POST DURAL PUNCTURE HEADACHE

Shahna Ali[1], S M Ahmad[2]

INTRODUCTION

Severe headache after dural puncture is called post-dural puncture headache (PDPH). The dural puncture may be diagnostic, therapeutic or for spinal anaesthesia. Carrie and Collins define post dural puncture headache (PDPH) as "a headache occurring after dural puncture and has a significant effect on the patients postoperative well being i.e. headache which is not only postural but also continues for more than 24 hours at any level of intensity or so severe at any time that the patient is unable to maintain upright position.[1]The headache that appears in the postoperative period after regional anaesthesia can be due to numerous reasons. However the most common cause is PDPH.

PDPH was first recorded by August Bier in 1899 and he gave a personal account of his headache, after spinal anesthesia given to him by his assistant.[2] Incidence of PDPH after intentional dural puncture varies form 0.1-36%, the highest incidence of 36% was noted after diagnostic lumbar puncture using a 20 or 22 gauge standard Quincke spinal needle.[3]Unintentional dural puncture with large tuohy needle (16 and 18 gauge) is associated with high PDPH incidence of 70-80% .In obstetric population receiving epidural anaesthesia the incidence of dural puncture is 0 - 2.6%.[4]

The pathophysiology of PDPH, risk factors, differential diagnosis and the treatment modalities have been discussed herewith. The known theory for PDPH is as follows:

The leak theory: Leakage of cerebro-spinal fluid (CSF) through dural puncture appears to be the main cause of PDPH and was first proposed in 1902.[5] This theory states that leakage of CSF through the dural hole causes decreased CSF pressure and volume, which is followed by gravity dependent downward sagging of the brain resulting in traction on the pain sensitive structure around the brain.[6,7]It has been estimated that an average human has 150 ml of CSF in subarachnoid space.[8]In patients with PDPH the loss is more than rate of replacement that is approximately 0.35ml/min.[9,10]

In upright position, the pain is more as it exacerbates the traction on intracranial structures and increase transdural lumbar CSF pressure leading to more loss.[11]Removal of CSF around 20 ml has shown to produce immediate PDPH which was reversed by restoration of intracranial pressure by injecting intrathecal saline.[12] In patients with PDPH,MRI done after dural puncture showed decrease in CSF volume.[13,14] The headache which is throbbing and orthostatic, is an important symptom of cerebral vasodilatation and intracranial congestion of blood and this supports the hypothesis that the loss of CSF causes compensatory cerebral vasodilatation resulting in PDPH. (Monro Kellie Doctrine).[15]A positron emission tomography study in these patients demonstrate brain activation in the region of major

Department of Anaesthesia and Intensive Care, JN Medical College and Hospital, Aligarh Muslim University, UP, India
Correspondence Address : Department of Anaesthesia and Intensive Care, JN Medical College and Hospital, Aligarh Muslim University, UP, India

basal arteries that is probably due to vasodilatation of vessels during headache.[16]

SYMPTOMS

The pathgnomonic feature of PDPH is its history and course of events after dural puncture. It is characteristically related to posture. The headache increases with upright position and is relieved in lying down. It may be associated with nausea and vomiting, auditory or visual symptoms. Auditory symptoms may be present in 3.5-12% and ocular in 3.4-13%.[17-19]

Neck stiffness along with pain radiating to the neck may be present .[16]

It has been seen that 40-65% exhibit sign in first 24hrs and about 70-90% of patients develop symptoms within 48hrs of puncture. The median recovery is 5 days with around 70% of patients recover spontaneously in a week.[17,20]

FACTORS INFLUENCING PDPH

The main factors influencing PDPH can be categorized as :
1. Patient related
2. Needle related
3. Puncture technique related

