Advances and Technical Standards in Neurosurgery

Edited by

L. Symon, London (Editor-in-Chief)
L. Calliauw, Gent
F. Cohadon, Bordeaux
J. Lobo Antunes, Lisbon
F. Loew, Homburg/Saar
H. Nornes, Oslo
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Preface

As an addition to the European postgraduate training system for young neurosurgeons we began to publish in 1974 this series of Advances and Technical Standards in Neurosurgery which was later sponsored by the European Association of Neurosurgical Societies.

This series was first discussed in 1972 at a combined meeting of the Italian and German Neurosurgical Societies in Taormina, the founding fathers of the series being Jean Brihaye, Bernard Pertuiset, Fritz Loew and Hugo Krayenbühl. Thus were established the principles of European co-operation which have been born from the European spirit, flourished in the European Association, and have throughout been associated with this series.

The fact that the English language is well on the way to becoming the international medium at European scientific conferences is a great asset in terms of mutual understanding. Therefore we have decided to publish all contributions in English, regardless of the native language of the authors.

All contributions are submitted to the entire editorial board before publication of any volume.

Our series is not intended to compete with the publications of original scientific papers in other neurosurgical journals. Our intention is, rather, to present fields of neurosurgery and related areas in which important recent advances have been made. The contributions are written by specialists in the given fields and constitute the first part of each volume.

In the second part of each volume, we publish detailed descriptions of standard operative procedures, furnished by experienced clinicians; in these articles the authors describe the techniques they employ and explain the advantages, difficulties and risks involved in the various procedures. This part is intended primarily to assist young neurosurgeons in their post-graduate training. However, we are convinced that it will also be useful to experienced, fully trained neurosurgeons.

The descriptions of standard operative procedures are a novel feature of our series. We intend that this section should make available the findings of European neurosurgeons, published perharps in less familiar languages, to neurosurgeons beyond the boundaries of the authors' countries and of Europe. We will however from time to time bring to the notice of our European colleagues, operative procedures from colleagues in the United States and Japan, who have developed techniques which may now be

regarded as standard. Our aim throughout is to promote contacts among neurosurgeons in Europe and throughout the world neurosurgical community in general.

We hope therefore that surgeons not only in Europe, but throughout the world will profit by this series of Advances and Technical Standards in Neurosurgery.

The Editors

List of Contributors

Andre, M. J., MD, Department of Histology, Embryology, and Cytogenetics, CHRU, University of Nantes, F-44035 Nantes Cédex 01, France.

Harding, A. E., MD, Professor, Institute of Neurology, The National Hospital, Queen Square, London WC1N 3BG, U.K.

Hirsch, J.-F., MD, Professor, Service de Neurochirurgie Pediatrique, Hôpital Necker-Enfants Malade, 149, rue de Sèvres, F-75743 Paris Cédex 15, France.

Hoppe-Hirsch, E., MD, Service de Neurochirurgie Pediatrique, Hôpital Necker-Enfants Malades, 149, rue de Sèvres, F-75743 Paris Cédex 15, France.

de Kersaint-Gilly, A., MD, Department of Neuroradiology, CHRU, University of Nantes, F-44035 Nantes Cédex 01, France.

Lajat, Y., MD, Department of Neurosurgery, Centre Hospitalier Régional et Universitaire (CHRU), University of Nantes, F-44035 Nantes Cédex 01, France.

Lindegaard, K.-F., MD, Department of Neurosurgery, Rikshospitalet, The National Hospital, University of Oslo, Pilestredet 32, N-0027 Oslo 1, Norway.

Lobato, R. D., MD, Service Neurosurgery, Hospital "12 Octubre", Faculty of Medicine, Universidad Complutense, Carretera Andalucía, Km 5, 4, E-28041 Madrid, Spain.

Mantoura, J., MD, Department of Neurosurgery, Centre Hospitalier Régional et Universitaire (CHRU), University of Nantes, F-44035 Nantes Cédex 01, France.

Menegalli-Boggelli, D., MD, Department of Neurosurgery, Centre Hospitalier Régional et Universitaire (CHRU), University of Nantes, F-44035 Nantes Cédex 01, France.

Moisan, J. P., MD, Department of Molecular Biology, CHRU and Institut National de la Santé et de la Recherche Médicale (INSERM Unit 211), University of Nantes, F-44035 Nantes Cédex 01, France.

Nornes, H., MD, Professor, Department of Neurosurgery, Rikshospitalet, The National Hospital, University of Oslo, Pilestredet 32, N-0027 Oslo 1, Norway.

