Post-tonsillectomy hyponatremia: a possible lethal complication

M. A. Agut Fuster, J. del Campo Biosca, A. Ferrer Rodríguez, M. J. Ramos Martínez, J. M. Viel Martínez, M. J. Agulles Fornés
Servicio de Otorrinolaringología. Hospital Francesc de Borja de Gandía. Valencia.

Abstract: Death in children following adenotonsillectomy is very rare. Its main causes are hemorrhage and aspiration. But there is another potentially lethal complication – post-surgical hyponatremia – whose warning signs are non-specific and can go unnoticed thus causing disastrous consequences within only a few hours. Post-surgical hyponatremia is not related to surgery, it is caused instead by an excessive administration of hypotonic liquids in a situation where there is a deficit in their excretion owing to an inappropriate secretion of antidiuretic hormone (ADH). Up to 26 deaths of previously healthy children due to this cause have been reported over the last ten years. We will discuss the etiology and pathophysiology of this complication and the recommendations for avoiding it according to a bibliographical review. We hope that fatal postoperative hyponatremia can be avoided after adenotonsillectomies on children.

Key words: Postoperative hyponatremia. Syndrome of inappropriate anti-diuretic hormone secretion (SIADH).

INTRODUCTION

Hyponatremia is defined as a concentration of serum sodium of less than 134 mEq/l (normal range: 135-145 mEq/l). It is the most common electrolytic alteration in the hospital environment and affects 2% of hospitalized patients. It has been described following many surgical procedures, above all kidney transplants, abdominal, orthopedic and cardiovascular surgery. It also occurs following ENT surgery, above all in cervical surgery, but it is after pediatric ENT surgery where it is most serious and has the worst prognosis. If the drop in serum sodium is moderate there are normally no symptoms and treatment is not required, the complication consequently goes unnoticed in the majority of cases and is not suspected. However, when the serum sodium drops below 120 mEq/l, a hyponatremic encephalopathy occurs. This begins with migraine, lethargy, nausea, vomiting, convulsions and ends with coma and death within a few hours owing to a transtentorial herniation. This is all provoked by a cerebral edema due to osmotic gradient, caused in turn by an acute drop in the concentration of sodium in the blood.

The seriousness of the pathology lies in the fact that the initial symptoms (migraine, drowsiness, nausea and vomiting) are non-specific and are normally attributed to the after effects of surgery, which can fatally delay the diagnosis.

The majority of the authors reviewed attribute severe post-tonsillectomy hyponatremia to a combination of two factors: the excessive administration of hypotonic fluids (low sodium content) during surgery aggravated by a Syndrome of Inappropriate ADH Secretion (SIADH) due to non-osmotic causes (hypovolemia, pain, stress), which causes water retention.

The objective of this study is to review this serious complication, its treatment and prevention. It is preventable if the use of hypotonic solutions is banned and patients with a risk of hyponatremia are recognized. We present the case of a three-and-a-half year old girl who underwent an adenoidectomy and trans tympanic drainage, in whom the problem was detected and resolved in time.

CLINICAL CASE

A three-and-a-half year old girl, weighing 17.8 kg, without any relevant history, who, after a normal preoperative examination, underwent an adenoidectomy and trans tympanic drainage without any noteworthy surgical incidents. The period immediately following surgery passed normally. Eight hours after surgery she deceptively presented drowsiness and lethargy followed later by migraine, nausea, and vomiting.
which were all attributed to the after effects of surgery. Two hours later he suddenly started to have generalized afebrile tonic-clonic convulsions, with eye deviation to the left, which was partially resolved with rectal and intravenous diazepam. However, she remained in a comatose state with no response to stimuli. She also presented mucocutaneous paleness, mydriatic pupils with slow light response and petechiae around the neck. An emergency brain CT was carried out, in which an initial cerebral edema was detected (Fig.1) and an emergency full analysis showed severe hyponatremia (116 mEq/l), elevated (48 mEq/l) sodium in urine, and hyperglycemia (234 mg/ dl).

