

CHARLES UNIVERSITY, PRAGUE,
FACULTY OF PHYSICAL EDUCATION AND SPORT¹
NA HOMOLCE HOSPITAL, PRAGUE²

INFLUENCE OF MECHANICAL ACTION ON THE INTRACRANIAL PRESSURE AFTER CRANIOCEREBRAL INJURY

MARTIN MAYER^{1, 2}, ANTONÍN HAVRÁNEK¹, KAREL JELEN¹

SUMMARY

This article shows how intracranial pressure in the secondary stage of craniocerebral injury can be positively influenced by acceptable mechanical incidences for patients; e.g. by changing the position or type of ventilation to the lungs.

Key words: biomechanics, craniocerebral injury, intracranial hypertension, intracranial pressure

INTRODUCTION

Craniocerebral injury is traumatic injuries involving the cranium and intracranial structures. It is a dynamic type of injury which is characterised by the morphological and functional disintegration of the brain and surrounding tissues. This action is caused by the influence of kinetic energy on the skull and brain. We can divide craniocerebral injury into primary and secondary.

Primary injuries are the immediate consequences related to incidences of mechanical shock to the brain and surrounding tissues directly after injury. The sector of the brain where primary damage occurs is nearly impossible to treat. Secondary lesion occurs after primary injury finishes. Main secondary lesions are dropsy brain, turgescence and hypoxic damage to the brain. Combination of primary and secondary lesions leads to a rise in dropsy brain, bleeding, eventual expansion of cerebro-spinal liquid, and progression of intracranial hypertension. The growth in intracranial pressure during craniocerebral injury depends on the increasing volume of one or more of the four compartments in the skull: brain, coeliolymph, blood and expansive lesion.

Statistical data indicating relevance of the craniocerebral injuries (CCI):

- Hospitalization for CCI is 150–200 persons per 100,000 occupiers per annum
- Mortality approximately 10%

- Most frequent age for CCI is 15–24 years
- Ratio men to women 2.5/1
- Most frequent reason of death for people younger than 35 years
- Half of the car accidents directly causes CCI
- The number of CCI recently increases to 36,000 ill persons per year in the Czech Republic

METHODS

CCI patients are generally hospitalized at the Intensive care unit (ICU). Their life functions are monitored by a vital function monitor. Some medical and hygienically procedures are necessary during the health care. These procedures mean increased risks to the patient as we must operate with him. Here we will demonstrate this situation on two examples: The first is the tracheotomy, i. e. surgical procedures, consists of making an incision on the anterior aspect of the neck and opening a direct airway through an incision in the trachea for a tracheostomy tube. This tube allows a person to breathe without the use of his or her nose or mouth.

The intervention caused to the patient by surgical tracheotomy is demonstrated by reproducing the results obtained by the vital functions monitor before, during and after the intervention (see Figure 1).

Second situation occurs when the patient begins to breathe spontaneously and his action interferes with the applied ventilator (see Figure 2). As in the first example, the results obtained by the vital functions monitor before, during and after the intervention (patient used the relaxation medicament) are given.

RESULTS AND DISCUSSION

The visualized examples were taken from hospitalised patients with craniocerebral injury at anesthesiology department (ARO) of the Na Homolce Hospital. The presented examples were taken from a large amount of intervention episodes acquired from firm patient's data. These episodes cover besides a large amount of tracheotomy and interference procedures also a large amount of other intervention procedures as are daily hygiene or pulmonary lavage. The analysis of these documents shows that all the mechanical interventions have serious influence on the monitored values. Especially, the intracranial pressure is very sensitive to these interventions

CONCLUSIONS

It is important to prevent the growth of a secondary brain lesion during the care of patients with acute craniocerebral injury. Early diagnosis of the patient's injury progress is important because quick response time for treating primary brain lesion helps to reduce

