The Anaesthesia Science Viva Book

Simon Bricker

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Clinical science as applied to anaesthesia, intensive therapy and chronic pain

A guide to the oral questions

Simon Bricker **MA, MBChB, FRCA**
Examiner in the Final FRCA
Consultant Anaesthetist
The Countess of Chester Hospital
Chester, UK

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Preface

The Final FRCA examination has a daunting syllabus which is tested by a multiple choice paper, by written short answer questions, and by two oral examinations, one in clinical anaesthesia, and a second in applied basic clinical science. This book is intended to give you some insight into how the clinical science viva works, along with some general guidance as to how to improve your chances of passing. More importantly it aims to provide you with a wide range of potential questions which contain, nonetheless, a manageable amount of information.

The introduction explains the format of the viva, outlines how the questions are constructed, conducted and marked, and offers some advice about technique. The questions then which follow, which are typical of those which have appeared, are divided broadly into the four areas which the examination is designed to cover, namely applied anatomy, physiology, pharmacology and clinical measurement. One section, entitled 'Miscellaneous Science and Medicine' includes a number of subjects which do not fall readily into any of the other categories.

You may notice that there is some overlap in content with the companion volume, 'Short Answer Questions in Anaesthesia'. Where this has happened I have reworked the answers both to give more detail and to focus the topic more specifically towards the oral part of the examination, but a degree of duplication in one or two of the questions is inevitable.

The answers have been constructed to provide you with enough information to pass the viva, but as I have had to be selective in the detail that has been included they cannot claim to be complete accounts of the subjects. This means that in some areas you may notice various omissions, but none I hope so egregious that your chances of success will be ruined. Each of the questions is prefaced by a short commentary on the relevance (or otherwise) of the subject that is being asked. There follows the body of the answer to the likely areas of questioning. This is presented mainly in the form of bulleted, but detailed points, which include supporting explanation. These are written in text rather than as lists, because I felt that this format would make the book easier to read. If some of the questions seem long, then it is either because the background information is complex, or because they contain enough material for more than one viva topic.

Even in a structured examination a viva may take an unforeseen course, and so the answers also include some possible directions which the questioning might follow. Although each one is intended to provide details more than sufficient to allow you to pass, in many cases they are simplified, and it is always possible that some examiners may ask part of the question in more depth than can be covered in a book of this size. There are 150 specimen questions in this book, and on the day of the examination you will be asked only four. Odds of about 40 to 1 or less do not provide a huge incentive for study, but I should hope that some of the material would be relevant to your anaesthetic practice. The material that you do find of little clinical relevance may at least prove of some future use as in due course you guide less experienced colleagues through the FRCA.

I promised my family that I would never again succumb to the temptation of writing a book. I lied. To my wife and three boys, therefore, my love and thanks for all their patience and support.

Simon Bricker
2004

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Advice on answering clinical science viva questions

The clinical science viva

The format of the current Final FRCA (Fellow of Royal College of Anaesthetists) examination has changed little since its inception in 1996, and the clinical science viva is intended still to test *the understanding of basic science to the practice of anaesthesia, intensive therapy and pain management*, with the proviso that *it is accepted that candidates will not have acquired a detailed knowledge of every topic during the period of recognised training*. To which some past candidates might respond testily that you could have fooled them, sometimes given their bitter perception that they had been examined almost to destruction on scientific minutiae.

This perception has been acknowledged recently by the college, which as a result is encouraging its examiners to emphasise the clinical application of the underlying science, rather than concentrating on those details which were meant to have been tested in the Primary FRCA examination. The basic science bias does, nonetheless, persist, if for no other reason than that many examiners are reluctant to dilute the rigour of what for most candidates will be the last examination in anaesthesia that they will ever take. This recognition on the part of the college, however, does mean that many of the clinical science questions will have two parts, namely the underlying science and its application. A question on anatomy, for example, may be completed by a discussion of relevant nerve blocks; and a discussion of magnetic resonance imaging (MRI) or lasers is likely to be followed by questions related to safety. The proportion allocated to the two parts of the question may well depend on the examiner's own interest and knowledge of the subject, but you will not be able to depend on your clinical expertise alone to get you through the viva. If there is doubt about your performance, the examiners are more likely to refer back to your knowledge of the facts of the underlying science, rather than to what may just be your clinical opinion.

The viva lasts 30 minutes, during which time you will be asked questions on four different and unrelated subjects. The time spent on each question should be similar, between 7 and 8 minutes.

The marking system

In common with all parts of the FRCA examination a 'close-marking' system is used. This means that instead of being given a numerical mark a candidate is awarded one

of the four grades, which range from '1' to '2+'. A '1' represents a poor fail and '1+' a fail; a '2' is a pass and a '2+' is an outstanding pass. One of the reasons for the close-marking system is to force examiners to make the definite choice between a pass and a fail, which a numerical marking system might otherwise allow them to avoid. A '1' mark in any part of the examination means that the candidate has been judged either to be potentially dangerous, or to be too ignorant of the fundamentals of anaesthetic practice to pass, even should their other marks include three '2+'s. A '2+' represents an outstanding pass, which is indicative of a potential prizewinner. A prize may be considered if a candidate achieves a '2+' in each of the four parts of the examination at their first attempt. For most candidates, therefore, the '1' and the '2+' marks are largely theoretical: what is much more important for them is the distinction between a '1+' and a '2'.

How the viva is marked

You will be aware that the FRCA is a structured examination. The material on which candidates are to be tested is now made available to the examiners in the week prior to the examination, but in random order. Previously they had access to the questions only on the day. At the examination itself the questions are allocated to sessions, such as *Monday 1*, and the sheet will include the four topics on which the candidates are to be examined during the first session of the vivas. The questions are changed after each session to avoid any possibility of later candidates obtaining unfair advantage. Each pair of examiners will decide between themselves which two questions of the four they are going to ask. That broadly is the extent of the choice that they are able to make, because the scope of each question is limited both by the guidance answer and by the relatively short time available for each topic. The first examiner will spend 7 or 8 minutes on the first subject before changing to the second. At the first bell, the other examiner will repeat the process. The examiner who is not asking questions will usually be making detailed notes, which will help to inform the marking process. At the end of the viva each examiner records an independent mark before conferring. It is usual for each question to be marked using the close-marking system, and it is from these marks that the final mark is agreed. The decision to confer a pass or fail will rest mainly on how well you have conveyed the scientific knowledge that was asked of you. But if you really are a borderline case then it is *probable* that clinical aspects of your performance will decide your fate. Should you have been weak on some of the basic science but have been reassuringly confident about clinical management then it may just tip the balance in your favour. The examiners try to look at each of the four topics separately before marking the viva as a whole. Do not, therefore, lose all heart if you feel that you have answered a question particularly badly. Try and leave it behind you, because your other answers may be able to redeem it, and you should not forget that all four questions are totally unrelated.

Appearance and affect

You cannot fail the Final FRCA because of your appearance or poor dress sense, and most examiners will be able to recollect candidates whose personal presentation could at the least be described as unconventional. At worst, however, an unkempt or casual appearance may convey the subliminal impression that you are unprofessional, and at best it is likely to be a distraction. It is sensible to wear something neutral and reasonably smart, which above all is comfortable and which you have worn before. The examinations areas can be hot, particularly in summer, and there is no need to increase your already high stress levels by forcing yourself into a three-piece suit or other outfit that sees the light of day only for weddings and funerals.