PATIENT RELATED

a) Age: Patients aged 20-40 years are most susceptible whereas the lowest incidence occurs after 50 years.[21,22]The lesser incidence of PDPH in elderly individual is due to decrease in the elasticity of cranial structures and reduction in overall pain sensitivity. In children PDPH is rarely reported suggesting a lower incidence.[23]As explained by lower CSF pressure in infants and children than adults and also the lower hydrostatic pressure in lumber regions generated by the upright position.[24]

b) Sex: Women are more likely to be affected than men. In the series reported by Vandane and Dripps women had twice incidence i.e,14% of PDPH compared with men i.e., 7%.[20] Some suggested that this difference was because of a large number of obstetric patients in the women's group. Nevertheless even after removal of these cases women still had higher (12%)incidence compared to men (7%).[25,26] Kang et al reported twice the incidence of PDPH in women (13.4%) compared with men (5.7%). This difference was not valid for smaller needle sizes.[27]

NEEDLE RELATED

There is direct correlation between needle size and risk of PDPH. Vandam and Dripps noted that the incidence ranged from 18% with a 16 gauge needle to 5% with 26 guage needle whereas the overall risk of PDPH was 11% in 11000 cases of spinal anesthesia.[20] There are enough evidences that both needle size, and tip design impact the incidence of PDPH. The results of a meta analysis of 450 articles showed reduction of PDPH when:

(i) small spinal needle was used compared with a large needle of the same type

(ii) non-cutting spinal needles rather than cutting needles were used, unless the discrepancy in needle size is very large[28].

With quincke needle the incidence of PDPH is directly related to the size of the needle used[29].The pencil point or blunt tip needles like whitacre needle are associated with lower PDPH rates because they are less traumatic to the longitudinal fibers of duramater , separating them and this produces a small rent with reduced CSF leakage. Lambert et al reported the rate of PDPH with 25 guage whitacre needle as1.2% in comparison to 27 guage cutting needle as 2.7%[30].A randomized comparison of 25 guage Whitacre and Quincke needle revealed a significantly lower incidence of

PDPH in the whitacre group 8.5% versus 3%.[31]

Cesarini et al performed a randomized trial of 24 gauge sprotte and 25 guage Quincke needle in patients receiving spinal anaesthesia for cesarean section. There were no cases of PDPH in the sprotte group but there was 14.5% incidence of PDPH in the Quincke group.[32] A modification of the Quincke needle has been made available, known as atraucan needle. It has a cutting point and double bevel which are intended to cut a small dural hole and then dilate it.[33].In the current anaesthetic practices, its role has not been clear.

PUNCTURE TECHNIQUE RELATED

Needle bevel orientation piercing the duramater, angle of insertion and number of punctures are important factors in puncture technique.

The orientation of the bevel of a spinal needle parallel to the long axis of the spine produced less dural trauma than occurred when the bevel is inserted perpendicularly.[34]Fink and Walker noted that the duramater consists of multidirectional interlacing collagen fibers and both transverse and longitudinal elastic fibres.[35]The insertion of the needle with the bevel parallel to the long axis of the spine most likely results in less tension on the dural hole. Norris et al investigated unintentional dural puncture occurring during the identification of the epidural space in 1558 women and the bevel of the epidural needle was randomly 2oriented either parallel or perpendicular to the longitudinal dural fibers during epidural cannulation. Accidental dural puncture occurred in 41 women (2.63%). Twenty women with the needle bevel oriented perpendicular and 21 with the needle bevel inserted parallel to the longitudinal dural fiber. Fourteen women out of 20 (70%) developed PDPH in perpendicular group and 5 out of 21 women (24%) suffered PDPH in the longitudinal group. These data suggest that the orientation of the epidural needle is not a factor in avoiding an accidental dural puncture but is crucial in diminishing the resultant PDPH.[36,37]

Angle of insertion At least one in vitro study suggests that the insertion of the needle at an acute angle results in decreased leakage of CSF.[38]
Number of puncture. Lybecker et al did not find a significant association between the number of punctures and the frequency of PDPH after multivariate analysis.[26] However recent analysis of prospective data on 8,034 spinal anesthetic patients showed increase in the incidence of PDPH with repeated dural puncture, this confirms the assumption that a second dural puncture increases the risk of PDPH.[39]

DIFFERENTIAL DIAGNOSIS

PDPH is a diagnosis of exclusion and other causes of head ache must be considered.We should be aware that dural puncture headache is only one of the many causes of headache in postoperative period.

