Alteration of the Pressure Setting of a Codman-Hakim Programmable Valve by a Television
—Case Report—

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Abstract

A 7-year-old girl presented in semicomatose condition. She had received a ventriculoperitoneal shunt using a Codman-Hakim programmable valve. Head computed tomography demonstrated hydrocephalus and head radiography showed that the pressure setting of the shunt valve had changed to 60 mmH$_2$O from 40 mmH$_2$O. The pressure setting was returned to 40 mmH$_2$O, and she was discharged because her clinical symptoms and hydrocephalus improved. One month later, she lost consciousness again and was transported to our hospital. Hydrocephalus and shunt valve pressure of 50 mmH$_2$O were noted, and the pressure setting was returned to 40 mmH$_2$O again. She was discharged without complications. We suspected that the valve pressure was caused by close contact with a television, because the patient tended to touch a television with her head during play. The valve pressure did not change after the television was placed on a high stand out of reach. We should recognize that there are many sources of weak magnetic fields that may influence a programmable valve in everyday life.

Key words: hydrocephalus, magnetic induction, programmable valve, television, ventriculoperitoneal shunt

Introduction

The Codman-Hakim programmable valve is designed to allow convenient transcutaneous adjustment of the multistage pressure setting by use of a special programming tool. However, the pressure setting may be accidentally changed by the effect of powerful external magnetic fields, such as those used by magnetic resonance imaging. Pressure settings are reportedly also affected by weak magnetic fields associated with everyday objects, such as telephone loudspeakers, headphones, hairdryers, a magnetic pillow, and even a toy containing a magnet. We present the case of a 7-year-old girl who tended to touch a television with her head during play, resulting in a change in the programmable valve pressure.

Case Report

This patient presented at birth with subarachnoid hemorrhage in 1997. She developed hydrocephalus and underwent placement of a ventriculoperitoneal shunt that included a Codman-Hakim programmable valve at age 3 months. She had mental retardation, but led a peaceful life until shunt malfunction occurred on April 26, 2004, and an operation to replace the Codman-Hakim programmable valve was performed. The pressure of the Codman-Hakim programmable valve was set at 40 mmH$_2$O (Fig. 1A), since she developed hydrocephalus when the pressure was raised slightly above this value. The patient did well for 6 months and then she lost consciousness and was transported to our hospital on October 12.

Head computed tomography (CT) demonstrated increased ventricle size (Fig. 2) and the pressure of the Codman-Hakim programmable valve was found to be set at 60 mmH$_2$O (Fig. 1B). The change in the pressure setting was thought to have caused the hydrocephalus, so the valve pressure was reprogrammed to 40 mmH$_2$O. She improved clinically and CT demonstrated decreased ventricle size (Fig. 3). She was hospitalized for 11 days and was discharged home without complications. One month
later, she lost consciousness and was transported to our hospital again on November 22. CT again demonstrated increased ventricle size and the pressure of the Codman-Hakim programmable valve was found to be set at 50 mmH₂O. Her clinical symptoms and hydrocephalus improved after reprogramming the valve pressure to 40 mmH₂O again. We suspected the presence of a magnetic field in the home that changed the pressure setting. Extensive questioning of her parents revealed that the patient had been putting her head alongside the television recently during play. She played there all day if not invited elsewhere. We suggested to her parents that the television be placed on a high stand and that the head of the patient should not be allowed to contact the television.

The pressure setting of the Codman-Hakim programmable valve has not changed since her parents put our suggestions into practice. The television was a cathode ray tube type manufactured in the first half of the 1990s. We measured the maximum magnetic induction of various cathode ray tube televisions made during that period, using a 410-type handheld gauss meter (Toyo Co., Ltd., Niiza, Saitama), and found that the magnetic fields ranged from 2 to 10 gauss.

**Discussion**

The manufacturers of the Codman-Hakim valve (Codman, Johnson & Johnson Co., Raynham, Mass., U.S.A.) consider that the minimum magnetic field that can change the setting of the Codman-Hakim programmable valve is about 82 gauss. However, the occurrence of pressure changes of unknown causes has led to the suspicion that common devices associated with low levels of magnetic induction can change the valve pressure settings. In nonhomogeneous magnetic fields, the Codman valve pressure setting can be changed at 150 gauss. These values are required to change a valve setting in contact for a short time. Prolonged contact and the influence of magnetic induction on the complex movement of the valve were not considered.

The magnetic fields generated by televisions are not of sufficient strength to alter the setting of
programmable valves, but we think that the change of valve pressure was caused by contact with a television in the present case for the following reasons. The patient played alone, putting her head beside the television for a long time before the change in valve pressure. The valve pressure changed twice in a short time-span, both times at home. The changes in valve pressure ceased after removal of the television from the patient’s reach. The child was not exposed to magnetic impulses during everyday living, other than from the television.

The magnetic field near the speaker of a cathode ray tube television is not very strong, and the values that we measured were actually lower than 10 gauss. The pressure setting of a valve can change when in contact with a magnetic field for a long time, even if the magnetic field is not strong, and the pressure setting does not change unless exact positional relations of the direction of magnetic induction and the valve are satisfied. Therefore, the pressure change of the valve will not always be the same even if the valve is exposed to the same magnetic induction. Moreover, the direction and magnitude of the changes in the valve pressure setting resulting from exposure to external magnetic fields cannot be predicted.

Whether such minor change in the pressure setting of a valve of 10 mmH2O or 20 mmH2O can cause hydrocephalus resulting in coma is unknown. Minor discrepancies between the pressure of a valve at discharge and the pressure of a valve on subsequent follow-up visits are commonly observed and generally without clinical sequelae. The chamber pressure of the valve was not measured by puncture to confirm the accuracy of the pressure setting, so such an association clearly remains conjectural. However, further adjustment of the valve’s opening pressure is important to improve the outcome in pediatric patients, because the clinical status of the patient may improve after minor adjustments of less than or equal to ±20 mmH2O. In addition, reduction in the brain compliance is suspected to occur after longtime use of shunt from infancy based on the ventricular form at the time of hydrocephalus. If the brain compliance decreased, hydrocephalus caused by a minor pressure change may result in coma.

Long exposure and movement of the valve in a magnetic field can cause a change in the pressure setting of the Codman-Hakim programmable valve. The Codman-Hakim programmable valve is frequently used for pediatric cases, and children can not necessarily follow instructions to avoid objects producing magnetic fields. Therefore, the surgeon must stress this point in discussion with the parents of any child with an implanted programmable valve.

References


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