You also cannot fail the FRCA because of inappropriate behaviour alone. Examiners are well aware of the stress that candidates are enduring, and many will make every

attempt to put you at your ease. They are also likely to assume that aggressive or facile responses are a manifestation of that stress and will make allowances accordingly. On one occasion, for instance, an aggressive candidate almost shouted *For God's sake don't ask me that – I've never even thought about it,* before ending her viva by saying *Thank heaven that's over – and thanks for nothing*. Other candidates, in contrast, can be very facile. Take the individual, for example, who replied to a particular question by responding that *I'll probably know the answer when you tell it me,* or another who was asked about etomidate, and who took what might be called the Bertie Wooster approach to vivas by riposting *It blocks the 1,2 hydroxy-whatsit, oh I don't know, I think you give the stuff and the atom bings off.* Examiners up to a point will be indulgent, but the overall impression that you are creating will not be reassuring, and if an inappropriate manner is accompanied by a weak performance then you will stand little chance of being given the benefit of the doubt. Take issue with examiners, by all means: it is stimulating for both sides to develop a considered discussion of a topic, but avoid getting into an argument, because the odds are not stacked in your favour.

There are rare occasions, perhaps not surprisingly given that a viva is a human interaction, when a candidate or examiner may take an immediate dislike to the other. If as a candidate, you find your examiner thoroughly disagreeable, then you will have to accept it philosophically and not let it show. The rules of this particular enterprise are not written to your advantage, and if you are angered or irritated by your questioner then you are very unlikely to perform at your best. What if it is the other way round, and the examiner, for whatever reason, takes an instant dislike to you? You need not worry. The examiner will be aware of the potential loss of objectivity and will therefore try hard not to let any hostility influence the marking process. In practice they are likely to overcompensate and mark more leniently than otherwise they might. It would probably be unwise, however, deliberately to be obnoxious in the hope of achieving this effect.

Oral questions

On average you will have about 7 minutes on the topic. Should a question have somewhat limited scope, or if your knowledge is thin, you may spend only 5 or 6 minutes or so discussing it before moving on for the final 9 or 10 minutes to a more substantial subject. As explained above, these vivas are structured and the examiners have no choice of question. Although it would be logical, given the avowed purpose of the clinical science viva, to subdivide the questions into anaesthesia, intensive therapy and pain management, in practice they do not fit readily into these categories. In the past, the four questions could be somewhat random: more recently it has become usual to have one question which relates to applied anatomy, one to physiology, one to pharmacology and one to physics, clinical measurement, equipment and statistics. This classification is not absolute: topics such as jaundice or latex allergy do not fit strictly into any one of these groups, but it does indicate the broad division of the available questions. The structured nature of the examination minimises the likelihood of an examiner being able to question you in excessive depth on a subject which happens to be their area of special interest or expertise. It also increases the probability of an examiner having to ask questions about a subject in which they do not even have a current generalist interest. The sub-speciality interests of examiners clearly change as retiring examiners are replaced, but at any one time only about 15–20% will have an interest in intensive care medicine, in paediatric anaesthesia or in neuroanaesthesia, and an even smaller number will work in chronic pain management. Thus a paediatric cardiac anaesthetist may find himself asking questions about adult ophthalmic applied anatomy, a neuroanaesthetist questions about neonatal fluid requirements, or an obstetric anaesthetist questions relating to intensive therapy ventilatory strategies. These examiners will not necessarily be ignorant of these topics, but it is certainly possible that your own clinical experience

will be more recent and better informed than theirs. This should give you confidence, and you should not let the stress of the examination situation override it. Many candidates will have had direct experience, for example, of the technique of percutaneous tracheostomy in intensive care. Unless your examiner is an intensivist, it is possible, if not probable, that he or she has performed not even one, and so your own clinical experience in this area is already much wider than theirs. Draw confidence from this, and do not be intimidated. The examiner guidance may well say, for instance, that the approach should be through the first and second tracheal rings, whereas you may be well aware of the increasing tendency to site the tracheostomy lower. If you do get the sense that the examiner is unhappy with your answer mainly because it does not accord with what is written on the sheet, then have the confidence to explain the current thinking. Do not be argumentative, but simply offer your considered reasoning of the issue. This is likely to increase your own credibility while somewhat denting theirs. So if you have recently seen an innovative technique used in the operating theatre, in the chronic pain clinic or in the intensive care unit then cite it in discussion.

The other consequence of the format of the structured viva is that it may lack fluency. It is partly a reflection of the examining technique. Some examiners simply introduce the question before initiating a discussion with only occasional reference to their paperwork. This is usually because they are familiar with the material, and can allow the viva to run a more spontaneous course because they have confidence enough in their own ability to assess the answers. An examiner who is less comfortable with the topic and who is less certain of the criteria against which the answers are to be judged, is likely to spend much more time referring to the answer sheet. Alternatively, of course, they might just be particularly pedantic in their interpretation of how a structured viva should be conducted. You may get a clue as to which of these you are facing by the way that they introduce the topic. One type of examiner may start by saying something like, *I imagine that you spend some of your time on call covering intensive care? Well, let's spend this first part of the viva discussing ways of supporting the circulation, in particular by the use of inotropes*. This kind of examiner is trying to put you more at ease by framing the question in a clinical context with which you will be familiar, while also emphasising the clinical application of the subject under discussion. The second type of examiner may simply look down at the sheet and intone *What is an inotrope?* This second examiner is likely to want facts, and ideally the facts that are listed on the answer paper. He or she clearly has not realised that you are not telepathic. If, however, you do have some confidence both in your knowledge and in your clinical experience you may be able to get them on the defensive. Remember that such an examiner may never have used dopexamine or enoximone, and if you sense a slight uncertainty which confirms that suspicion, then expound as freely as they will let you. Remember also that this may be the limit of the manipulation that you will be able to employ.

What you may be able to do, however, is to pace the viva. The clinical science questions broadly have two parts, namely the basic science and its application. In general the underlying science represents the core aspect, because there may often be less to discuss about the direct clinical implications. The examiner may then have to move away into diffuse topics that may be only distantly related to the main question. Take, for example, the humidification of inspired gases or the anatomy of the inguinal region. The questions about the measurement of humidity and different methods of humidification will occupy much more time than the discussion of the clinical benefits. Equally the anatomy of the nerves supplying the lower abdominal wall will take longer to discuss than the description of a field block. There is a danger, therefore, that if you complete the first part too rapidly then the viva may drift away from the core topic and meander round subjects that will neither gain nor lose you much credit. The overall impression, however, may be that your knowledge about the main subject was sketchy. To an extent, therefore, you will have to gauge what is the key area of

questioning and concentrate on supplying as many details as you can muster. This applies particularly to anatomy. If you are able to give a detailed account, which defers your proceeding to the supplementary questions, then so be it. You will have passed on the question that you were asked, and it is the examiner's responsibility to move the viva onto other areas if he or she so wishes. As an extreme example of this process, there was one sitting of the examination in which a candidate who was in full flow about a topic was interrupted by a newly appointed examiner, who having recognised that the individual was very knowledgeable wished to move onto another area. The candidate paused, looked him in the eye and announced *No, thank you, but I would like to finish,* before talking almost until the bell sounded. He passed. Embark on that brave strategy only if you have substantial and justified confidence in your abilities, because usually you will be unable to manipulate the viva and it will not work.