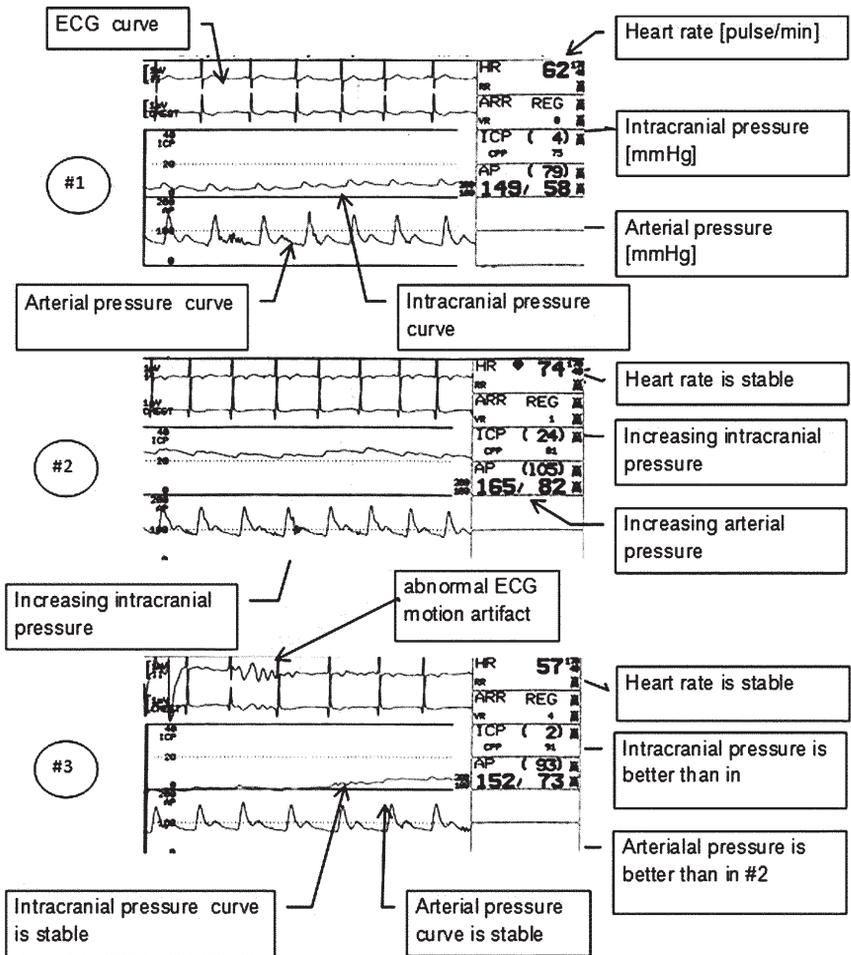


Figure 1. Tracheotomy

#1 ICP and AP values before tracheostomy. All values are practically normal.

#2 Values within the surgical procedure. ICP largely increases, arterial pressure increases, heart rate is stable.

#3 Values measured after tracheotomy. Heart rate and AP pressure are normalized, ICP values are better than before the procedure.

the level of the secondary lesion. Continual measuring of the intracranial pressure is one the basic diagnostics of craniocerebral injury. It is necessary to measure the intracranial pressure as soon as possible and to try to keep its magnitude outside hypertensive values.

In the secondary state of craniocerebral injury, the intracranial pressure can be positively changed by acceptable mechanical incidence on patients. For example, we can change the position of the patient or type of ventilation. Monitoring of the intracranial pressure can help us to decide when to apply the necessary procedures.