a) Migraine Headache
Migraine headache is classically described as unilateral throbbing headache, sometimes accompanied by nausea and vomiting and there is no relief in the supine position. Careful questioning and physical examination needs to be done for other causes of headache.[40]

b) Lactation Headache
After child birth, headache is associated with increased plasma vasopressin concentration. This gives rise to episodes of intense headache during breast feeding, especially in those women who are known to suffer from migraine.[41]

c) Brain Tumour
The headache is dull in character rather than throbbing, is mostly accompanied by nausea, vomiting, seizures may also occur. There are usually focal signs and there is evidence of increased intra-cranial pressure.[42]

d) Tension Headache
It is a gradual onset dull, persistent pain that extends over the entire head. There is no relation to the position of the patient.

e)Subarchnoid Heamorrahge
Headache produced by SAH is sudden, severe and mainly in the occipital region, associated with vomiting ,neck stiffness and decreased level of consciousness or coma.

f)Cortical vein thrombosis (CVT)
The headache is severe and throbbing in nature, there may be focal signs with, seizures and coma may follow.[43]

g)Meningitis
There is severe headache in meningitis, and this is accompanied by fever, neck stiffness, and a positive kernig sign. There is lethargy, confusion, vomiting and seizures .

h)Pneumocephaelus
Air used for identification of epidural space may cause sudden headache, accompanied by neck and back pain. It is also positional in nature, worse on sitting-up and relieved by lying down.

i)Spontaneous Intracranial Hypotension(SIH)
Spontaneous Intracranial hypotension is a condition with symptoms and pathophysiology indistinguishable from the PDPH. It is thought to be due to rupture of a perineural cyst of the spine.[44]

j) Subdural Haematoma
It is a rare association with dural puncture and should be looked as a cause of PDPH.[45]

Headache after regional anesthesia which does not present with the classic symptoms, especially posture related, warrants a neurological evaluation. A contrast CT or MRI scan should be done before therapeutic measures are undertaken.

PREVENTION OF PDPH

Headache after dural puncture can be prevented by minimizing leakage of CSF. Studies have shown that bed rest on recumbent position may delay the onset but does not decrease the incidence of PDPH.[46,47] In general the relative risk of PDPH decreases with each successive reduction in needle diameter. Studies have shown that needle size is of primary importance in preventing headache but shape of the needle also has an influence on incidence of PDPH. Non-cutting needle and smallest gauge needle should be used in order to prevent PDPH. It has also been suggested that an acute angle of insertion of a needle into the dura may produce a flap that can readily close on itself. It was Digiovanni and Dunbar that suggested that prophylactic epidural blood patch might help to prevent PDPH but early studies were disappointing.[48]The following studies reevaluated the use of prophylactic blood and showed the decrease incidence of PDPH after blood patch.[49]

MANAGEMENT

Treatment of PDPH is divided into two categories:
1) Pharmacological which is the conservative approach

2) Invasive approach

The conservative approach includes the following strategies:

a)Bed Rest
The patient is asked to take to bed rest and avoid the discomfort associated with an upright position.

b)Hydration
Oral hydration remains a popular therapy for

PDPH but there is no evidence that vigorous hydration has any therapeutic benefit in a patient with normal fluid intake.[50] In case when patient is unable or unwilling to take fluids orally, intravenous fluid should be given.

c)Analgesics
Simple analgesics such as acetaminophen and nonsteroidal anti-inflammatory drugs may provide some benefits. Many post surgical patients are already receiving mild opiates to treat postoperative pain that would help in PDPH. It is controversial whether addition of opioids to single local anesthetic solution decreases the incidence of PDPH.[51]

d)Other Drugs
Caffeine has been used to treat PDPH for many years. Its efficacy have been assessed in a randomized double blind trial by Sechzer and Abel.[52]In this trial patients , who received caffeine sodium benzoate 500mg intravenously, had better relief of PDPH than those who received a placebo. Camann et al. observed that oral caffeine 300mg is superior to placbo for the relief of PDPH.[53]Caffeine is a cerebral vasoconstrictor and one study has demonstrated a reduction of cerebral blood flow after intravenous administration of caffeine sodium benzoate for PDPH.[54]Theophylline also a cerebral vasoconstrictor has been demonstrated to be more effective than placebo.[55]

Alternatives for treatment of PDPH which have appeared in literature, sumatriptan and ACTH harmone. Carp et al reported the administration of sumatriptan 6mg to six patients with PDPH with complete resolution of headache in four hours.[56]This drug is cheap and administered as subcutaneous injection.