What you can do, however, is refine your viva technique to improve the overall impression that you create. Take, for example, two imaginary candidates who have been asked about the Poiseuille–Hagen equation. The examiner initiates the questioning in an interchange which may go as follows:

Examiner: Does this have any clinical relevance?
Candidate: Yes.
Examiner: Can you give me some examples?
Candidate: It affects fluid flow through tubes.
Examiner: In what ways?
Candidate: If you increase the driving pressure, then you increase the flow.
Examiner: Anything else?
Candidate: If you increase the viscosity of the fluid then the flow will decrease.
Examiner: Are there any other important factors?
Candidate: The diameter of the tube is important.
Examiner: In what way?
Candidate: If you double the diameter then the flow will increase by sixteen times.
Examiner: In what clinical situations may this be of importance?
Candidate: In giving fluids.
Examiner: Can you think of any others?
Candidate: Airway obstruction in children.

The interchange with the second candidate begins in the same way, but thereafter is somewhat different.

Examiner: Does this have any clinical relevance?
Candidate: The Poiseuille–Hagen equation strictly speaking applies only to Newtonian or ideal fluids, but in practice it still has both cardiovascular and respiratory implications. The relationship means that gas or liquid flow through a tube is inversely proportional to the length and viscosity of the fluid, and is directly proportional to the pressure gradient down the tube and, crucially, to the fourth power of its diameter. This means, for example, that major fluid resuscitation will be much more effective if a pressure infusor is used to deliver low-viscosity fluid through a short, wide-bore cannula. The equation is also relevant in conditions of airway obstruction. This is of particular importance in young children whose small airways may be further narrowed by inflammation and oedema, and in whom gas flow may be critically impaired.

You will notice that the first candidate actually has given the examiners much the same information as did the second. The difference lies in the fact that each of their rather abbreviated answers was prompted, and he or she gave no real sense of any mastery of the subject. The second candidate, in contrast, required no prompting, but demonstrated instead an orderly and logical approach that conveyed the impression of obvious familiarity with, and understanding of the topic.

Only the occasional candidate achieves the fluency of the second example, whereas rather more candidates behave like the first, and require a little help. Yet if you do have some knowledge of the subject asked, you can train yourself, with practice, to deliver the information both with more facility and with more enthusiasm. This applies particularly to the clinical areas of the viva. If you are asked, for instance, how you approach weaning an intensive care patient from a ventilator, you could say that *I would follow the unit protocol and would begin by …*, or alternatively you could start by commenting that *This can be a really difficult problem, particularly after prolonged ventilation or in those with pre-existing lung disease, but in general I would….* If you take the first approach it will look as though you have read the information in a book; if you take the second it will appear as if weaning patients from intermittent positive-pressure ventilation (IPPV) is a challenge with which you are enthusiastically familiar. Your overall performance will be more impressive for it.

The viva on each subject lasts less than 8 minutes. The examiners will take about 20–30% of this total time in framing the questions. That leaves you, therefore, with only about 5 or 6 minutes during which you have to talk. Were you to read out steadily, fluently and without hesitation one of the average length answers in this book, it would probably take you twice that long. There are few candidates, moreover, who are able to answer viva questions as rapidly as they can read. You should find this reassuring, because it means that you cannot be expected to convey more than a proportion of the information that appears in each of the specimen questions.

Why do they have to ask these kinds of questions?

When your examiner looks up with an air of benign amusement from the question paper and invites you to discuss *Cytochrome P450* or *Chirality*, your initial instinct may be to leap across the table to transfix them with your free Royal College examinations' pencil. Some examiners, at least, will ask these questions with at least a hint of apology, which may raise your spirits marginally as you sense that these individuals might be on your side. Other examiners will be completely bereft of irony.

The difference between them should be obvious, but it might be of interest, if little consolation, were you to be aware of some of the reasons why such questions can arise.

A brief history of anaesthesia's inferiority complex

Anaesthesia had its humble origins in mid-nineteenth century dentistry, and although hospital-based anaesthesia did become more sophisticated, in the early twentieth century simple anaesthesia in the UK was still being delivered by some individuals who were not medically qualified. There were even some who did not have so much as a rudimentary general education. In contrast, however, physicians and surgeons of that era had a high social and intellectual standing that had been established for centuries. As the speciality of anaesthesia evolved over the succeeding decades of the twentieth century, it continued to enjoy only very modest status. There were, however, some politically astute individuals who recognised the potential perils of anaesthetic humility and who thought it unwise to succumb to anaesthesia's inferiority complex. In particular they recognised the truth that anaesthetists could achieve equality of status with surgeons only if they had a qualification that was equivalent to the Fellowship of the Royal College of Surgeons, the FRCS. It was this realisation which explained the early two-part examinations, first the Diploma of Anaesthesia, and then the FFARCS (Fellow of the Faculty of Anaesthetists of the Royal College of Surgeons) which was the immediate forerunner of the FRCA. These examinations were modelled on the FRCS, had a low pass mark in the region of 25–30%, and which by including in the syllabus detailed anatomy and pathology, created the precedent for rigour in the basic sciences.

This establishment of a difficult anaesthetic examination with a low pass rate did in fact play a crucial role in the development of the speciality. When you are tempted, therefore, to curse the college for erecting the hurdles of the Primary and Final FRCA, you can at least reflect that the difficulty of these examinations may in some oblique way ensure that you get paid the same as your colleagues in surgery and medicine. Anaesthesia has a reputation for having among the most difficult post-graduate examinations and, superficial though this may sound, it does remain one of the ways in which the speciality safeguards its standing.

Did this attempt to mirror the FRCS take the process too far? At times it can certainly seem so, and you may have to console yourself with the familiar, yet no less true observation that *Examinations are formidable even to the best prepared … for the greatest fool may ask more than the wisest man can answer* (Reverend Charles C. Colton 1780–1832). A more recent perspective has been provided by a distinguished professor of medicine and scientist from Oxford. During his valedictory speech to the faculty, he commented that in 30 years of clinical medicine his intimate knowledge of the Krebs' cycle had influenced his management … *of not one single patient*. Some, but not all, examiners agree with the wisdom of that view, and do not accept that a detailed knowledge of scientific minutiae is necessary for the safe and effective practice of clinical anaesthesia. It may be obvious at your viva into which category the examiner falls.

Strategies for answering clinical science questions

Anatomy

Some candidates demonstrate a very detailed knowledge of areas of human anatomy, which allows them to embark on a thorough description of all the relevant structures and their immediate relations. Others have a more modest working knowledge, and there is a final group which includes candidates who are able to demonstrate only that they have a very vague idea of where these structures lie. You will know as soon as the question is asked which of these types you most closely match. One strategy for passing questions on applied anatomy is simply to learn it, or at least develop enough confidence to be able to launch into a rapid account of the area in question. The speed of delivery is important. There are not many examiners who will be able to recall the precise anatomical details that are found in the specimen questions in this book. This means that they will probably have to make repeated reference to their guidance sheet in order to check that what you are saying is true. If they were to ask you to clarify more than one or two of your descriptions then much of the time in the viva would be lost. There is a tendency, therefore, for the examiner to listen to what you are saying, rather than making frequent interruptions. At the end of your account he or she may simply judge their overall impression of its accuracy. Confident presentation may, in this instance, allow you to mask gaps in your knowledge.

