of the patient's finger until bone is impacted. The penetration of the needle must not advance beyond 27mm.
FIG. 9. PUNCTURE POINT.

Needle aligned with landmarks determined by a template.

1. Template.
2. Puncture point corresponding to 3.
3. Landmark for assessing height of needle insertion.
4. Landmark for indicating the lower border of the tragus.
FIG. 10. TEMPLATE DEMONSTRATING THE ALPHA PLANE.

Lateral view showing the needle aligned with the template which is placed on the Alpha plane. The clinician's forefinger exerts pressure over the incisal teeth to ensure a wide open mouth position.

The template is a wire with the extremities bent at right angles in rectangular form. The placement of rubber tubing enables the clinician to assess the height for insertion of the needle and its direction to the lower border of the tragus when parallel to the Alpha plane.
FIG. 11. RADIOGRAPH SHOWING NEEDLE AT THE LATERAL SIDE OF THE CONDYLE.

The needle pathway in relation to the Sigmoid notch, the upright position of the ramus and the surface of the injection site.
FIG. 12. ENTRANCE INTO THE PTERYGO-MANDIBULAR SPACE. (Frontal section.)

The entrance is a cleft approximately 2.2mm wide. The needle should be placed as close as possible to the deep tendon of the temporalis muscle just below the tuber of the maxilla.
FIG. 13. HIGH NEEDLE PATHWAY TO THE INJECTION SITE.

1. Maxillary artery.
2. Inferior alveolar nerve.
3. Lateral pterygoid muscle.
FIG. 14. INJECTION SITE AT THE CONDYLANE NECK.

1. Maxillary artery.
2. Inferior alveolar nerve.
3. Lateral pterygoid muscle.
4. Injection site at the condylar neck.
5. Deep tendon of the temporalis muscle.
FIG. 15. DIFFUSION OF THE ANAESTHETIC SOLUTION USING BLUE DYES AT CONDYLAR NECK.
(Horizontal section.)

Study carried out by Gregg & De Jean (59) demonstrates that dispersion of an anaesthetic solution deposited at the lateral side of the condyle extends on the lower side of the medial surface of the lateral pterygoid muscle and as far anteriorly as the buccinator muscle.

"Flooding" the region blocks all oral branches of the mandibular nerve. As the buccal nerve is distant to the injection site, it is obvious that an adequate volume and concentration of the solution is important to block sensory conduction.

Note that the Masseter and Temporalis muscles 'bulge' medially in the wide open mouth position.
FIG. 16. HISTOLOGY OF TISSUES AT THE INJECTION SITE AT THE LATERAL SIDE OF THE CONDYLE.

The photo micro-graph shows the histology 1mm from the condyle in the coronal plane. (Frontal section X30).
1. Lateral pterygoid muscle and its tendon.
2. Loose areolar fatty connective tissue.
Same magnification as in Fig. 2.
FIG. 17. MODE OF SPREAD OF ANAESTHETIC SOLUTION IN THE MANDIBLE.

1. Centrifugal spread of anaesthesia in the Gow-Gates mandibular block technique.
2. Centripetal spread of anaesthesia in the inferior alveolar block technique.
FIG. 18. GRAPH SHOWING PROGRESSIVE ONSET OF ANAESTHESIA.

The above graph shows the membrane potential and pain threshold prior to and after the injection of 3ml of 4% prilocaine without vasoconstrictors. The increased stimulus voltage required to produce a response after the injection indicates the progression of anaesthesia along the inferior alveolar nerve.

This is in accord with the concept of De Jong who states (18) that the proximal areas (molar teeth) are supplied by fibres from the mantle bundles, and that the distal region (central teeth) are supplied by fibres from the central core bundles of the nerve trunk. See Fig. 19.
FIG. 19. DIAGRAMATIC REPRESENTATION OF THE
DISPOSITION OF FIBRES IN THE NERVE TRUNK\(^{18}\)

1. Mantle Bundles.
2. Central Core Bundles.
FIG. 20. DIFFUSION OF ANAESTHETIC SOLUTION
1 CENTIMETRE BELOW CONDYLAR NECK.
(Horizontal section just above the lingula.)

Note the more lateral and linear dispositions of the nerve trunks. It was shown that the anaesthetic solution diffused along the medial side of the lower part of the lateral pterygoid muscle.
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BIBLIOGRAPHY


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PUBLICATIONS

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Jastak J.T., Regional Anaesthesia of the Oral Cavity.

Shane S.M.E., Principles of Sedation, Local and General Anaesthesia in Dentistry.


C. Films:

War Veterans Administration of America.
University of Southern California.
University of Texas Science Center.
University of Sydney.
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University of Pennsylvania.
MANDIBULAR CONDUCTION ANESTHESIA: A NEW TECHNIQUE USING EXTRAORAL LANDMARKS

GEORGE A. E. GOW-GATES
Parramatta, New South Wales, Australia

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Mandibular conduction anesthesia: A new technique using extraoral landmarks

George A. E. Gow-Gates, Parramatta, New South Wales, Australia

It is recognized that some failures can be anticipated when one endeavors to secure mandibular anesthesia by means of the current techniques. Various reasons have been given to explain this small but significant failure rate: (1) Deposition of the solution at a level below the mandibular foramen—Bremer demonstrated that no known landmark in common use consistently determined the correct height for depositing an anesthetic solution above the lingula of the mandible and that the use of the apex of the buccal pad, coronoïd notch, or the bisecting of the nail of the index finger resting on the occlusal plane as a level for the puncture point will produce failures in at least 5 per cent of the cases. (2) The presence of supplementary innervation from the auriculotemporal, the mylohyoid, or possibly the cutaneous colli nerves (transverse cutaneous nerve of the neck). (3) Unsatisfactory dosage of anesthetic—the usual 2 ml. of anesthetic is inadequate in no less than 15 per cent of cases.

