Introduction

Burn injury - also known as combustion injury - is an impairment of the tissue, which is caused by extreme heat, electricity, chemicals, friction or radiation. Concerning children, in Hungary and worldwide the most affected age group is below the age of 5 years. The most common cause of burn injury in children is scald from hot water.

The severity of burns is influenced by several factors. The mechanism of the injury, length of time, depth and range of the burns, age, and general wellbeing of the child are important factors. Burns can be classified by damage to the skin layers (depth of burns) and extent of affected skin (percentage of total body surface area [TBSA] burned). The most moderate burn - called a first-degree burn (redness of the skin, like sunburn) - affects only the superficial skin layers without blisters or a wound. Generally, these superficial burns do not need medical care.

Partial thickness or second-degree burns (blisters covering a red base) reach the deeper skin layers, extending to the whole epidermis and the dermis. They can be divided into two further groups:
• Second-degree superficial partial burns (II/A or II/1) penetrate into the dermal-epidermal papillary region.2 Therapy is mostly conservative. Plenty of conservative methods are known, such as bandaging with cream or solution, impregnated webs, modern foam, and vacuum therapy.

• In cases of partial burns, which extend to the deeper layer (II/B or II/2), also the reticular layer of the dermis is damaged. The appropriate treatment is a surgical intervention to tangentially excise the necrotic skin part (debridement).

In the mixed type of second-degree burn, with the help of an appropriate indication, conservative treatment methods can also be used.

Third-degree burns (widespread thickness with a white, leathery appearance) extend to all layers of the skin and even further. Bones can be involved in fourth-degree burns (carbonization), the affected area homogeneously black and charred. These kinds of injury require complex surgical interventions.

To sum up, currently burns are classified as superficial (1st and 2nd degree [II/A or II/1]) and deep (2nd degree [II/B or II/2] and 3rd degree).

Aquamet Ag foam is a hydrofiber dressing which consists of a superficial polyurethane waterproof layer and a multilayered absorbent surface. It contains 1.2% silver ion. The dressing absorbs the wound secretion because the hydrofiber layer transforms into gel, which facilitates wound-humidification, faster healing, and blocks infections.3,4,5

The main component of Curiosa gel is Zinc-hyaluronon, which promotes cell regeneration and contributes to faster regeneration of the wound.6,7

Aquamet Ag, a hydrofiber dressing material containing silver, has been reported to produce good clinical results. However, only a limited number of studies exist in the paediatric population.8

While clinical studies with either Aquamet Ag foam or Curiosa gel have been conducted and beneficial effects of each treatment in superficial second degree burns have been found,8 to our knowledge no data is available on the effect of combining these treatments in the same burn types.

The aim of this study is to present the results of treating children with superficial and mixed second-degree burns with Zinc-hyaluronon gel combined with a special foam dressing containing silver.

**Patients and methods**

Prospective research was conducted between January 1, 2014 and December 31, 2015 at the Surgical Unit, Department of Pediatrics in Pécs. Seventy-three (73) children with superficial and mixed-typed second-degree burns were treated with Zn-hyaluronon gel combined with Aquamet Ag foam.

In nearly 75% of the cases, burn depth was undoubtedly superficial. We applied Aquamet Ag foam dressing with Zn-hyaluronon gel primarily after debridement. If the burn depth was not clearly assessable (II/1 or II/2) by the primary care physician, we applied silver nitrate solution for 24 hrs. On the following day, burn depth was assessed by a burn specialist and in cases where the burn was superficial, we used the dressing under study. However, when the burn depth was II/2 degree, we continued initial therapy. At primary treatment, debridement was carried out with sedation or under general anaesthesia.

In cases where silver-nitrate dressing was applied at first intervention, the Zn-hyaluronon gel and Aquamet Ag foam dressing was used during the control examination on the following day and removed 7 days later. In children whose primary treatment was Ag foam dressing completed with Zn-hyaluronon gel, the dressing was checked on the 2nd day and removed on the 6th or 7th day.

**Results**

Seventy-three (73) patients were divided into 3 groups according to their age: children between 0-5 years (71.23%), between 6-10 years (15.07%) and over 10 years (13.7%). The most affected was the youngest age group (Fig. 1).

We also studied gender distribution. Out of 73 injured children, 44 were boys and 29 were girls. Similar to international and European incidence rates, boys (63.27%) are more likely to be exposed to burn injury (Fig. 2).