What if you are the candidate whose recollection of an area is vague? Your chances of success in the question will depend on whether it is what could be termed 'theoretical anatomy' or is 'practical anatomy'. The coronary arterial and venous circulation is an example of theoretical anatomy. Certainly it is important, and of course it is true that anaesthesia may influence it, but it remains a visual construct, which we neither see nor feel. One tactic, which may salvage something from this part of the viva, is to move swiftly to the functional anatomy of the circulation. *The main importance for anaesthetists of the right and left coronary circulations*, you could state loftily, *lies in the way that we can influence oxygen supply and demand*. The examiner will take you back to check that you indeed are ignorant of the anatomy, but you will at least have initiated the physiological discussion which is the second part of the question and which, in any case, is generally of greater interest to anaesthetists, both candidates and examiners alike. Other examples of theoretical anatomy are the cerebral circulation and the blood supply to the spinal cord.

Questions on 'practical anatomy' should be rather easier to handle, because they relate to areas such as the internal jugular vein and the brachial plexus; detailed knowledge of which is of direct and self-evident importance. You can also reinforce this knowledge by disciplining yourself to visualise the relevant structures each time that you perform or observe one of these procedures. If you rehearse in your mind the nerves that are being blocked for an awake carotid endarterectomy as you see it being done, or describe the anatomy of the sacrum to a less experienced colleague to whom you are teaching a caudal block, it will not be long before the details are secure without recourse to yet more evening study. You can, in other words, revise for the Final FRCA during the course of your daily work. This does not, of course, apply only to anatomy, but is true of other areas of the examination as well.

The examiner may ask you if you have performed a particular procedure, or may even give you a question that allows you to discuss, for example, an upper or lower limb block of your choosing. In respect of practical procedures that you claim to have undertaken, you should be aware that the threshold for a pass shifts upwards. If you say that you regularly perform caudal blocks in children or interscalene blocks in adults, but then show that your knowledge either of the anatomy or of the appropriate drug doses is at best hazy, then you will almost certainly fail the viva with a '1+'. You will incur a '1', if your answer is judged to be dangerous. In examination anaesthesia as in real-life anaesthesia, whenever you are in any doubt you should choose the safest option. Better in both situations to admit that you have done very few caudal or interscalene blocks, and that you would seek experienced help.

Anatomy questions finally, do lend themselves readily to diagrammatic answers. Many candidates seem to benefit from being allowed to describe the anatomy while they draw: producing the diagram acts as a stimulus to recollection. It is worth practising this technique because the number of anatomy topics is relatively restricted and it is almost certain that one of them will appear as a question.

Physiology

Anatomy, pharmacology and physics are all large scientific disciplines, yet in the context of the Final FRCA their scope is restricted, and the areas of specific relevance to anaesthetic practice are finite. Physiology, in contrast, is very wide ranging, and questions appear which are related to all the systems, including renal, gastrointestinal and endocrine.

The questions in the clinical science viva are not weighted formally, and so in theory a question about the nephron or the functional anatomy of the liver will be treated just the same as one about respiratory function or cardiovascular compensatory mechanisms. You will not, of course, be asked more than one such topic, and so examiners do not find themselves having to argue about the merits of a particular candidate who knew everything about bile salts but nothing about functional residual capacity. What you might find them discussing, however, is the candidate who knew little about the physiology subject, but who performed well in most of the other areas. If the physiology topic is one that might be considered a core area, such as respiratory or cardiovascular function, then that candidate's chances of passing the viva diminish. If, however, the topic is one that is rather more peripheral, then the examiners are more likely to make allowances. What this means, in practice, is that you should concentrate your study more on areas such as respiratory and cardiovascular physiology, than on hepatic and gastrointestinal function. It is not that you will not get asked a question on these latter, but you will disadvantage yourself much more by ignorance of the former.

Pharmacology

The number of core anaesthetic drugs is limited. The sum of the regularly used induction agents, neuromuscular blockers, volatiles, analgesic drugs and local anaesthetics exceeds barely 20. The pharmacology of these substances is almost by definition

applied science, and so you will find examiners much less forgiving of deficiencies in anaesthetic pharmacological knowledge than they would be of ignorance of lasers or medical statistics. You may feel somewhat aggrieved if the viva concentrates on gamma amino butyric acid (GABA) and *N*-methyl-D-aspartate (NMDA) receptor theory, but you should recognise that there is only so far that such a topic can be pursued, and you should be able to acknowledge finally that questioning about the scientific foundation of your everyday anaesthetic practice is a legitimate area of enquiry. Given the restricted numbers of drugs, however, it should not be an insuperable task to acquire the necessary amount of information. Some of the questions can be straightforward and lend themselves readily to a structured answer that you can adapt across the range of anaesthetic drugs. One such question, for instance, may ask you to enumerate the properties of an ideal volatile agent, and to compare desflurane and sevoflurane against that ideal. You will see that this same question could be asked of local anaesthetics, neuromuscular blockers, inotropes, anti-emetics and any number of classes of agents. You will also need to have some understanding of subjects such as pharmacokinetics and receptor theory. Much of the knowledge that you may have acquired in working for the Primary FRCA will stand you in good stead for this part of the Final FRCA.

Clinical measurement and equipment

You might have hoped to have left most of the physics and clinical measurement behind, but as also applies to pharmacology questions, much of the work that you did for the Primary FRCA will also be helpful for the Final FRCA. Some final examiners are mesmerised by the physics involved in some of the questions that appear: others find it less beguiling. If you are examined by one of the former group then expect to be asked to define, for example, the SI units that are appropriate to the particular question, and do not worry if you get so immersed in the science that you never reach its clinical application. At the other extreme lie the examiners who take the view that complex anaesthetic devices are essentially black boxes whose inner workings can safely be left a mystery. In this case the viva will follow a rather different course, and it is probable that the emphasis will be more on clinical uses and on sources of error in interpretation of the information that is delivered. You will need, therefore, to be prepared for both. But even examiners who have considerable enthusiasm for this subject will recognise that there is only so far that it can be reasonably taken. The detailed physics underlying MRI, for example, is too formidable to be covered in a viva such as this. If you can articulate the basic principles of the topic, whether it is MRI scanning or defibrillation, and if you can demonstrate that you are aware of its clinical and safety implications, then in most cases that should be enough to ensure you a pass.

Statistics

There are doctors who have an intuitive gift for statistics, which is a subject that they find very straightforward. Included among such doctors are some examiners and some candidates, and they do not, therefore, understand the collective groan that goes up when the prospect emerges either of having to ask or to answer a question on medical statistics. The fact remains, however, that the topic is unpopular with the majority of anaesthetists. Yet paradoxically this may be of some benefit to those who are uncomfortable with the concepts. Is a pair of examiners really going to fail a candidate on the basis of statistical ignorance alone? That would be a decision much harder to justify than were it to be based on a poor performance in a question about respiratory physiology or anaesthetic pharmacology. Most examiners, moreover, are conditioned by their own experience of asking about statistics to expect less than brilliant answers. What this means in practice is twofold. First, that the questions are not

especially demanding, and second, that as long as you are able to enunciate some basic principles and definitions then you are more likely to get a bare pass than you would were you to offer the same level of information about, say, the anatomy of the epidural space. So as a minimum make sure, for example, that you know the difference between parametric and non-parametric data and tests, between paired and unpaired *t*-tests, and about the null hypothesis. Be prepared to discuss briefly the principles which underlie meta-analysis and be familiar with the results of at least one meta-analysis which is of clinical importance.