Collier described the anecdotal use of long acting ACTH for PDPH in six patients.[57]Recently its use as single intravenous infusion of ACTH 1.5 u/kg in 250 ml of normal saline has been reported to provide effective relief in 2 cases.[58]However this drug also requires further trials.

INVASIVE APPROACH

a)Epidural blood patch
Gormley in 1960 reported the successful treatment of post spinal headache after the administration of 2-3 ml of blood in epidural space.[59]Later on its efficacy had been reported with 10ml of blood in epidural space.[60] Crawford in his study found better results with20ml of blood.Blood exerts a mass effect in the epidural space compressing the dural sac and displacing the conus medularis, cauda equina and some times also the nearby nerve roots.[61]

It is estimated that a 96% to 98% success rate can be expected from a properly executed blood patch.[62]The blood patch should ideally be performed at 24 hours after puncture to be more effective.

The blood should be injected at a rate of 1.0ml over 3 seconds so as not to cause lyses. The blood will not form a proper clot to seal the dural tear if it is injected too quickly and the patient may complain of increasing pressure and discomfort in the back, buttock or legs.

The patient should remain supine and immobile for 30 minutes to 1 hour to allow the blood to form a clot. Major complications are rare. Many patients complain of backache which occurs in approximately 16% of patients and may last for upto 3 months.[63] Other complications include bleeding, infection, arachnoiditis and failure to relieve the headache

b)Epidural Saline
Epidural administration of saline has been used to relieve headaches after dural puncture for 40 years.[64]The benefit of single and continuous infusion has been proposed.[65]Some anesthesiologist have reported the successful use of saline infusion for 24 hours to treat PDPH patients with failed epidural blood patch.[66]

c)Epidural Dextran
Epidural dextrans 40 or gelatin have also been found effective in management of PDPH. Administration of 30- 40ml provided good pain relief in all patients treated with gelatin.[67]

CONCLUSION

Diagnosis of PDPH is straightforward in most cases and it is diagnosis of exclusion. Clinicians should be aware that there may be other causers of headache that may show up as PDPH. EBP is the gold standard but there are risks associated. Accidental dural puncture is an unfortunate complication of therapeutic anaesthetic procedure and has a significant impact on the health care cost, as it prolongs hospitalization, it often last for several days and may be associated with auditory and visual disturbances, nausea, vomiting and cranial nerve palsy. Although PDPH is a self limiting and nonfatal condition, its postural nature prevents the patient from performing routine activity. Therefore these patients require psychological support and a lot of reassurance in addition to therapeutic measures. Prevention, early and appropriate diagnosis with timely treatment is key to success in its management.

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Input from a statistician should be sought at the planning stage of the study. The statistical methods with enough details to enable a knowledgeable reader with access to the original data to verify the reported results, should be incorporated. Give a brief note of how you arrived at the chosen sample size of your study. Give the exact tests used to analyse the data statistically and include an appropriate reference if the test is not well known. If computer software was used, give the type and version of the software. When possible, quantify findings and present them with appropriate indicators or easurement error or uncertainty (such as 95% Confidence Intervals). Avoid sole reliance on statistical hypothesis testing such as the use of p values, which fails to convey important quantitative information.

Results

This section has to have two essential features: there should be an overall description of the major findings of the study; and the data should be presented clearly and concisely. Present your results in logical sequence in the text, tables and illustrations. Do not repeat in the text all the data in the table or illustrations; emphasise or summarise only important observations. It is worthwhile stating briefly what you did not find, as this may stop other workers in the area undertaking unnecessary studies.