The technique described in this article uses external landmarks whereby the needle is directed to a higher puncture point, thus ensuring an adequate height for depositing the solution above the lingula. The following extraoral landmarks provide a consistent guide for directing the needle to a desirable height above the lingula:

1. The puncture point lies in the plane extending from the lower border of the intertragic notch (Fig. 1) of the ear through the corners of the mouth.

2. The tragus of the ear is the external landmark toward which the needle is directed.

3. The angulation of the ear to the side of the face is used as a guide for assessing the divergence of the ramus of the mandible from the sagittal plane.

TECHNIQUE

The patient is seated in the chair with the headrest adjusted so that the face is in a horizontal plane (Fig. 2). The intertragic notch thus presents an
Fig. 1. 1, Target area on tragus. 2, Plane from lower border of intertragic notch to corners of mouth. 3, Anti-tragus.

Fig. 2. Patient’s face in horizontal position showing needle aligned with plane from lower border of intertragic notch to corners of the mouth. Needle is directed to target area on tragus.

upward inclination. The operator is situated in front and to the side of the patient, who is instructed to open the mouth as widely as possible so that the condyle assumes a more frontal position and is in a closer relationship to the mandibular nerve. The head is inclined slightly toward the operator, thus enabling him to correlate the puncture point with the external landmarks. The operator may be either standing or seated. If the injection is for the right side of the patient, the syringe is held in the right hand between the thumb and the forefinger, while the forefinger of the left hand distends the cheek. It is convenient to gain support and steady the syringe by resting the little finger of the right hand against the face. For the left side, the procedure is reversed. The puncture point is lateral to the pterygotemporal depression but medial to the tendon of the temporal muscle. It lies in the plane extending from the lower borders of the right and left intertragic notches through the corners of the mouth (Fig. 3). The needle is aligned with this plane, then paralleled with the angulation of the ear to the face and directed toward the target area on the tragus of the ear (Fig. 1). The syringe usually lies over the incisal edge of the cuspid on the opposite side of the mandible but can vary either anteriorly or posteriorly according to the divergence of the ramus as assessed by a study of the angulation of the ear to the side of the face. If the lower part of the ear appears to be well concealed when viewed from the midline position, this would
Fig. 3. View of retromolar area showing height and position of puncture point. Obvious is the higher level and more lateral position of the needle than in current techniques.

Fig. 4. Lateral cephalogram showing height and position of the needle at the base of the neck of the condyle with the use of extraoral landmarks.

suggest that the ramus is not greatly divergent and that, consequently, the syringe (being parallel to the plane of the ear) will be placed more anteriorly. On the other hand, if the ear appears to be very prominent, the indication is that the ramus is more divergent and the syringe will be posterior to the cuspid. The needle will penetrate the mucosa as close as possible to the anterior border of the ramus (which is palpated with the forefinger) and yet sufficiently medially to avoid the medial tendon of the temporal muscle. The farther medially the injection is made, the greater will be the depth of insertion. The needle is then advanced toward the target point on the tragus (Fig. 1). Care has to be taken that the needle is not aimed too far superiorly and laterally; other-
wise, it may enter the sigmoid notch. The needle is advanced through the buccinator muscle and passes into the pterygomandibular space, which has on its medial side the pterygomandibular ligament and the medial pterygoid muscle. On the lateral side of the space lies the tendon of the temporal muscle and the ramus the roof of the space is formed by the lateral pterygoid muscle. In the anterior part of this space lies the lingual nerve, and farther posteriorly the inferior alveolar nerve passes downward. Penetration of the needle produces little or no pain because of the absence of terminal nerve endings. The needle comes to rest at the neck of the mandible at the commencement of the sulcus colli as indicated in the radiograph (Fig. 4). Just anterior and superior to this point, the inferior alveolar, lingual, and buccal nerves are united as a common trunk (Figs. 5 and 6). The fact that the posterior wall of the sulcus colli is concave enables the operator to positively palpate bone and thus to know that he has reached the desired position. However, if bone cannot be palpated when the needle has penetrated to a depth of 25 mm., this could indicate that the syringe has been placed either too far medially, showing that the divergence of the ramus has not been correctly determined, or too far laterally and too high and thereby entering the sigmoid notch.

In my experience, however, with the use of the visible extraoral landmarks described as guides for directing the needle, the possibility of entering the sigmoid notch is remote. When bone is encountered, the needle is withdrawn slightly, an aspiration test is performed, and the anesthetic solution is deposited (with gentle pressure) in this position as rapidly as possible without causing pain to the patient. Since the condyle is in a more forward position when the mouth is open, the mouth should remain open for some 20 seconds, so that
the straightened mandibular nerve is bathed in the pool of anesthetic solution. This solution also diffuses throughout the interpterygoid fascial pouch, thus blocking supplementary innervation in the condyle region, spreading forward under pressure to reach the buccal nerve.