Prioritising the questions

When you are contemplating the syllabus for the Final FRCA you may, understandably, feel daunted by the requirement to know about what seems like a vast range of disparate subjects. It may be helpful for you to give different priority to these, so that you do not spend a disproportionate amount of time learning dispiriting detail about topics in which you may have little interest. You need to visualise, therefore, a situation in which at the end of your viva one examiner has awarded you a '2', whereas the other has given you a '1+'. At this point they will confer in order to arrive at a final mark. They will not be seeking to fail you, but they need to determine which side of the pass–fail border you are destined to fall. To that end they will probably go through each of the viva questions that you have been asked. The deciding factor is often a question that has been answered very poorly, and you have to imagine them saying *He (or she) did all right on questions A and B, not so well on C, but knew almost nothing about D.* It is Question 'D' that may determine your fate. If it is on the internal jugular vein, on propofol or on pulse oximetry, then quite reasonably you are more likely to fail, because these are core areas of anaesthetic practice. If, on the other hand, question 'D' was on the fuel cell, on plasma proteins or on immunology, then the examiners may be more forgiving, reasoning that these subjects are less central to the practice of safe clinical anaesthesia. It may be that you are so well organised and so self-disciplined that you will be able to cover every area with equal enthusiasm. If, however, you have to make some choices about how to apportion your time, you may decide that you will have to spend less of it on some subjects. So when you are working through the topics during your preparation for the examination, imagine that each one potentially is your question 'D' and into which category it might fall. If you believe that it might be peripheral to clinical practice then do not ignore it completely, but concentrate your efforts on more mainstream areas.

2

Anatomy and its applications

The internal jugular vein

Commentary

Outside the intensive therapy unit, the right internal jugular vein is probably the first site of choice for central venous cannulation. It is readily accessible and has a comparatively low complication rate. The ability to cannulate the vessel is a core skill.

The viva

You will be asked to describe its anatomy.

- The internal jugular vein originates at the jugular foramen in the skull (the foramen drains the sigmoid sinus) and is a continuation of the jugular bulb.
- It follows a relatively straight course in the neck to terminate behind the sterno-clavicular joint where it joins the subclavian vein.
- Throughout its course it lies with the carotid artery and the vagus nerve within the carotid sheath, but it does change position in relation to the artery. Initially it lies posteriorly before moving laterally and then anterolaterally.
- The vein is superficial in the upper part of the neck before it descends deep to the sterno-cleidomastoid muscle. In the neck the structures through which a cannulating needle passes are skin and subcutaneous tissue, the platysma muscle, sterno-cleidomastoid (in the lower neck) and the loose fascia of the carotid sheath.
- Anterior to the vein at the top of its course lie the internal carotid artery and the vagus nerve.
- Posterior to the vein are (from above downwards): the lateral part of C_1, prevertebral fascia and vertebral muscles, the cervical transverse processes, the sympathetic chain, and at the root of the neck, the dome of the pleura. On the left side the jugular vein lies anterior to the thoracic duct.
- Medial to the vein are the carotid arteries (internal and common), and four cranial nerves: the ninth (glossopharyngeal, IX), the tenth (vagus, X), the eleventh (accessory, XI) and the twelfth (hypoglossal, XII).

Direction the viva may take

You may be asked briefly to describe a technique for venous cannulation.

- You will have had experience of this technique. Describe the one with which you are most familiar.
- As an example: the high approach. (This is a so-called landmark technique, as opposed to one which is guided by the use of ultrasound.) A fine 'seeking' needle (25G or similar) is inserted at the level of the superior border of the thyroid cartilage (at about C_4) and on the medial border of sterno-cleidomastoid.
- The needle is directed caudally at an angle of 30° in the direction of the ipsilateral nipple. The vein is usually quite superficial, although this will depend on the body habitus of the patient.
- Once the vein is located, the Seldinger technique (catheter over guide wire) can be used to establish definitive central access.

Further direction the viva could take

You may be asked finally about the complications associated with the technique and how these may be avoided.

- **Complications:** Some of these can be minimised by the use of an ultrasound-guided needle. The National Institute of Clinical Excellence (NICE) report of September 2002 recommended the routine use of ultrasound for locating the internal jugular vein. Evidence to support its use for other sites is not yet robust.
- **Pneumothorax (and haemothorax):** The risk is minimised by using a high approach, which avoids the dome of the pleura.
- **Intrapleural placement:** Here too the risk is minimised by using a high approach which avoids the pleura. A check X-ray will prevent inadvertent intrapleural infusion.
- **Air embolism:** Positioning the patient head down during insertion decreases the risk.
- **Cardiac dysrhythmias:** These may occur should the guide wire or catheter be inserted as far as the heart.
- **Carotid artery puncture or cannulation:** The risk is reduced if the artery is palpated continuously throughout cannulation, and it is minimised by the use of an ultrasound-guided needle.
- **Thoracic duct injury (chylothorax):** The thoracic duct cannot be damaged if the left side is not used. Otherwise the risk is minimised by using a high approach.
- **Infection:** Central line infection can be disastrous. Significant infection is said to occur in around 12% of insertions, although the rate of bacterial colonisation is likely to be higher. The risks are reduced by scrupulous aseptic technique as well as meticulous aftercare. See *Central venous pressure and cannulation*, page 141.

The cerebral circulation

Commentary

This is a standard question, but is one which contains a lot of anatomical detail. It may be helpful to practice drawing a simple explanatory diagram. The viva may also touch on the physiological aspects of cerebral perfusion or briefly on the subject of intracranial pressure.

The viva

You will be asked about the arterial supply to, and the venous drainage of the brain.

Arterial supply

- The brain is supplied by four major vessels: two internal carotid arteries which provide around two-thirds of the arterial supply, and the two vertebral arteries which deliver the remaining third.
- The vertebral arteries give off the posterior inferior cerebellar arteries, before joining to form the basilar artery. This also provides the anterior inferior cerebellar, and the superior cerebellar arteries.
- The basilar artery then gives off the two posterior cerebral arteries, which supply the medial side of the temporal lobe and the occipital lobe.
- The artery then anastomoses with the carotid arteries via two posterior communicating arteries.
- The internal carotid arteries meanwhile, give rise to the middle cerebral arteries, which supply the lateral parts of the cerebral hemispheres. They also provide much of the supply to the internal capsule, through which pass a large number of cortical afferent and efferent fibres.
- The carotids also give rise to the anterior cerebral arteries, which are connected by the anterior communicating artery, and which supply the medial and superior aspects of the hemispheres.
- The three arterial stems (basilar and carotid arteries), linked by the anterior and posterior communicating arteries, comprise the arterial circle of Willis.

Venous system

- The cerebral and cerebellar cortices, which are relatively superficial structures, drain into the dural sinuses. These venous sinuses lie between the two layers of the cranial dura mater. The superior sagittal sinus lies along the attached edge of the falx cerebri dividing the hemispheres, and drains usually into the right transverse sinus. The inferior sagittal sinus lies along the free edge of the falx, and drains via the straight sinus into the left transverse sinus. (The straight sinus lies in the tentorium cerebelli.) The transverse sinuses merge into the sigmoid sinuses before emerging from the cranium as the internal jugular veins.
- Deeper cranial structures drain via the two internal cerebral veins, which join to form the great cerebral vein (of Galen). This also drains into the inferior sagittal sinus.
- The cavernous sinuses lie on either side of the pituitary fossa and drain eventually into the transverse sinuses.