Perrin-Resche, I., MD, Department of Nuclear Medicine, CHRU, University of Nantes, F-44035 Nantes Cédex 01, France.

Resche, F., MD, Professor, Department of Neurosurgery, Centre Hospitalier Régional et Universitaire (CHRU), University of Nantes, F-44035 Nantes Cédex 01, France.

Richard, S., MD, Department of Neurohistology, Ecole Pratique des Hautes Etude, Hôpital de la Salpêtrière, F-75651 Paris Cédex 13, France.

Sorteberg, W., MD, Department of Neurosurgery, Rikshospitalet, The National Hospital, University of Oslo, Pilestredet 32, N-0027 Oslo 1, Norway.

Williams, B., MD, ChM, FRCS, Midland Centre for Neurosurgery, Holly Lane, Warley, West Midlands, B67 7JX, U.K.

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A. Advances

Post-Traumatic Brain Swelling

R. D. Lobato

Service Neurosurgery, Hospital "12 Octubre", Faculty of Medicine, Universidad Complutense, Madrid (Spain)

With 13 Figures

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Introduction

Brain swelling is a general term to denote an increase in the volume of the brain. It may be defined as any increase in brain volume produced by an increase in volume of any or all of the constituents of the brain. Brain swelling may be due to an increase in the cerebral blood volume (CBV) (engorgement or hyperemia), to an increase in the amount of extra or intracellular water (oedema) or to an extra mass.

Historically, increased cerebral volume following head injury was divided into oedema and swelling. These terms were used interchangeably in clinical practice until the advent of computerized tomography (CT), when they have been increasingly used to refer to more specific conditions. Brain oedema, which is a specific state consisting of fluid retention and

decreased blood volume in the involved cerebral substance, may be seen as a particular form of swelling. Traumatic oedema may be a combination of cytotoxic oedema, which involves primarily cellular elements, and vasogenic oedema, which affects the extracellular spaces resulting primarily from increased capillary permeability to plasma proteins[73]. Interstitial oedema may also occur when there is obstruction to CSF flow. Oedematous brain tissue appears as normal density or a radiolucent area on the CT scan which does not enhance after intravenous contrast injection[25, 45, 64, 81–83, 105, 115, 156]. By contrast, hyperemic brain shows slightly elevated CT numbers and postcontrast enhancement, mostly of the cerebral cortex[21, 75, 151, 156, 158]. The distinction of oedema from hyperemia is of more than academic interest as therapeutic management may differ in accordance with the underlying pathophysiology. However, differentiation between normal and oedematous brain, or between normal and hyperemic brain may be difficult or impossible. Increased protein and lowered lipid content in oedematous brain may offset the effect of increased tissue water rendering recognition of oedema difficult[81, 83, 115]. On the other hand, a low density area in the brain may not reflect brain oedema but ischaemia[81, 82, 104].

Brain swelling, local or universal, is the most frequently noted secondary change following head trauma[86]. Clinically there are three independent syndromes of post-traumatic brain swelling (primarily defined in terms of volume), i.e. diffuse, hemispheric and focal[1, 20, 25, 36, 37, 47, 64, 69, 75, 83, 87, 88, 90, 128, 151, 156, 158]. The latter is the syndrome of "contusion plus oedema", which consists of a radiolucent area that develops about an intracerebral haematoma or a contusive focus[1, 69, 82, 104, 105]. This ring of decreased density spreading through the white matter within hours or days after injury, probably represents vasogenic oedema similar to that accompanying brain tumours or experimental cold lesions and will not be discussed here.

The other two brain swelling syndromes develop acutely after trauma involving one cerebral hemisphere (acute cerebral hemispheric swelling = ACHS), or both cerebral hemispheres (acute generalized brain swelling = AGBS). The first is typically seen in patients operated for acute extracerebral haematoma in a deep coma in whom the underlying cerebral hemisphere expands to fill the space so created leading to raised ICP[1, 11, 25, 47, 68, 69, 81, 87, 88, 90, 112, 124, 128, 135]. The syndrome of AGBS mainly occurs in children and adolescents, and consists of diffuse bulk enlargement of both cerebral hemispheres without midline shift; ICP may be within normal limits but it is somewhat elevated in two third of the cases[14, 20, 21, 25, 37, 61, 71, 87, 157, 158]. This phenomenon, which has been considered to be the commonest CT finding in head injured children[20, 158], has been given different names such as "diffuse cerebral swelling", "diffuse brain swelling", "generalized oedema" or "acute generalized cerebral swelling". This paper considers the possible pathophysiological mechanisms involved in the pro-