**DISCUSSION**

Bremer states that various landmarks as taught do not always provide an adequate height for carrying the point of the needle above the tip of the lingula, thus resulting in failure to secure profound anesthesia of the mandible. To confirm this hypothesis, he carried out measurements on 400 mandibles, and found that the height of the lingula above the occlusal plane ranged from 1 to 19 mm. (Fig. 7).

Measurements of heights of planes on 400 mandibles passing through the lingula and parallel to the occlusal plane are given in Table I. According to this table, a needle placed 3 mm. above the occlusal plane and parallel to it would lie above the lingula in 42 per cent of the cases and below it in 58 per cent of the cases, whereas if the needle is placed 11 mm. above the occlusal plane, it would lie above the lingula in 95 per cent of the cases and below it in
Fig. 7. Illustrated are various heights of planes measured by means of current techniques compared with that provided by using extroral landmarks. Height of apex of buccal pad is normally 10 mm. above the occlusal plane.

Table I

<table>
<thead>
<tr>
<th>Highest level maximum in mm.</th>
<th>Cumulative number of cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>62</td>
<td>15.5</td>
</tr>
<tr>
<td>3</td>
<td>169</td>
<td>45.4</td>
</tr>
<tr>
<td>5</td>
<td>332</td>
<td>83.2</td>
</tr>
<tr>
<td>7</td>
<td>311</td>
<td>77.2</td>
</tr>
<tr>
<td>9</td>
<td>360</td>
<td>90.2</td>
</tr>
<tr>
<td>11</td>
<td>380</td>
<td>95.3</td>
</tr>
<tr>
<td>13</td>
<td>391</td>
<td>98.3</td>
</tr>
<tr>
<td>15</td>
<td>396</td>
<td>99.2</td>
</tr>
<tr>
<td>17</td>
<td>398</td>
<td>99.7</td>
</tr>
<tr>
<td>19</td>
<td>399</td>
<td>100.0</td>
</tr>
</tbody>
</table>

5 per cent of the cases. The significance of these measurements indicates the unreliability of the occlusal plane as a guide to the height of the lingula.

Jorgensen and Haydon6 also state that a plane through the deepest point on the anterior border of the ramus and parallel to the occlusal plane is not a reliable guide for the placement of the needle above the lingula.

When the conventional mandibular injection technique is employed, satisfactory anesthetization of individual teeth is not always achieved, even though conduction along the inferior alveolar nerve trunk is apparently completely blocked. The explanation of this phenomenon is said to lie in the presence of small twigs which depart from the main nerve trunk proximal to the area of the lingula, and pass to tooth apices via their own individual rontos.4

The technique described in this paper effectivelly anesthetizes the entire distribution zone of the sensory component of the mandibular division of the trigeminal nerve. The needle point during injection is situated in such a way that the anesthetic solution (under gentle pressure) bathes the mandibular nerve and its branches within the confines of the interpterygoid fascial pouch. Onset
of anesthesia is rapid and extends buccally and lingually as far anteriorly as the region of the distal surface of the central incisor. This does not occur with standard techniques, although, on anatomic grounds, it should be expected.

Various authors have stated that some failures can be attributed to an inadequate quantity of anesthetic solution and resistance to anesthesia. I have consistently used 2.2 ml of 2 per cent lignocaine (lidocaine) hydrochloride with 1:80,000 epinephrine. The technique described has been used far in excess of 50,000 cases, and has resulted in a reduction in the failure rate to a negligible number.

The technique may be summarized as follows:

1. The head is placed in a horizontal position so that the intertragic notch assumes an upward inclination. The face is turned slightly toward the operator in order to allow visual correlation of the puncture point with the external landmarks.
2. The mouth is opened as widely as possible.
3. The anterior border of the ramus is palpated with the forefinger.
4. The region of the puncture point is dried and is painted with the antiseptic solution and topical anesthetic.
5. The puncture point will lie on the lateral margin of the pterygo-mandibular depression and just medial to the medial tendon of the temporal muscle.
6. The needle is aligned with the plane that extends from the lower borders of the intertragic notches through the corners of the mouth, and is also parallel to the angulation of the ear to the face.
7. The needle is aimed at the posterior border of the tragus and advanced. The depth of penetration will be approximately 25 mm.
8. Bone will be palpated at the base of the neck of the condyle; then the needle is withdrawn 1 mm.
9. Aspiration is performed and the solution is rapidly deposited in the one position.
10. The mouth is kept open for another 20 seconds in order to permit diffusion of the anesthetic solution.

SUMMARY

A technique of mandibular nerve block is described which uses a more lateral approach at a higher level than those techniques currently used, in order to enable the deposition of anesthetic solution on the one position at the neck of the condyle, thereby anesthetizing the inferior alveolar, lingual, buccal, and supplementary nerves simultaneously. The technique makes use of extraoral landmarks.