Direction the viva may take

The direct anaesthetic implications of the anatomy described above are modest. You may be asked about cerebral perfusion (see *Cerebral blood flow*, page 127) or intracranial pressure (see *(Raised) intracranial pressure*, page 124), although these are both complete topics in themselves. Below are some miscellaneous facts, which may prove useful during the discussion.

- The circle of Willis provides very effective collateral blood supply in the presence of arterial occlusion. Three out of four of the main arteries can be occluded, as

long as the process is gradual, without producing cerebral ischaemia. The normal intracranial blood volume is around 150 ml.

- The middle cerebral artery has been described as 'the artery of cerebral haemorrhage'. This is mainly because it supplies the internal capsule, where a large number of important cortical afferent and efferent fibres congregate.
- The superficial areas of the cerebral (and cerebellar) cortex drain to the venous sinuses via thin-walled veins. These are vulnerable to rupture, with the formation of subdural haematomata, particularly in the elderly in whom there is a loss of brain mass.
- Other potential intracranial catastrophes include cavernous sinus thrombosis, sagittal sinus thrombosis and cortical vein thrombosis (CVT). CVT is associated with pregnancy, and is reported as occurring in between 1 in 3000 and 1 in 6000 deliveries. If this figure is accurate then CVT is being under-diagnosed, because very few obstetric anaesthetists encounter the one or two cases a year that this incidence would suggest.

Anatomy of the orbit

Commentary

Questions on the eye seem to be disproportionately common in the Final FRCA, despite the fact that alternative forms of local anaesthesia are now widespread. Sub-Tenon's block and topical instillation of local anaesthetic drops are supplanting traditional retrobulbar and peribulbar anaesthesia, which are fast losing relevance for anaesthetists. The abiding attraction for examiners may lie in the fact that considerable anatomical detail is concentrated in a small well-circumscribed area. Although the viva will end up discussing local anaesthetic blocks, anatomy remains the core part of this question. There is more information below than overall you will need, but it is included in case at some stage of the questioning you are asked for further detail.

The viva

You may be asked simply to describe the anatomy of the orbit, or you may be invited to concentrate on one aspect, such the extraocular muscles.

- The bony orbit has been described variously as a pyramid whose apex is directed inwards and upwards, as a cone, and as a pear whose stem points towards the optic canal. Its roof is comprised of the orbital plate of the frontal bone, with the anterior cranial fossa above, while its floor is formed by the zygoma and the maxilla, with the maxillary sinus beneath. Its medial wall is formed by parts of the maxilla, lacrimal bone, ethmoid and sphenoid, and beyond it lie the ethmoid air cells and the nasal cavity. The zygoma and the greater wing of the sphenoid make up its lateral wall.
- It contains the globe, together with the muscles, nerves and blood vessels that subserve the normal functions of the eye.
- The normal globe has an axial length of around 24 mm (this is measured in the anteroposterior diameter). An eye longer than 26 mm is usually myopic. Its outer layer comprises sclera and cornea, the middle vascular layer contains the choroid, the ciliary body and the iris, and the innermost layer is made up of neural tissue in the form of the retina.
- The movements of the globe are controlled by the six extraocular striated muscles. The four recti (lateral, medial, superior and inferior) originate from the annulus of Zinn, the tendinous ring which encircles the optic foramen, and insert beyond the equator of the globe. The lateral and medial recti have two heads. The superior oblique muscle originates above and medial to the annulus, curves round the trochlea (which acts like a pulley) before inserting behind the equator and beneath the superior rectus. The inferior oblique originates from the lacrimal bone and inserts posterolaterally on the globe, having passed beneath the inferior rectus muscle.
- **Motor innervation:** The lateral rectus is supplied by the sixth cranial nerve, the abducens and the superior oblique is supplied by the fourth, the trochlear. The remaining muscles are supplied by the third cranial nerve, the oculomotor. (This also supplies levator palpebrae superioris, which elevates the eyelid.)
- **Autonomic innervation:** Sympathetic innervation is by the long and short ciliary nerves via the superior cervical ganglion. Nerve impulses dilate the pupil via the dilators of the iris. Parasympathetic innervation is by the short post-ganglionic ciliary nerves via the ciliary ganglion. The pre-ganglionic supply comes from the oculomotor nerve, and its impulses constrict the pupil.
- **Sensory supply:** This is derived mainly from the ophthalmic branch of the fifth cranial nerve, the trigeminal (V), although branches of the maxillary division make some contribution to lateral structures and to the nasolacrimal apparatus. There are a large number of sensory nerves for such an anatomically confined area. The examiner is unlikely to dwell on these in any detail, but in summary the innervation that may have relevance for ocular surgery can be outlined as

follows. The ophthalmic division V^1, branches into the frontal nerve, which then subdivides into the supratrochlear nerves (medial upper conjunctiva), the supraorbital nerve (upper conjunctiva) and the long ciliary nerve (cornea, iris and ciliary muscle). V^1 also forms the nasociliary nerve, which in turn branches into the infratrochlear nerve (inner canthus and lacrimal sac), and the long sensory root to the ciliary ganglion (thence to the cornea and iris). The lacrimal branch of V^1 supplies the rest of the conjunctiva.

- **Foramina:** The orbit contains nine fissures and foramina, of which three are particularly important: the optic foramen (canal), and the superior and inferior orbital fissures.
- **Optic canal:** The optic nerve traverses the optic foramen together with the ophthalmic artery.
- **Superior orbital fissure:** Through this fissure run the oculomotor, trochlear and abducens nerves to the extraocular muscles, together with the frontal, nasociliary and lacrimal nerves, and the superior and inferior ophthalmic veins. The oculomotor, abducens and nasociliary nerves traverse the lower part of the fissure and enter the muscular cone between the two heads of the lateral rectus. The trochlear, frontal and lacrimal nerves remain outside the cone.
- **Inferior orbital fissure:** Through the inferior fissure run the zygomatic and infraorbital nerves (branches of V^2), the infraorbital artery and the inferior ophthalmic vein.

Direction the viva may take

You will be asked about methods of anaesthetising the eye.

- **Topical:** The anterior structures can be anaesthetised using topical amethocaine 0.5% or 1.0%, oxybuprocaine 0.4% and proxymetacaine 0.5%. Topical anaesthesia is simple and (mostly) safe and effective, although the lack of akinesia of the eye and eyelids means that the surgeon has to control eye movement via the intraocular instruments. Anaesthesia can be supplemented by the addition of lignocaine to the irrigation fluid, or by further instillation of drops. The use of drops, however, is associated with corneal oedema, and excessive doses may worsen this problem.
- **Retrobulbar block:** This is performed by a single injection, which is made either percutaneously or transconjunctivally. The axial length of the eye gives a guide to needle depth and if the transconjunctival approach is used a 25-mm needle is amply long enough to reach the retrobulbar muscular cone. The injection is made at the junction of the lateral and middle thirds of the orbital margin in the inferotemporal quadrant. Complications include retrobulbar haemorrhage, penetration of the globe, damage to the optic nerve or ophthalmic vessels, and central spread of local anaesthetic. Retrobulbar block is very effective, but these potential complications have led a number of ophthalmic surgeons and anaesthetists to abandon it in favour of other techniques.
- **Peribulbar block:** This has been cited as a safe and effective alternative to retrobular block, but it too is not without its problems. Larger volumes of local anaesthetic are required (8–10 ml rather than 3–4 ml) which increases the intra-orbital pressure and causes periorbital chemosis. The onset of block is also considerably slower and the failure rate higher. The risk of scleral perforation is not removed because the technique requires one inferotemporal and one superonasal injection, both of which are directed beyond the equator of the globe. Some practitioners include a third injection, made at the extreme medial side of the palpebral fissure.
- **Sub-Tenon's block:** The popularity of this technique has increased recently, because it is viewed as safer than either of the sharp needle approaches. It is, however, more invasive, in that a modest amount of surgical dissection is

necessary. After topical anaesthesia to the conjunctiva the patient is asked to look upwards and outwards (in the direction of the person performing the block). This improves access to the inferonasal quadrant where the injection is made, as posterior as possible. A fold of conjunctiva is drawn upwards with forceps. A small nick at the base of this fold with surgical scissors usually opens the sub-Tenon's fascia. A blunt cannula is then inserted gently into this space and guided backwards following the contour of the globe. Injection of 4–5 ml of local anaesthetic solution will provide analgesia and adequate akinesia. The globe can in theory be perforated, but the complication is sufficiently rare for sub-Tenon's block to be considered suitable for administration by trained, but non-medical practitioners.

