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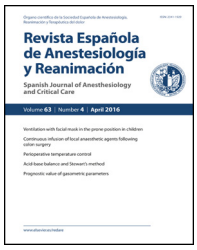

CONTINUING EDUCATION

Influence of general anaesthesia on the brainstem☆,☆☆

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Abstract The exact role of the brainstem in the control of body functions is not yet well known and the same applies to the influence of general anaesthesia on brainstem functions. Nevertheless in all general anaesthesia the anaesthesiologist should be aware of the interaction of anaesthetic drugs and brainstem function in relation to whole body homeostasis. As a result of this interaction there will be changes in consciousness, protective reflexes, breathing pattern, heart rate, temperature or arterial blood pressure to name a few. Brainstem function can be explored using three different approaches: clinically, analyzing changes in brain electric activity or using neuroimaging techniques. With the aim of providing the clinician anaesthesiologist with a global view of the interaction between the anaesthetic state and homeostatic changes related to brainstem function, the present review article addresses the influence of anaesthetic drug effects on brainstem function through clinical exploration of cranial nerves and reflexes, analysis of electric signals such as electroencephalographic changes and what it is known about brainstem through the use of imaging techniques, more specifically functional magnetic resonance imaging.

PALABRAS CLAVE
Tronco encefálico;
Pares craneales;
Propofol;

Influencia de la anestesia general sobre el tronco encefálico

Resumen El papel que desempeña el tronco encefálico en el control del funcionamiento basal del organismo y los detalles sobre cómo la anestesia general puede influir sobre este aún no está completamente definido. Sin embargo, en cada anestesia general el anestesiólogo debe ser

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consciente de la interacción de los fármacos anestésicos y la función del tronco encefálico en relación con la homeostasis del organismo. Como resultado de esta interacción habrá cambios en el nivel de consciencia, los reflejos protectores del organismo, el ritmo respiratorio, la frecuencia cardíaca, la temperatura o la presión arterial entre otros. La función del tronco encefálico puede ser explorada usando 3 enfoques diferentes: a través de la exploración clínica, analizando los cambios en la actividad eléctrica del cerebro o mediante el uso de técnicas de neuroimagen. El presente artículo de formación continuada trata de la influencia de los efectos de los fármacos anestésicos sobre la función del tronco encefálico. Para ello se estudia la exploración clínica de los nervios craneales y de diversos arcos reflejos afectados, el análisis de las señales eléctricas, tales como los cambios electroencefalográficos, y lo que se sabe acerca del tronco encefálico a través del uso de técnicas de imagen, más concretamente a través de imágenes obtenidas por resonancia magnética funcional. El objetivo es proporcionar al anestesiólogo clínico una visión global de la interacción entre los cambios inducidos por los anestésicos relacionados con la función del tronco encefálico.

Introduction

Drugs used to achieve general anaesthesia act on various central nervous system receptor systems in the brain and spinal cord. These receptor systems are in turn part of the neuronal subpopulations that form control centres, communication tracts, cortical and subcortical regions, nerve stems of the peripheral and autonomic nervous systems, and spinal cord reflex arcs.

Much progress has been made in recent years in our understanding of the structure and function of the central nervous system. Systems analysis has facilitated the integration of findings from laboratory tests, experiments in animal models and clinical experience, particularly in diagnostic and therapeutic tools. Recent technological advances, coupled with data from clinical trials in which neurological functional deficits have been associated with areas of involvement, have contributed significantly to this field. The development of the electroencephalogram (EEG), with its high temporal resolution, has been invaluable, while positron emission tomography, and above all functional magnetic resonance imaging (fMRI), have provided a clearer picture of the relationship between function and structure. Despite these advances, the central nervous system, its relationship with the rest of the body, and the key role of the brainstem, remain largely unknown. Recent research has paved the way to individualized patient evaluation—a ground-breaking, highly promising approach that will enable anaesthetists to take into account the individual variability produced by genetic polymorphisms that can influence EEG during general anaesthesia.[1]

The brainstem is an anatomical structure located between the brain and the spinal cord composed of 3 well-differentiated regions: the midbrain, the pons, and the medulla (in descending order from cephalad to caudad). It controls the most automatic bodily functions; most cranial nerves arise from the brainstem and it is the control centre of the parasympathetic nervous system.

In routine clinical practice, actions controlled by nerves originating in the brainstem (including the autonomic nervous system) can be seen to disappear during anaesthesia induction and reappear during awakening. Some authors have even suggested that the brainstem could play a part in modulating postoperative cognitive dysfunction.[2] This is important for various reasons: first, because it allows investigators to explore how the gradual effect of a particular drug on functions controlled by the brainstem induces a specific state, for example, the transition from consciousness to unconsciousness, and secondly, because general anaesthesia induction can potentially give insight into the relationship between the different brainstem structures and how they affect higher brain centres to produce the changes associated with anaesthesia. Finally, because anaesthesia-induced changes in the brainstem determine important physiological changes in the rest of the body that must be monitored, and at times compensated, in order to maintain homeostasis.

The aim of this article is to describe the basic state of the knowledge of the brainstem from 3 different perspectives: clinical evaluation, neuroelectric tests and neuroimaging studies. In each case, the brainstem will be evaluated before and after the administration of anaesthetic drugs in order to describe their effect on this part of the brain. This will give anaesthesiologists a clear understanding of the complex mechanisms of anaesthesia.

Functional structure of the brain stem

Vital functions and physiological sleep

Studies in the fields of neuroanatomy, neurophysiology, neurochemistry, molecular genetics, etc. have provided a wealth of information on the nuclei and tracts involved in brainstem functions. However, the greatest breakthroughs have been made following the recent development of structural neuroimaging (computed tomography or