Suspecting SIADH, intravenous treatment was started with a hypertonic saline solution (NaCl 3%), a bladder catheter and intravenous furosemide. The patient’s condition stabilized although the decrease in her level of consciousness persisted. A new analytical test showed, after four hours, a sodium level of 125 mEq/l, after which the fluid therapy was changed to isotonic serum glucose. The patient began to recover consciousness progressively and ten hours after the convulsions began sodium was at 134 mEq/l. A new CT showed that the signs of a cerebral edema had disappeared (Fig. 2), but migraine and feverish symptoms persisted. The patient remained under observation for 48 hours until she had fully recovered and, following discharge, was monitored by Neuropediatrics. Her condition was asymptomatic and without any neurological consequences.

After subsequently reviewing the case, we believe that there was an excessive ingestion of hypotonic fluids (5% glucose) during surgery that could not be quantified exactly according to the inputs (serum therapy, ingestion) and outputs (bleeding, diuresis, vomiting) of fluids. This combined with SIADH to produce an acute severe hyponatremia, which was fortunately diagnosed and treated in time.

**DISCUSSION**

According to the majority of the authors reviewed 1-14, post-surgical hyponatremia in children is caused by the excessive administration of intravenous hypotonic solutions combined with water retention produced by an inappropriate secretion of ADH. ADH is released by non-osmotic causes that are associated with surgery, such as hypovolemia, pain, post-surgical stress, medication, opiates, inhaled anesthetics and others (Table 1). Under normal conditions the serum hypo-osmolality produced by water intoxication would inhibit the secretion of ADH, facilitating diuresis and returning the ionic balance to normal. According to some authors9,12-14 hypovolemia is the most important stimulus triggering SIADH, for which reason it should be avoided by administering isotonic fluids, which reproduce the ionic concentration of the blood. This non-osmotic stimulus for the secretion of ADH is usually resolved around the third day after surgery but can last up to five days2.

Other authors7 point out that the two requirements (water intoxication and ADH secretion) must coincide...
and that an isolated increase of ADH will not produce the symptoms if appropriate fluids are administered. If there is not an excessive infusion of liquids, a hidden intake of fluids has to be suspected (ice cream, residual water in the stomach, renal generation after excreting hypertonic urine...). On the other hand, it must be taken into account that natremia decreases after surgery of any intensity, major or minor, and this drop occurs even if hypotonic fluids have not been administered.

When these two events combine, they produce an acute severe hyponatremia (serum sodium less than 120 mEq/l) during which, owing to an osmotic gradient, the free water spreads to the cerebral parenchyma and produces a hyponatremic encephalopathy caused by cerebral edema which, if not treated, develops into a coma and brain death from transtentorial herniation in a few hours. Furthermore, children develop hyponatremic encephalopathy with higher concentrations of sodium than adults do and their lower capacity for brain expansion. The incidence of post-operative hyponatremia in children has been evaluated at 0.34% and the mortality rate is significant; in the last ten years around 50 cases have been published which include 26 fatalities among previously healthy children following minor surgery.

Therefore, although the classic rule, according to the formula of Holliday and Segar, was that of using hypotonic fluids (glucose 5% + NaCl 0.2% which provides 51 mEq/l of sodium, 1/3 of isotonic saline), the unanimous current recommendation is the administration of maintenance isotonic fluids (154 mEq/l of sodium and potassium) following surgery for hospitalized children at risk of SIADH.

**Table 1: Clinical situations with an increase in the release of ADH in children**

<table>
<thead>
<tr>
<th>Hemodynamic stimuli (reduction of the circulatory volume)</th>
<th>Hypovolemia, nephrosis, cirrhosis, hypoadosteronism, hypertension, congestive cardiac failure, hypoalbuminemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non hemodynamic stimuli</td>
<td></td>
</tr>
<tr>
<td>- Alterations of the CNS: encephalitis, meningitis, cerebral tumors, cranial trauma</td>
<td></td>
</tr>
<tr>
<td>- Pulmonary diseases: pneumonia, asthma, bronchitis, TB.</td>
<td></td>
</tr>
<tr>
<td>- Bronchogenic carcinoma</td>
<td></td>
</tr>
<tr>
<td>- Drugs:</td>
<td></td>
</tr>
<tr>
<td>Which stimulate the release of ADH:</td>
<td></td>
</tr>
<tr>
<td>opiates, anti-depressives, carbamazepine, clofibrate, clorpropamide</td>
<td></td>
</tr>
<tr>
<td>Which strengthen ADH in the kidneys: cyclophosphamide.</td>
<td></td>
</tr>
<tr>
<td>With an unclear mechanism:</td>
<td></td>
</tr>
<tr>
<td>Haloperidol, amitriptyline, ecstasy (methylenedioxymethamphetamine), cytoxan, vincristine.</td>
<td></td>
</tr>
</tbody>
</table>