The trigeminal nerve

Commentary

The applied anatomy of the trigeminal nerve is relevant mainly for those working in the management of chronic pain. Trigeminal neuralgia, however, is described classically as one of the most severe pains in human experience, one which is said to have driven some patients even to suicide. It is a dramatic condition, and one that is amenable to a range of treatments. You should have some familiarity with it.

The viva

You will be asked to describe the anatomy of the trigeminal nerve.

- The trigeminal (fifth cranial nerve) is the largest of the 12, and provides the sensory supply to the face, nose and mouth as well as much of the scalp. Its motor branches include the supply to the muscles of mastication.
- It has a single motor nucleus and three sensory nuclei in the brain. The motor nucleus is in the upper pons, and lying lateral to it is the principal sensory nucleus, which subserves touch sensation. The mesencephalic nucleus is sited in the midbrain and subserves proprioception. Pain and temperature sensation are subserved by the nucleus of the spinal tract of the trigeminal nerve. This lies deep to a tract of descending fibres, which run from the pons to the substantia gelatinosa of the spinal cord.
- Sensory fibres pass through the trigeminal (Gasserian) ganglion. It is crescent shaped (hence its alternative description as the semilunar ganglion), and lies within an invagination of dura mater near the apex of the petrous temporal bone, and at the posterior extremity of the zygomatic arch. The motor fibres of the trigeminal nerve pass below the ganglion.
- From this ganglion pass the three divisions of the nerve: the ophthalmic (V^1), which is the smallest of the three, the maxillary (V^2) and the mandibular (V^3).
- **Ophthalmic division:** This passes along the lateral wall of the cavernous sinus before dividing just before the superior orbital fissure into the lacrimal, nasociliary and frontal branches. The frontal branch divides further into the supraorbital and supratrochlear nerves.
- **Maxillary division:** This runs below the ophthalmic division before leaving the base of the skull via the foramen rotundum. It crosses the pterygopalatine fossa, giving off superior alveolar dental nerves, zygomatic nerves and sphenopalatine nerves before entering the infraorbital canal and emerging through the infraorbital foramen as the infraorbital nerve.
- **Mandibular division:** This is the largest of the three branches and is the only one to have both motor and sensory components. Its large sensory root passes through the foramen ovale to join with the smaller motor root, which runs beneath the ganglion. Its branches include the sensory lingual, auriculotemporal and buccal nerves; the inferior dental nerve, which is mixed motor and sensory; and motor nerves, the masseteric and lateral pterygoid, to the muscles of mastication.

Direction the viva may take

You may be asked about trigeminal neuralgia.

- Trigeminal neuralgia is a neuropathic pain with a reputation as one of the worst pains in human experience.
- **Pathogenesis:** This remains speculative. It may be caused centrally, with abnormal neurones in the pons exhibiting spontaneous and uncontrolled discharge in the nerve. It may also be due to peripheral factors; either demyelination (in younger patients trigeminal neuralgia may be a first symptom of multiple sclerosis), or compression by abnormal blood vessels in the posterior fossa.

- **Clinical features:** The peak onset of the condition is in the middle age. The pain commonly is intermittent, lancinating and extremely severe. Attacks are spasmodic and last only for seconds. Patients are pain free in the interim, but episodes may be very frequent. Pain is limited usually to one (occasionally two) of the branches of the trigeminal nerve, which supply sensation to the face. It occurs least commonly in the ophthalmic division, which accounts for only around 5% of cases, and more frequently in the maxillary or mandibular divisions. The distribution is always unilateral. Paroxysmal pain can be precipitated by trigger points around the face reacting to the lightest of stimuli, such as a light breeze or touch, and by actions such as chewing or shaving.

Further direction the viva could take

You may be asked briefly to discuss methods of treatment.

- **Pharmacological**
  - *Carbamazepine*: This is effective in more than 90% of cases of true trigeminal neuralgia (100 mg b.d. up to maintenance of 600–1200 mg day^{-1}). The full blood count must be monitored, because the drug can cause bone marrow suppression.
  - *Phenytoin*: This is effective in a smaller proportion (around 60%) and can be given intravenously for acute intractable pain (the starting dose is 300–500 mg day^{-1}).
  - *Baclofen*: This is an antispasmodic gamma-amino butyric acid (GABA) analogue, which binds to $GABA_B$ receptors (the dose is up to 80 mg day^{-1}).
  - *Gabapentin*: This is a GABA analogue, which does not, however, act on GABA receptors. Its mechanism of action is unclear. It is an anticonvulsant, which is also used increasingly to treat neuropathic pain. The dose is titrated against response to a maximum of 1800 mg daily.
- **Destructive**
  - *Radiofrequency ablation*: A needle is passed percutaneously and under X-ray control through the foramen ovale to the trigeminal ganglion. The entry point of the needle is below the posterior third of the zygoma. Chemical ablation may also be used. This technique can be complicated by anaesthesia dolorosa, in which the patient loses not only the pain, but also most of the sensation to that side of the face, which feels dead and 'woody'.
- **Surgical decompression**
  - This is the most invasive therapeutic technique because it requires exploration of the posterior fossa to identify the aberrant vessel(s), which are compressing the nerve near its emergence from the pons.

Sensory nerve supply to the face

Commentary

The major sensory supply to the face is easy to describe, it is the numerous terminal branches that may give you more difficulty. The examiner equally may not immediately be intimate with the 25 or more named nerves which originate from the trigeminal, and so your detailed knowledge needs extend only to those branches which can be blocked with local anaesthetic to allow minor surgery on the face or to provide post-operative analgesia.

The viva

You will be asked to describe the sensory innervation of the face.