I gratefully acknowledge the assistance given by Professor M. Jolly, Department of Oral Medicine and Oral Surgery; Professor B. Barker, Department of Anatomy, University of Sydney; Dr. A. O'Meara, Research Graduate, Department of Preventive Dentistry; and Dr. J. Watson, Department of Anatomy, University of Sydney Dental Health Education and Research Foundation Scholar for 1972.
Appendix: Some anatomic aspects of the Gow-Gates technique for mandibular anesthesia

John E. Watson, B.D.S., M.D.Sc., *Sydney, Australia

DEPARTMENT OF ANATOMY, UNIVERSITY OF SYDNEY

The almost invariable success of this technique in anesthetizing the buccal nerve, together with other major divisions of the mandibular nerve trunk, probably revolves around two factors:

1. The extreme forward position of the condyle (the neck of which is the target area for the needle) in the wide-open mouth position. The point of the needle during injection is thus much closer to the mandibular nerve trunk and, hence, the root of the buccal nerve than anatomy texts or dissected specimens would suggest. Standard textbooks are necessarily preoccupied with "anatomic position"; in this case, the mandibular position in which the condyle rests is the glenoid fossa.

*University of Sydney Dental Health Education and Research Foundation Scholar for 1972.
2. The restricting influence of the interpterygoid fascia that prevents virtually completely the medial diffusion of the anesthetic solution, which must then diffuse predominantly in the sagittal plane, as far as the anterior and posterior limits of the interpterygoid fascia.

The presence of the interpterygoid fascia, a sagittally oriented sheet of connective tissue, is probably important in another respect. The point of the needle must occasionally damage one or more components of the pterygoid venous plexus, a notoriously fragile structure. The absence of overt clinical signs of internal hemorrhage, as observed by the originator of this technique, suggests that any occasional hemorrhage is limited by the constraining influence of the interpterygoid fascia, thus rendering any bleeding clinically insignificant. In this connection, it is worth noting that Sieker and Du Brul\(^1\) attribute the rapid and alarming swelling, which not infrequently accompanies maxillary tuberosity block, to the rupture of the posterosuperior alveolar artery (or a branch thereof) and not the pterygoid venous plexus. The close proximity of two small arteries to the injection target zone should not be overlooked. Posterior to the mandibular nerve trunk lies the small accessory meningeal artery, and posterior to that again is found the larger middle meningeal artery. The possibility that the point of the needle will strike one of these, especially the former, cannot be precluded. The reported absence of detectable hemorrhage resulting from the use of this technique may be attributed to the relatively greater resilience and robustness of arteries than of veins and the difficulty of impaling those arteries, whose freedom to move is not restricted in some way. With regard to the not uncommon rupture of the posterosuperior alveolar artery, it is probable that the tortuous configuration of this artery, together with its indelastic periosteal investment, makes this vessel especially vulnerable in attempted tuberosity block anesthesia. These circumstances do not apply to the two meningeal arteries mentioned. In the apparently rare case in which a meningeal artery is actually ruptured, the restricting factors previously discussed no doubt operate to prevent extensive extravasation of blood.

The technique, by virtue of its reported consistent success with the buccal nerve, has the advantage of not requiring a separate injection for this nerve. Because of the variable depth at which the nerve may be found in the area in which it is approached in the standard buccal injection technique, some penetration of the temporalis muscle or tendon is usually involved. In this region, the temporalis is normally quite tough and dense, and penetration by the needle often produces subsequent tenderness in the muscle. Another possible explanation for the relative absence of postclinical muscular tenderness in the Gow-Gates technique lies in the triangular form of the entrance to the corridor through which the needle must pass in order to reach the mandibular nerve or the inferior alveolar nerve. In the wide-open mouth position, this entrance is in the shape of a narrow triangle with the apex pointing downward, being bounded laterally by the medial tendon of the temporalis muscle, medially by the anterior border of the medial pterygoid muscle, and superiorly by the lateral pterygoid muscle. Because the triangle is slightly broader above than below, it follows that, other factors being equal, the more superior approach
advocated by Gow-Gates involves less risk of impinging upon the temporalis or medial pterygoid muscles. Because of individual anatomic variation, the standard technique occasionally involves piercing one of these muscles, thus leading to postclinical tenderness.

REFERENCE

A clinical evaluation of the Gow-Gates mandibular block technique

J. E. Watson and G. A. E. Gow-Gates

In describing a new technique for mandibular anaesthesia in which the anaesthetic solution is deposited, not near the lingula as in orthodox techniques, but against the condylar neck, Gow-Gates claimed that employment of the technique had resulted in a reduction in the failure rate to negligible proportions. It was also claimed that the method consistently anaesthetised all three oral branches of the mandibular nerve — inferior alveolar, lingual, and buccal, with one injection. Provided these claims can be substantiated, the technique represents a major advance in oral local analgesia in respect of both reliability and elimination of supplementary injections.

The present study was undertaken to investigate the hypothesis that the Gow-Gates technique of mandibular block analgesia is clinically more reliable in producing excellent local anaesthesia with a single injection than the conventional mandibular block techniques.

MATERIALS AND METHODS

The trial was designed to use five groups, two experimental and three control. One experimental and two control groups each received 2.2 ml of 3 percent prilocaine with 1:300,000 adrenaline. The remaining two groups, one experimental and one control, each received 2.2 ml of 3 percent prilocaine with felypressin (Octapressin, Astra). The respective experimental and control groups are summarised in Table I. In the two experimental groups, the first author acted as observer-recorder and the second author performed the injections using the Gow-Gates technique. Two control groups were included as a precaution against the possibility that a single operator may not have been a representative exponent of the conventional technique.