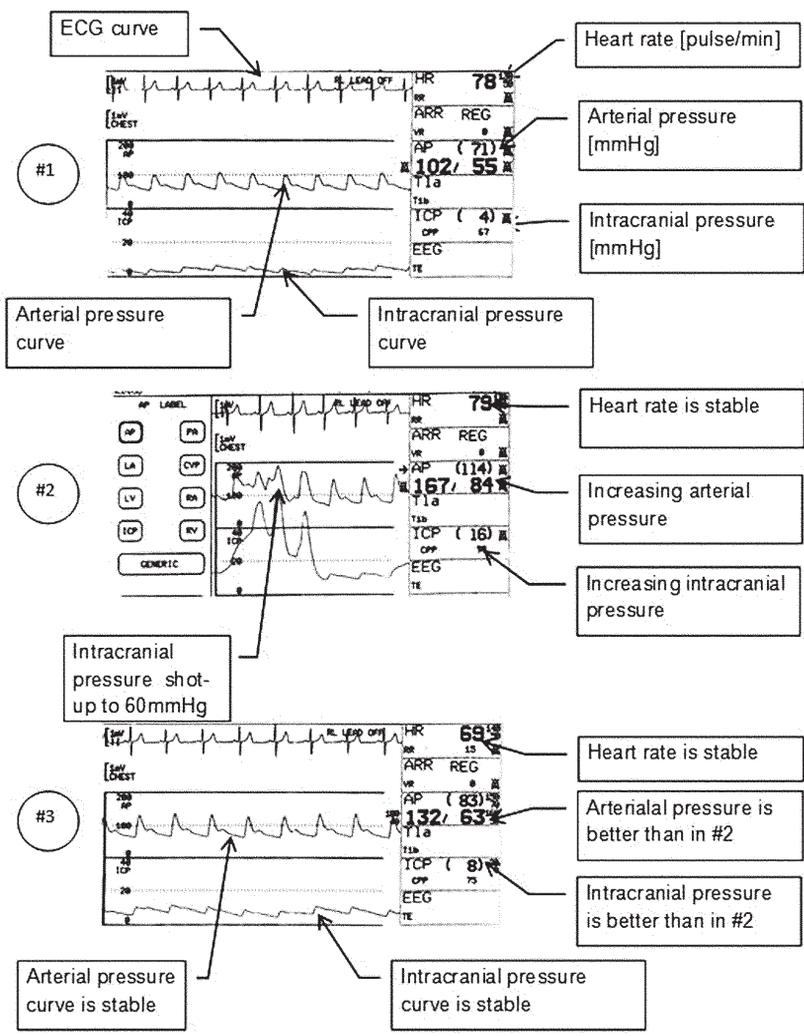


Figure 2. Interference of the mechanical ventilator controlling breathing and the patient's spontaneous breathing activities.

#1 ICP, AP and HR values measured before any interference.

#2 Values within the intervention. ICP largely increases up to the maximum 60 mmHg. Systolic pressure increases and the heart rate is stable.

#3 Values measured after application of relaxation medicament which stops the patient's spontaneous breathing. All the measured values are normal.

ACKNOWLEDGEMENTS

This work was supported in part by the Ministry of Education, Czech Republic; Research Plan SVV-2011-263601, GAČR P 407/10/1624 grant. We appreciate this help.

REFERENCES

- WALTERS, F. J. M. (1998). Intracranial Pressure and Cerebral Blood Flow. *Physiology*. Issue 8, Article 4.
- MAYER, M. (2009). *Biomechanické aspekty dynamiky intrakraniálního tlaku při kraniocerebrálním poranění*.
Colloquium: Faculty of Physical Education and Sport, CharlesUniversity Prague, Czech Republic.

VLIV VNĚJŠÍHO MECHANICKÉHO PŮSOBENÍ NA INTRAKRANIÁLNÍ TLAK PŘI KRANIOCEREBRÁLNÍM PORANĚNÍ

MARTIN MAYER, ANTONÍN HAVRÁNEK, KAREL JELEN

SOUHRN

Článek ukazuje, jak je možné nitrolební tlak v sekundární fázi kraniocerebrálního poranění pozitivně ovlivnit přijatelným mechanickým působením na pacienty, např. tracheostomií nebo způsobem ventilace plic.

Klíčová slova: biomechanika, kraniocerebrálním poranění, intrakraniální hypertenze, intrakraniální tlak

Martin Mayer
martin.mayer@homolka.cz