Discussion

It is difficult not to write a long and detailed analysis of the literature that you know so well. A rough guide to the length of 'Discussion', however is that it should not be more than one third of the total length of the manuscript (IMRAD) Emphasise and summarise the new and important findings of the study and the inferences that follow from them. Discuss possible problems with the methods used. Compare your results with previous work or relate your observations to other relevant studies. Discuss the scientific and clinical implications of your findings. Do not repeat in detail data or other material given in the 'introduction' or the 'Results' section. Discuss and analyse the limitations of your study, including suggestion for future work.

Conclusions

Link the conclusions with the goals of the study but avoid unqualified statements and conclusions not completely supported by your data.

Acknowledgements

They should be brief and should include reference to the source of technical help, material support and financial assistance. Individuals named must approve their inclusion in the acknowledgements, before the paper is submitted.

References

The references of the article are the foundation on which the work of the study is built. They provide the scientific background that justifies your study, including the methods used. AAAR follows 'Vancouver style' of quoting the references as superscripts in which references are numbered consecutively in the order in which they are first mentioned in the text. Identify references in text, tables, and legends by Arabic numerals in parentheses. References cited only in tables or in legends to figure should be numbered in accordance with a sequence established by the first identification in the text of the particular table or figure. Use the style of the examples below, which are based with slight modifications on the formats used by the U S National Library of Medicine in Medline database. The titles of journals should be abbreviated according to the style used in Medline. The references must be verified by the authors(s) against the original documents. Restrict references to those that have a direct bearing on the work described, preferably less than 25 for general articles and 6 for short communications.

Examples of correct forms of references are given below.

A. Journals:

1. Standard journal article List all authors, but if number exceeds six, list only first three and add et al. Fery AM, Haynes AR, Owen KJ, Farrall M, Jack LA, Lai LY, et al. Predisposing locus for Alzheimer's disease on chromosome 21, Lancet 1989; 1: 352-5.

2. Organisation as author : The Royal Marsden Hospital Bonemarrow Transplantation Team. Failure of syngeneic bonemarrow graft without preconditioning in post- hepatitis marrow aplasia. Lancet 1977; 2: 742 4.

3. No author given : Coffee drinking and cancer of the pancreas (editorial). BMJ 1981; 283:628.

B. Books and other Monographs

1. Personal author(s): Colson JH, Armour WJ. Sports injuries and their treatment, 2nd rev. ed. London: S. Paul, 1986.

2. Editor(s), compiler as authors : Diener HC, Wilkinson M, editors. Drug-induced headache. New York: Springer Verlag, 1988.

3. Chapters in a book: Weinstein L, Swartz MN. Pathologic properties of invading microorganisms. In:Sodeman WA Jr,

Sodeman WA, editors. Pathologic physiology: mechanisms of disease. Philadelphia: Saunders, 1974: 457-72.

C. Other published Material

Newspaper article: Rensberger B, Specter B, CFCs may be destroyed by natural process. The Washington Post 1989 Aug. 7; Sect. A:2 (Col.5).

D. Unpublished Material

Lillywhite HD, Donald JA. Pulmonary blood flow regulation in an aquatic snake. Science. In press or Personal Communication

E. Internet References

Complete Website address and the location to be mentioned.

Tables

Do not include tables in the text.
Type each table, double-spaced on a separate sheet.
Number tables consecutively in the order of their first citation in the text and put a brief title for each. Give each table a short abbreviated heading, Mention explanatory matter as well as explanations of all non-standard abbreviations used in the table, in footnotes and not in the heading. Identify statistical measures of variations such as standard deviation and standard error of the mean. Indicate approximate position of each table in relation to the subject matter of the text right hand margin of the appropriate page of the manuscript. If you use data from another published or unpublished source, obtain permission and acknowledge fully. Maximum tables allowed in any manuscript is as follows:

Maximum tables allowance

General Article (excluding abstract)	6
Case Report	2
Brief Report	4
Technical Communication	5
Review Article	10
Medical Intelligence Article	6
Special Article	6
Editorial	1
Letter to the Editor	2

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Submit Figures Letters, numbers, and symbols should be clear and even throughout and of sufficient size that when reduced for publication each item will still be legible. Each figure should have a label pasted on its If a figure has been published, acknowledge the original source and submit written permission from the copyright holder to reproduce the material.