In the Gow-Gates technique the patient's head is placed in a horizontal position so that the landmarks may be sighted without strain. When compared with the conventional approach as seen in Figure 1, the puncture point in this technique (Figure 2) is much higher than, and somewhat lateral to, the puncture point for the lingula approach.

![FIG. 1. — Syringe in position for administering conventional inferior alveolar block.](image)

The needle is inserted just medial to the medial tendon of temporalis and passes through a corridor of relatively avascular fat. The target zone, is the neck of the mandibular condyle below the insertion of lateral pterygoid. The needle point should lodge in the region marked by the cross in Figure 3. The vertical difference between this target zone and the lingula can be appreciated to some extent from this illustration. The correct placement of the syringe just prior to aspirating and injecting is shown in the lateral radiograph, Figure 4.

In the control groups, a single operator was responsible for a single group, but the three groups had separate operators. The operators used the conventional mandibular block technique, that is, the solution was
deposited in the region of the lingula.

The experimental and control groups comprised patients attending typical urban practices. No subject received premedication prior to the injection.

The grade of anaesthesia, assessed by the method used by Dobbs and De Vier, was noted according to how the patient reacted to the dental procedure performed at that appointment.

The Dobbs and De Vier system of grading depth of anaesthesia based on clinical criteria is:

**TABLE I. — Details of experimental and control groups.**

<table>
<thead>
<tr>
<th>Anaesthetic solution</th>
<th>Volume</th>
<th>Number of Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.2 ml</td>
<td></td>
</tr>
<tr>
<td>3% prilocaine with adrenaline</td>
<td>57</td>
<td>(I) 83</td>
</tr>
<tr>
<td>1:300,000</td>
<td></td>
<td>(II) 60</td>
</tr>
<tr>
<td>3% prilocaine with felypressin</td>
<td>63</td>
<td>41</td>
</tr>
</tbody>
</table>

**FIG. 2. — Syringe in position for administering the Gow-Gates mandibular block. Note high puncture point just medial to the mental tend of the temporals' muscle.**

**FIG. 3. — A mandible showing the target zone marked with cross for the Gow-Gates technique.**

Grade A — completely satisfactory anaesthesia.
Grade B — the subject feels some slight pain but does not require reinforcement.
Grade C — feeble anaesthesia, another injection required.

The only modification made was to include the designation "Doubful" in Grade B, for those instances when it was difficult to be certain that the anaesthesia was completely satisfactory.

**TABLE II. — Results of trial using 2.2 ml of 3 percent prilocaine with adrenaline 1:300,000.**

<table>
<thead>
<tr>
<th>Grade of anaesthesia</th>
<th>Experimental group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
</tr>
<tr>
<td>A</td>
<td>56</td>
<td>98.2</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>1.8</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>57</td>
<td>100</td>
</tr>
</tbody>
</table>

**TABLE III. — Results of trial using 2.2 ml of 3 percent prilocaine with felypressin.**

<table>
<thead>
<tr>
<th>Grade of Anaesthesia</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
</tr>
<tr>
<td>A</td>
<td>62</td>
<td>98.4</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>63</td>
<td>100</td>
</tr>
</tbody>
</table>
RESULTS

The results are summarised in Tables II and III.

Grade A anaesthesia was present in significantly more (P<0.01) subjects in the experimental groups than in the respective control groups (chi-square test).

No significant difference (chi-square test) was detected by the success rates of the three control operators using the traditional mandibular nerve block procedure.

In the experimental groups a high proportion of the subjects were tested for a response to a sharp probe in the regions of distribution of buccal and lingual nerves. These tests, and the freedom from pain during the actual operative procedures, confirmed that buccal and lingual nerves are consistently anaesthetised along with the inferior alveolar. Not one subject in any of the two experimental groups provided any evidence that a supplementary injection was needed.

Within the two experimental groups, a total of 27 third molars and 2 central incisors received treatment. All 29 of these subjects clearly had Grade A anaesthesia. The nine third molars which required extraction were first tested by sinking a high-speed burr into the pulp without any reaction from the patient. Each central incisor required a cavity preparation and both of these were noticeably close to the pulp.

DISCUSSION

In the hands of its originator, the Gow-Gates technique consistently yields a higher percentage of "Grade A" or clinically excellent anaesthesia than do conventional techniques. This is confirmed clearly by the comparison between experimental and control groups in this series of trials.

When one compares the results of the experimental trials reported in this paper with other published studies using identical anaesthetic solutions, it is found that a higher proportion of subjects injected by the Gow-Gates technique showed Grade A anaesthesia than those receiving the conventional inferior dental block.

Another factor which could be easily overlooked is that supplementary injections are not normally necessary with the Gow-Gates technique. When the conventional block is used, supplementary injections are often necessary for extraction of posterior teeth, cavity preparations involving buccal gingiva of posterior teeth, matrix and wedge placement for deep proximal cavities on posterior teeth, treatment involving third molars, and treatment involving central incisors.

With the orthodox approach the occasional failure to obtain Grade A anaesthesia in the third molar even though excellent pulpal anaesthesia is achieved in the other teeth of the same quadrant is an intriguing problem. Watson has offered an explanation for this phenomenon. The difficulty has never arisen in the authors' experience when the Gow-Gates technique is used.