Concerning the causes of the burns, hot liquid scalds - for instance wounds from boiling water, tea, coffee, hot oil or other types of fluids - were the most common cause of injury (36/73 pts, 49.31%). As for contact burns, touching a radiator or a stove with the palm of the hand was frequent (21/73 pts, ...
28.77%). Some burns were caused by household equipment (7/73 pts, 9.59%), and others by stepping on a hot surface (3/73 pts, 4.11%). We documented 4 (5.48%) cases in which the injury originated directly from fire, including the flame of matches, candles and lighters. Only 1 child in the sample had injuries due to electricity (1.37%) and 1 (1.37%) due to other mechanisms (Fig. 3).

In 61 children (83.56%), wound size was smaller than 5% TBSA. In 4 children (5.48%), it was between 5 and 10% TBSA, and in 8 children (10.96%) the burn covered over 10% TBSA (Fig. 4). Burns were located on every body part, and in 38 cases (52.05%) on more than one area. The children with burns over 10% TBSA with more than one burnt area on their body were admitted to the ward. The most affected areas were the upper extremities, palms of the hands, and the chest.

Here, we report the short-term results of the study. Using the Zn-hyaluronon gel combined with Aquacel Ag foam dressing, no wound infections were diagnosed in the sample (73 children).
In general, epithelialization of the burned area was observed 6-7 days after primary treatment (Figs. 5 and 6), which corresponds well with results from other methods of dressing for this type of burn. In the children treated with traditional methods, anaesthesia had to be used every day or every second day to change the dressing, while the foam dressing containing silver can be used until the wound heals.

In 8 of the 73 children, debridement was performed because of a wide-ranging second-degree burn injury. Aquacel Ag foam and Zn-hyaluronon gel were applied after debridement. No anaesthesia was needed to change the dressings. Application and removal of the dressings were performed under analgesia. All escharotomies were performed under general anaesthesia. We observed the epithelialization of the burned areas 6 to 7 days after primary treatment.

Discussion

The burn injuries occurred in families with lower social and economic status, where the danger of an infection during the healing process is higher. It is important that, where possible, childhood burns are treated in a pediatric surgical department or burn centre. We conducted a prospective study for two years in one centre in Hungary, treating seventy-three (73) children with superficial and mixed-type second-degree burns with Aquacel Ag foam and Zn-hyaluronon gel.

The limitations of our study are that it was conducted in one centre only and involved only one method. It was non-comparative and not randomized.

Most of the patients diagnosed with a burn injury under 5% were treated with this new method. Due to the modern dressings, epithelialization generally occurred on the 6th day, as in other previous studies. According to our results and in our experience, there were no cases of infection.

Conservative treatment of burns with the widely-used local remedy, silver-sulfadiazine ointment, creates a heavy, oozing fatty layer that is difficult to tolerate. This thick, adherent layer also makes proper determination of burn depth very difficult. Silver-sulfadiazine was the gold standard for the treatment of superficial burns in our centre. Disadvantages of this treatment are the need for daily dressing changes and difficulty in assessing burn depth.4

Treatment of mixed-type burns is still a big challenge, and whether or not conservative treatment is sufficiently effective is a widely discussed topic. Treatment for a coherent and deep second-degree burn wound is a surgical intervention, whereas mixed-type second-degree burns can also be effectively treated with conservative methods.

In nearly 75% of the children, we used Aquacel Ag foam dressing with Zn-hyaluronon gel at the first intervention. We checked the dressing on the second day, and removed it on the sixth or seventh day. In 8 children, the combination dressing was applied after escharotomy, and removed 10 days after surgical intervention.

Hydrofiber dressing containing silver combined with hyaluronon gel containing zinc tends to be effective against infections and also promotes wound healing. The dressing is comfortable and can be easily applied. It also creates an appropriate environment for proper wound healing and also promotes wound healing.6,8 In contrast to traditional treatments, applying, changing and removing a combination of Aquacel Ag foam and Zn-hyaluronon dressing is painless, and in 62 cases anaesthesia was not required. A very important aspect of this new method is that it reduces physical strain and stress for the child due to fewer checks and dressing changes. On average, 2.5 dressings were used on each child that did not require escharotomy. Due to the reduced number of dressings and anaesthesia required, the approximate cost of treatment per child was cut by half. Currently there are only a few clinical studies reported in the literature on the application of Aquacel Ag dressing to paediatric patients with partial thickness burns.3,10,11,12 In these studies, hospital length of stay was significantly shorter for the Aquacel Ag group.9,12 Moreover, dressing frequency was 3-4 times lower in the Aquacel Ag group than in the standard dressing group.8

Conclusion

According to our experience and study results, Aquacel Ag foam dressing combined with Zn-hyaluronon gel can be considered to be an effective, gentle and child-friendly treatment, which ensures preferential wound healing and adequate cosmetic results. We must note, however, that this dressing should be applied only after an exact estimation of burn depth.

BIBLIOGRAPHY