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All measurements length, height, weight and volume,etc. should be reported in metric units (metre, kilogram, or litre) or their decimal multiples. Temperatures should be given in degree Celsius. Blood pressure should be given in millimetres of mercury. All haematologic and clinical chemistry measurements should be reported in the metric system in terms of the International System of Units (SI).

Abbreviations and Symbols

Use only standard abbreviations. Avoid abbreviations in the title and abstract. The full term for which an abbreviation stands, for should precede its first use in the text unless it is a standard unit of measurement.

Correspondence

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or brief notations of general interest. The manuscripts must be double-spaced, and a title and two copies must be provided. Letters may be submitted at **aaarjournal@gmail.com .**

B. The editor may change, delete or modify in any way all items of correspondence.Maximum Word Allowance: When submitting your manuscript, please observe the maximum word count allowed for each type of submission; and the maximum allowance for figures, tables, and references (word count should reflect text only and must be listed in the cover letter):

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General Article (excluding abstract)	3000 words
Case Report	800 words
Brief Report	1000 words
Technical Communication	1500 words
Review Article	4000 words
Medical Intelligence Article	3000 words
Special Article	2000 words
Editorial	1500 words
Book Review	750 words
Letter to the Editor	200 words
Abstract	350 words
Implications	50 words

Non-textual Material Maximum Allowance

Figure and Tables No more than 3 each or a combination of 6 total. Do not duplicate data in tables and figures. References No more than 25 references per article, up to 40 references are acceptable.

Submission of manuscripts

Manuscripts (including tables, figures, photographs,etc). accompanied by a covering letter should be signed by all the authors. The covering letter must provide an undertaking to the effect that (a) the article has not been published or submitted to or accepted for publication in any form in any other journal,(b) the authors vouch safe that the authorship of this article will not be contested by any one whose name (s) is/are not listed, (c) on acceptance the article will become copyright of AAAR (d) the sequence of the names of co-authors (e) the manuscript has been read and approved by all the authors,(f) name, address and the email ID of the corresponding author (responsible for communication).On final preparation, A letter of acceptance or otherwise, will normally be sent to the author within 3 (three) months. Articles which are not accepted cannot be sent to the author unless accompanied by adequate postage stamps.

A Completed checklist must accompany each manuscript submitted to Asian Archives of Anaesthesiology and Resuscitation.

Checklist for submitting the manuscript

General

1. Two complete sets of the manuscripts (including tables) are submitted.
2. A floppy disk or CD is submitted with two files : the complete manuscript and a separate file containing only the title page, abstract, and references.
3. Manuscript is typed double-spaced, with ample, left ,justified, margins.
4. Pages are numbered consecutively, starting with the title page.

Title Page

1. On the first page are typed the title, author name(s) and major degree(s), and affiliation(s).

2. The name, address, telephone and FAX numbers, and E-mail address of the corresponding author are to be given.

3. The manuscript title is no longer than 100 characters (letters and spaces) and does not contain any abbreviations.

4. A short title (no more than 30 characters) is provided at the bottom of the page for use as a running foot.

Summary

* An abstract is provided. For all kind of articles, this abstract is limited to 200-250 words.

References

1. References correspond to the specifications of the Uniform Requirements for Manuscripts Submitted to Biomedical Journals" promulgated by the International Committee of Medical Journal Editors.

2. References are identified in the text by superscript figures, eg., Miller.

3. Each reference is cited in the text. Those appearing in tables and figures should be cited in the text where the table or figure is mentioned.

4. References are numbered consecutively in the order in which they appear in the text. (Vancouver Style)

5. Unpublished data, personal communications, submitted manuscripts, statistical programs, papers presented at meetings, and nonpeer

review publications are not listed in the bibliography.