Initial pain is a transient discomfort which is often experienced by the patient when the anaesthetic solution is first released. Goldman and Gray reported a prevalence of initial pain in 4.6 percent of subjects when using 3 percent procaine with adrenaline 1:900,000 in the conventional block. Initial pain was not observed or complained of in any of the experimental groups in these studies although not all subjects were questioned on this account. Goldman and Gray suggest that adrenaline might be a major factor in initial pain and that the discomfort could be due to an ischemic effect.

In orthodox mandibular block techniques the object is to deposit the solution close to the inferior alveolar nerve trunk whereas...
the target zone in the Gow-Gates technique is approximately 10mm from the nerve trunk. If, as appears likely, the condylar neck is less prone to initial pain than the lingula region, then direct irritation of neural elements by the anaesthetic solution is possibly a material factor in initial pain.

SUMMARY

A Gow-Gates mandibular block was administered to each of 120 subjects in two experimental groups, a different prilocaine solution being used for each group. Control groups were 194 subjects, all of whom received a conventional inferior alveolar block using identical anaesthetic solution.

The prevalence of clinically excellent anaesthesia was significantly higher (P<0.01) in the groups receiving the Gow-Gates technique.

Supplementary injections were not needed to anaesthetise any region of distribution of inferior alveolar, lingual, or buccal nerves.

Initial pain upon release of the anaesthetic solution was not observed with any of the prilocaine solutions in the experimental groups.

REFERENCES


THE GOW-GATES
MANDIBULAR BLOCK:
FURTHER UNDERSTANDING

George A. E. Gow-Gates
and
John E. Watson, B.D.S., M.D., S.C.

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THE GOW-GATES
MANDIBULAR BLOCK:
FURTHER UNDERSTANDING

George A. E. Gow-Gates†
and
John E. Watson, B.D.S., M.D., S.C.‡‡

INTRODUCTION

Current techniques for mandibular block injections generally use intra-oral landmarks some of which are variable, obscure and unreliable.1,2 The assumption that sensory transmission can best be intercepted at lingula has not been substantiated by the many modifications introduced in recent years.3 Being confusing they create confusion and consequently dentists are becoming increasingly disenchanted with this technique and are searching for more reliable methods for controlling pain. Gow-Gates4 described a mandibular block technique in which the anaesthetic solution is deposited at the neck of the condyle in preference to the region of lingula.5 It was demonstrated in a clinical trial by Watson and Gow-Gates6 that correct use of the technique consistently produces analgesia in all three oral sensory portions of the mandibular branch of the trigeminal nerve since it employs a single intra-oral puncture point and deposits the solution entirely at a single target area without altering the position of the needle. An overall success rate of 98.3% Grade A analgesia, as defined by Dobbs & De Vier (1950), was achieved when using 2.2ml of various commercially available Prilocaine solutions. Table (1) This result was significantly better than the 84.2% achieved by three control operators employing conventional inferior alveolar block technique. An independent study by Rood (7) using a modified version of the inferior alveolar block produced a lower success rate of 76.2%.

†Dr. Gow-Gates is a general practitioner of Dentistry near Sydney, Australia.
‡†Dr. Watson is on the Faculty of the Department of Anatomy, University of Sydney.

Some clinicians have found difficulty in locating the neck of the condyle. This may occur should the mouth close even slightly as the condyle must be positioned at the articular eminence to provide a more direct and more predictable pathway from puncture point to target area.

The purpose of this paper is intended to clarify the position of the target area by means of a template, and anatomical relationships to the needle as it penetrates the pterygo-mandibular space.

The Landmarks are: (Fig 1)

Intra-orally:
The medial side of the deep tendon of the Temporalis muscle.
Extra-orally:
1. The apex of the intertragic notch.
2. The lower border of the tragus.

The target area:
The lateral region of the condyle neck just below the insertion of lateral pterygoid.

The reference planes are:
1. Extending from the lower border of the tragus, through the corners of the mouth.
2. The plane of the tragus to the side of the face. (Fig. 2).

The correct landmark is the center of the external auditory meatus but being concealed by the tragus, its lower border is adopted as a visual aid.

All landmarks are placed in the same plane and have a common feature as they appear to be triangular in shape, the intertragic notch, the pterygo-temporal depression, and the pterygo-mandibular space although pyramidal, has its apex of its posterior triangle at the target area, below the insertion of the lateral pterygoid muscle, the most restricted part of the space.
Diagram demonstrating the template placed in position along the reference plane extending from the tragus of the ear to the corner of the mouth, and how this plan intersects the condylar neck just below the area of lateral pterygoid insertion.

Viewing a skull laterally, (Fig. 3A) it can be seen that it consists of an upper ovoid part, the cranium, and a lower triangular section having its apex at the symphysis. Similar design is apparent on its basilar aspect and is a reminder to the clinician of the necessity for directing the needle laterally. (Figs. 3B & C)

The Template is shown in (Fig. 4).

Figure 1 represents the design of the template which effectively gives the proper orientation of the landmarks when placed along the reference plane from the apex of the intertragic notch to the corner of the mouth see Fig. 5A.