**Hypotonic fluids (glucose 5% + NaCl 0.2%)**

As we have previously summarized, hyponatremic encephalopathy can be very difficult to recognize in children since the symptoms are variable and non-specific and do not correlate to the serum sodium or the rapid development of hyponatremia. The initial and most constant symptoms are migraine, nausea, vomiting, lethargy and asthenia and can be attributed to the after effects of surgery, from which they should be distinguished by the levels of sodium in the blood. The advanced symptoms, because of cerebral edema, are convulsions, mydriasis, coma and respiratory arrest. Therefore electrolytes in the blood and urine are measured in order to reach a diagnosis, since sodium in urine (natriuria) is typically greater than 40 mEq/l. The suspected diagnosis is important: if the diagnosis is not borne in mind and corrective measures are not taken opportunistically the symptoms can be made worse because the normal volumes of fluids will continue to be administered.

As for treatment, if the patient only presents mild symptoms (migraine, sleepiness) or is asymptomatic, and serum sodium is higher than 125 mEq/l, the treatment will be conservative with restricted fluids and close supervision (checking natremia values every two hours). In more serious cases, sodium of less than 125 and with a risk of cerebral edema, a hypertonic saline solution of NaCl at 3% (which provides 50 mEq of Na each 100 ml) has to be administered according to the formula:

\[
\text{Na desired} - \text{Na present} \times 0.6 \times \text{weight (kg)} = \text{mEq of Na to provide}
\]

**Or, in our case:**

\[
125 - 116 \times 0.6 \times 17.8 = 96 \text{ mEq of Na.}
\]

Therefore, if 100 ml provides 50 mEq, 192 ml of NaCl 3% is needed to add 96 mEq of sodium and increase the natremia to 125 mEq/l (Na desired) in 2-4 hours, since the serum Na shouldn’t be corrected at a rate greater than 1-2 mEq/l per hour. A rapid correction can produce osmotic demyelination syndrome, which has been associated with lesions in the white matter of the brain stem and with pontine myelinolysis. These lesions are more common in therapy with hypotonic solutions should therefore be banned, especially if the prior natremia is less than 138 mEq/l. It is worth remembering that isotonic saline solution can also give rise to hyponatremia if an excessive quantity of liquid is administered in a situation with an excess of vasopresine, such as SIADH or the post-surgical period. Although there is no composition that is ideal for all children, the isotonic serum glucose solution of NaCl at 0.9% in serum glucose at 5% is the safest composition in the majority of patients. Although glucose solutions are routinely used on patients who have undergone surgery and hours of fasting, only newborns and diabetic children are at risk of hyperglycemia.
adults than in children. Other authors think that, in serious cases, treatment should be rapid since the risk of not treating the cerebral edema is much greater than the small risk of osmotic demyelination.

When natremia of 125 mEq/l of Na is reached, the hypertonic solution is changed for another maintenance isotonic.

Intravenous furosemide at 1mg/kg with a bladder catheter is also useful since it excretes free water. Thiazide diuretics, on the other hand, are related to hyponatremia. Other drugs with few therapeutic indications are Lithium Carbonate, which inhibits the renal effects of ADH, and Demeclocycline (tetracycline), which reduces the effects of ADH at the renal tubular cell level.

In conclusion we think it is important to emphasize:

The importance of identifying patients with a high risk of developing post-surgical hyponatremia.

The use of isotonic solutions with serum therapy control in Pediatrics.

And the knowledge of this uncommon but potentially dangerous complication, whose initial symptoms are non-specific due to which the diagnostic suspicion is fundamental.

References