6. The bibliography is typed doublespaced.

7. Abbreviations of Journal titles conform to those used in Index Medicus, National Library of Medicine.

Tables

1. Each table is typed on a separate sheet of paper with its title.

2. Tables are numbered with Arabic numerals.

3. Each table contains all necessary information in order that it may stand alone, independent of the text.

4. No table contains data that could be included in the text in several sentences.
5. Vertical lines are not used.

6. Irrelevant and extra tables must not be included

Figures

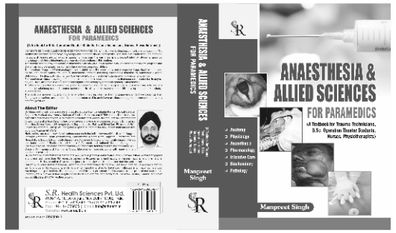
1. Each figure is cited in the text.

2. Figures have been prepared with the journal column size in mind.

3. Letters and identifying marks are clear and sharp, and the critical areas of radiographs and photomicrographs are identified.

4. Legends and explanatory material appear in the accompanying caption and not no the figure itself.

5. Legends are typed together on one page. Legends for photomicrographs include information regarding stain and magnification.



BOOK REVIEW

ANAESTHESIA AND ALLIED SCIENCES FOR PARAMEDICS,2013,first edition

Editor-Dr Manpreet Singh, MD, FCCP, FIMSA, FACEE,MAMS

Publisher : Mr Rahul Jain - SR health Sciences, (CBS Publishers,India)

Darya Ganj, Delhi, India

Phone of publisher: 09810825524

E-mail-rahul@srhealth.in,rahuljain09@gmail.com

The editor of this book, Dr Manpreet Singh is involved in teaching the students of BSc Medical Technology and Operation Theatre, Trauma Technician courses, MBBS and MD (Anaesthesiology and Intensive care) at Government Medical College, Chandigarh ,India.

'ANAESTHESIA AND ALLIED SCIENCES FOR PARAMEDICS' is first book of its kind and comprises of six sections. All sections are colour coded for easy identification.
Section one consists of anatomy, physiology and clinical biochemistry for paramedics. Details of all muscles, bones and joints along with their actions, nerves and vessels are compiled in a tabular form so that it can be easily learnt and recapitulated by students. Essential physiology and clinical biochemistry are concised subsections of this section.

Second section provides every detail about anaesthesia and its various sub-specialities. This section has 40 chapters i.e from history of anaesthesia till modular operation theatre suit details. Apart from basics of anaesthesia and sub-specialities of anaesthesia, it highlights operation theatre suit, air-conditioning of Operation theatre and ICU, sterilization, pain management, dialysis room management and transportation of patients and anaesthesiologists.

Third section, 'Pharmacology in Anaesthesia' describes intricacies of all anaesthetic drugs and emergency drugs. These drugs are described in tabular forms in easy language. This section will help the students to explain the drugs that are asked in table viva during examination.

Section four covers all the anaesthesia instruments. These includes anaesthesia machine , automated external defibrillator, sutures, vaporizers and all airway management equipments. The details of instruments will be very beneficial for the students during training periods, examination, table viva and day-to-day practice.

Fifth section provides knowledge of 32 unique topics of modern anaesthetic practices that requires utmost attention. It highlights brief knowledge about clinical audit, hospital waste management, ECG, EMG, cardiopulmonary resuscitation 2010 guidelines, intensive care topics and physics in anaesthesia.

The final section 6, highlights all the scoring systems, algorithms and grading in anaesthesia. The students will be elated to read this section as they will feel comfortable to find all gradings at one place.

This book will be extremely useful to all residents of anaesthesiology and paramedics i.e MSc. Operation Theatre, BSc Medical Technology students, operation theatre technicians nurses, physiotherapists and trauma technicians. I assure that the student will not move away from this comprehensive book that will be useful in all types of examinations, skill development and knowledge augmentation.

The book is a sincere tribute to my father who had this dream for me. I am fortunate enough to have blessings from Almighty, my teachers and parents. All the contributors of this book have provided me a great support and deserve my heartfelt gratitude.

Dr Manpreet Singh (Editor)
India
Ph:09646121503
manpreetdawar@gmail.com,manpreetdawar@hotmail.com