BC is placed along the reference plane, B directly below the tragus, and its sides AB and CD at right angles to the plane. The syringe is aligned with the plane positioned over the canine tooth on the opposite side to that being anesthetized. The point of the needle placed just medial to the temporalis tendon, its height corresponding to the upper side of E and then directed to the lower side of F. (Fig. 5B)

Penetration of the needle is generally within the range of 25-27mm without regard to the cephalic index. It must not penetrate deeper than 27mm, otherwise it should be withdrawn slightly, relocating the needle further medially if penetration is less than 25mm, and further distally, moving the syringe towards the premolar, if greater than 27mm.

Routinely a 33mm, long, 25 gauge needle is used and the protrusion of the hub permits an assessment of depth of penetration.

The three dimensional approach enables the clinician to relate by tactile sensation what he knows, to that seen, and to what is felt before depositing the anesthetic solution. Providing the technique has been correctly carried out, all oral sensory branches of the mandibular branch of the trigeminal nerve will be effectively blocked without any supplementary injections.
Anatomical Studies

The co-ordination of the landmarks guides the needle along a safe anatomical pathway. The template provides the proper orientation for the needle to impact the neck of the condyle.

Most regional block techniques require the placement of the needle as close as possible to the nerve trunk, but an important feature of this method is that the anesthetic solution is deposited approximately 20mm from Foramen Ovalis and the nerve avoiding risk of trauma to the nerve trunk with potential resultant paresthesia.

In the Gow-Gates technique the needle is guided towards the lateral side of the condyle neck just below the insertion of the lateral pterygoid muscle. Post-operative trismus, one of the problems associated with conventional techniques, does not occur because major muscles are not penetrated. The radiograph shows the position of the condyle at the articular eminence and the upright inclination of the ramus. (Fig. 6).

Latency is variable but mostly shorter than in the conventional technique, and although of no clinical consequence, it does appear that the spread of anesthesia is different. With the conventional technique, numbness in the lower lip is the criterion for an adequate block of the inferior alveolar nerve but with this technique the first sign of anesthesia is the numbness in the ramus and teeth followed by the lip and tongue. This was confirmed by probing the investing soft tissue buccally and lingually before numbness in the lip was observed. The region of the molar is anesthetized before the canine, and the canine before the central. The onset of analgesia was somewhat like a wave flowing from the proximal to the distal zones of distribution of the oral sensory branches of the mandibular nerve.

Based on the distribution of the brachial plexus nerve, De Jong states that the proxi-
inferred alveolar nerve on 33 patients using a "Malek" pulp tester calibrated for each individual patient to voltage and membrane potential before the injection. The first permanent molar, canine and central incisor were tested on each subject.

After the injection of 3ml of 4% prilocaine without vasoconstrictor, pain threshold was determined relating stimulus to time in minutes as indicated in the graph. (Fig. 7).

A broad spectrum of dental procedures, including restorative and surgical work, pulp extirpations etc. were performed and all treatments were completed on the initial visit.

Pulpal anesthesia in all teeth from third molar to central was adequate with a unilateral block and no supplementary injections of any type were administered. Volume and concentration of the anesthetic solution is most important with this technique particularly if pulpal anesthesia of the incisor teeth is required.
Figure 4.
Photo showing design of template.

Figure 5A.
Lateral view showing syringe aligned with template.

Figure 5B.

Experience has shown that restorative procedures could be commenced in the molar region within 4 minutes and depending on position, teeth more anteriorly placed would require a slightly longer time for analgesia.

This study supports De Jong's concept of distribution of the nerve fibers within the nerve trunk that the proximal areas are innervated from fibers of the mantle bundles and those more distally with those from the central core bundles. Consequently, the molar teeth which are innervated by the more peripherally placed fibers are blocked before the centrals supplied by the fibers of the core bundles.

Figure 6.
Radiograph showing upright position of the ramus and condyle at the articular eminence. Needle above the crest of the coronoid process and contacting the target area.

Figure 7.
Graph showing membrane potential and pain threshold following the injection of 3ml of 4% Prilocaine without vasoconstrictors. The increased stimulus voltage required to produce a response after injection is indicative of the onset of anesthesia.
TABLE 1

Success Rate of Anesthesia
2.2 ml of 3% Prilocaine with Octopressin

<table>
<thead>
<tr>
<th>Grade</th>
<th>Go-N-Gates Technique</th>
<th>Orthodox Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>98.4%</td>
<td>85.4%</td>
</tr>
<tr>
<td>B</td>
<td>1.6%</td>
<td>9.7%</td>
</tr>
<tr>
<td>C</td>
<td>0%</td>
<td>4.9%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

2.2 ml of 3% Prilocaine with 1:300,000 Adrenalin

<table>
<thead>
<tr>
<th>Grade</th>
<th>Go-N-Gates Technique</th>
<th>Orthodox Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>96.2%</td>
<td>85.5%</td>
</tr>
<tr>
<td>B</td>
<td>1.8%</td>
<td>4.8%</td>
</tr>
<tr>
<td>C</td>
<td>0%</td>
<td>9.7%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

DISCUSSION

Quite apart from the obvious advantage that correct use of this technique results in a higher percentage of Grade A anesthesia, it also resolves other problems associated with the inferior alveolar block injection, such as trismus and intravascular penetration. Some of the major advantages of the technique are discussed below.