- The sensory supply to the face is provided mainly by the three divisions of the fifth cranial nerve, the trigeminal. (As the largest cranial nerve it also supplies much of the scalp, the mouth, teeth and the nasal cavity.) The skin over the parotid gland and the angle of the mandible is supplied by the greater auricular nerve, which arises from the ventral rami of the second and third cervical nerves.
- At the trigeminal (Gasserian) ganglion the nerve separates into the ophthalmic (V^1), the maxillary (V^2) and the mandibular (V^3) divisions.
  - *Ophthalmic*: The ophthalmic nerve supplies the skin of the nose, the forehead, eyelids and the scalp. (It also supplies the globe, the lacrimal apparatus and the conjunctiva.) The nerve divides just before the superior orbital fissure into the lacrimal, nasociliary and frontal branches. The large frontal branch divides further into the supraorbital and supratrochlear nerves. The supraorbital nerve supplies the skin of the forehead and scalp sometimes as far back as the lambdoid suture. The supratrochlear nerve supplies part of the upper eyelid and the skin of the lower part of the forehead near the midline. The lacrimal nerve supplies the skin adjacent to the medial canthus of the eye, while the nasociliary nerve and its branches supply the skin of the nose down as far as the alae nasae.
  - *Maxillary*: This runs below the ophthalmic branch before leaving the base of the skull via the foramen rotundum to divide into its various branches. The zygomatic nerve divides further on the lateral wall of the orbit into a zygomatico-temporal branch which supplies the skin of the temple, and a zygomatico-facial branch which supplies the skin over the cheekbones. The maxillary nerve proper crosses the pterygopalatine fossa to enter the infraorbital canal from which it emerges through the infraorbital foramen as the infraorbital nerve. This supplies the skin of the lower eyelid, of the cheek and upper lip.
  - *Mandibular*: Its large sensory root passes through the foramen ovale with branches that include the auriculotemporal, lingual and buccal nerves. The auriculotemporal nerve emerges from behind the temporo-mandibular joint to supply the skin over the tragus and meatus of the ear as well as the skin over the temporal region. The mandibular division also provides the inferior dental nerve, and one of its terminal branches, the mental nerve, emerges through the mental foramen in the mandible to supply the skin of the chin and lower lip.

Direction the viva may take

You will be asked how you could provide local anaesthesia for superficial surgery on the face.

- The supraorbital and supratrochlear nerves can be blocked a few millimetres above the supraorbital ridge. If the injection is made too close to the eyebrow it

increases the risk of periorbital haematoma. Alternatively, a single insertion point can be used in the midbrow region to allow bilateral blocks.

- The infratrochlear nerve can be blocked by a needle directed along the medial wall of the orbit via an insertion site about 1 cm above the inner canthus.
- The infraorbital nerve can be blocked as it exits the infraorbital foramen, which lies about 1.5 cm (a finger's breadth) below the inferior orbital margin in line with the pupil. The nerve can also be blocked by an intra-oral approach, injecting above the canine (3rd) tooth.
- The mental foramen, conveniently, is also in line with the pupil and can be blocked in the mid-point of the mandible (although the height of the foramen varies with age, being nearer the alveolar margin in the elderly).
- The superficial branches of the zygomatic nerve can be blocked by subcutaneous infiltration, or by injection at their sites of emergence from the zygoma.
- The auriculotemporal nerve is blocked over the posterior aspect of the zygoma, and the greater auricular nerve by infiltration over the mastoid process behind the ear.
- Relatively small volumes of 3–5 ml of local anaesthetic will usually be sufficient to block all these nerves described.

Further direction the viva could take

The viva could continue with the subject of the trigeminal nerve and trigeminal neuralgia.

- See *The trigeminal nerve*, page 18.

Local anaesthesia for carotid endarterectomy

Commentary

A multicentre trial of the merits of local anaesthesia versus general anaesthesia for carotid endarterectomy makes this a topical and practical question (at least at the time of writing). Carotid surgery in patients who are awake is both challenging and interesting and you will find it much easier to give a credible account if you have been able to see, or better still perform, some of the blocks that are required.

The viva

You will be asked to describe the local anaesthetic blocks that are performed for this procedure.

- The nerves which supply the lateral aspect of the neck all derive from the ventral rami of the second, third and fourth cervical spinal nerves ($C_{2,3,4}$). The first cervical nerve has no sensory distribution to skin.
- **Superficial cervical plexus anatomy:** The cutaneous supply to the anterolateral aspect of the neck is via the anterior primary rami of C_2, C_3 and C_4. These nerves emerge from the posterior border of the sterno-cleidomastoid muscle midway between the mastoid and the sternum. The accessory nerve is immediately superior at this point. The lesser occipital nerve (the first branch) supplies the skin of the upper and posterior ear, the greater auricular nerve (the second branch) supplies the lower third of the ear and the skin over the angle of the mandible, the anterior cutaneous nerve (the third branch) supplies the skin from the chin down to the suprasternal notch, and the supraclavicular nerves (the fourth branch) supply the skin over the lower neck, clavicle and upper chest.
- **Superficial cervical plexus block:** All these nerves can be blocked at the mid-point of the sterno-cleidomastoid by infiltrating up to 20 ml of local anaesthetic solution between the skin and the muscle. The external jugular vein crosses the muscle at this point and can be a useful landmark.
- **Deep cervical plexus anatomy:** The ventral ramus of the second nerve emerges from between the vertebral arches of the atlas and axis and runs forward between their transverse processes to exit between longus capitis and levator scapulae. The ventral ramus of the third nerve exits the intervertebral foramen lying in a sulcus in the transverse process, and emerges between the longus capitis and scalenus medius muscles. The ventral ramus of the fourth and remaining cervical nerves appear between the scalenus anterior and the scalenus medius.
- **Deep cervical plexus block:** Deep cervical plexus block in effect is a paravertebral block of C_2, C_3 and C_4. Needles are inserted at each of the three levels, using as landmarks a line between the mastoid process and the prominent tubercle of the sixth cervical vertebra (which is palpable as Chassaignac's tubercle at the level of the cricoid cartilage). The C_2 transverse process is approximately one finger's breadth below the mastoid process along this line; with C_3 and C_4 following at similar intervals caudad. After encountering the transverse process 5–8 ml of local anaesthetic can be injected with due precautions. As there is little resistance to the spread of solutions through the paravertebral space in the cervical region, adequate anaesthesia can also be obtained using a single-needle technique and a larger volume (15–20 ml) at a single level, usually C_3.

Direction the viva may take

You could be asked briefly about the complications of the blocks, which may be linked to a discussion about the benefits of the technique.

- **Complications:** Superficial cervical plexus block risks mainly what can be described as generic complications of local anaesthesia, namely intravascular

injection and systemic toxicity. The complications of deep cervical block are much the same as those associated with interscalene block, which is not surprising given the anatomical similarities, and include injection into the vertebral artery, extension of the block either extradurally or intrathecally, phrenic nerve block and cervical sympathetic block, which will manifest as Horner's syndrome (miosis, ptosis, anhydrosis and enophthalmos). The recurrent laryngeal nerve may also be affected with resultant hoarseness.

- **Advantages of endarterectomy under local anaesthesia:** Normal cerebration depends on adequate cerebral perfusion, and in the awake patient it is very obvious whether or not this is being preserved. There is no interference with cerebral autoregulation, and the requirement for vasoactive drugs is less. Proponents for the technique claim lower morbidity and mortality, but robust outcome data must await the results of the trial.
- **Disadvantages of endarterectomy under local anaesthesia:** Cerebral oxygen consumption does not fall (cerebral metabolic rate for oxygen, $CMRO_2$, decreases under general anaesthesia) and a higher pulse and blood pressure during surgery results in higher myocardial oxygen demand than otherwise would be the case. It does also mean, however, that cerebral perfusion pressure is higher. Cooperation can on occasion be a problem: immobility during extended surgery may be very uncomfortable for the patient, and should their cerebration be obtunded by ischaemia they may become restless and agitated. The nerve blocks may sometimes prove inadequate as surgery proceeds, but local supplementation by the surgeon can circumvent this problem.