(1) **Full pulpal analgesia from third molar to central incisor.** There has never been any worthwhile anatomical or physiological evidence to support a widespread belief in the existence of decusation of inferior alveolar fibers to innervate contralateral incisor pulps. This fallacy may have originated in the frequent failure of conventional inferior alveolar block techniques to produce satisfactory analgesia of ipsilateral incisors. The authors have regularly demonstrated complete pulpal analgesia in lower central incisors, thus providing a clinical refutation of the old fallacy. The onset of analgesia occurs in the third molar well before it affects the incisors. It must also be remembered that **time** is a most important factor for potentiating the effectiveness of the block and is subject to a number of variables.

Some patients may require premedication with tranquilizers or sedatives to increase membrane potential or to inhibit prostaglandin synthesis.

(2) **Adverse reactions are very rare.** The authors have never observed an instance of major syncope associated with this block and even cases in which the patient experienced a mild reaction are extremely uncommon. The comparative absence of undesirable effects is attributed to the combination of the recumbent position and injection into the relatively avascular region of fat anterior to the condylar neck.

(3) **Post-operative sequelae are rare.** Patients with some experience as recipients of the conventional "ligula" block often volunteer that the Gow-Gates block produces less discomfort both during the injection and subsequently.

In common with all other intra-oral mandibular block techniques, the needle first penetrates the oral mucosa and the underlying sheet of buccinator muscle. After this, the needle point traverses a corridor of fat between the medial head of temporalis and the medial pterygoid muscle. Neither muscle is impaled by the needle at any time and this is probably the explanation for the reduced level of discomfort.

The mandibular nerve is closely related to artery and vein. Directing the needle away from the nerve trunk assists in avoiding vascular penetration. Furthermore the target zone for the placement of the solution is relatively avascular and reduces the incidence of positive aspirations. (Table 2)

(4) **The speed of injection may vary.** The authors have investigated the effects of various rates of injection from 8 seconds to 40 seconds per 2.2 ml of solution. Rapid injection was not found to impair the effectiveness of analgesia nor increase the occur-

---

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>Inferior Alveolar Block</th>
<th>Reported incidence of positive aspiration.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harris</td>
<td>3.6%</td>
<td>1957</td>
</tr>
<tr>
<td>Forrest</td>
<td>4.2%</td>
<td>1959</td>
</tr>
<tr>
<td>Shira</td>
<td>12.0%</td>
<td>1962</td>
</tr>
<tr>
<td>Frye</td>
<td>12.9%</td>
<td>1962</td>
</tr>
<tr>
<td>Shiano and Stambre</td>
<td>11.0%</td>
<td>1964</td>
</tr>
<tr>
<td>Cohen et al</td>
<td>10.9%</td>
<td>1969</td>
</tr>
<tr>
<td>Barlett</td>
<td>11.7%</td>
<td>1972</td>
</tr>
<tr>
<td>Corkery and Banett</td>
<td>16.8%</td>
<td>1973</td>
</tr>
<tr>
<td>Adams and Mount</td>
<td>17.0%</td>
<td>1976</td>
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</table>

Gow-Gates Mandibular Block

<table>
<thead>
<tr>
<th>Gow-Gates and Watson</th>
<th>1.6%  (Unpublished study)</th>
</tr>
</thead>
</table>
rence of post-operative sequelae. This may be of considerable advantage where one is dealing with a restless patient who is likely to move during the injection. In practice 20 seconds is usually taken to discharge 2.2 ml.

(5) Vasoconstrictors in the anesthetic solution are unnecessary. Whilst the operator may choose any solution suitable for dental purposes, the authors have found that 4% prilocaine without added vasoconstrictors yields consistently excellent results. This solution has been found less irritating in infiltration anesthesia probably because its pH is closer to neutral than that of other solutions.

The authors have tested a wide range of anesthetic agents with this block technique and have observed the plain prilocaine solution to be better tolerated by patients generally and by cardiac patients in particular.

Standardization of anesthetic solution has been found advantageous in that the operator need have no anxiety about unsuspected cases of cardio-vascular disease or hypersensitivity to added vasoconstrictors. Whereas the placement of the anesthetic solution in a desirable position at lingula or immediately superior to it may not even provide partial anesthesia of the inferior alveolar nerve, it has been proved that the condyle region is a reliable site to intercept sensory transmission of all oral branches of the mandibular nerve.

A feature of considerable importance is the sensation of solid resistance when the needle point encounters the bony condylar neck after having passed effortlessly down the fatty layer between the medial head of temporalis and the medial pterygoid muscles. This is not the sensation of deflection often experienced when the needle meets bone at an acute angle in lingula approach techniques, but a sudden halt to the previously unimpeded progress of the needle. It is this feature that the greatest safety factor of the Gow-Gates technique lies. THE SOLUTION IS NOT INJECTED UNLESS THE NEEDLE POINT IS RESTING AGAINST THE BONY CONDYLANAR NECK.

No case of facial nerve paralysis or any other comparable phenomenon has ever been observed or reported as a consequence of this technique.

Numbers of clinicians have volunteered that the modest outlay of time and effort required to master this technique is amply rewarded by the confidence in having a safe and reliable method of overcoming pain in the mandible.

REFERENCES


Reprint requests to:
Dr. George A. E. Gow-Gates
85, Macquarie St.
Parramatta, N.S.W., Australia, 2150

John E. Watson, B.D.S., M.D.Sc.,
Sydney, Australia
Department of Anatomy,
University of Sydney