INCREASE OF THE CURE RATE OF BURN PATIENTS BY IMPROVING BURN WOUND MANAGEMENT METHODS


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SUMMARY. In order to summarize the progress of burn wound management of the patients in our burn ward and its correlation with the improvement of treatment results in the past 44 years, the general data (hospitalization time, cure rate, operation times) of 12,568 cases were analysed in terms of three periods, namely 1958 to 1980, 1981 to 1990, and 1991 to 2002. The beneficial effects of the systemic application of recombinant human growth hormone, post-burn immediate escharectomy en masse, the external application of epithelial growth factor, and the coverage of split-thickness skin donor sites with razor-thick skin on wound healing and overall therapeutic results were also analysed. It was found that there was an increase in the number of burn patients admitted to our burn ward in recent decades. The overall cure rate, especially that of major burn patients, increased significantly with the improvement of burn wound management. Hospitalization time was shortened and wound-healing time reduced. The analysis suggested that escharectomy en masse as early as possible, systemic application of growth hormone, and external application of epithelial growth factor are beneficial to early burn wound healing.

Introduction

Common causes of burn death include internal organ failure, severe infection, and inhalation injury, and burn wound management is closely correlated with these three complications, especially severe systemic infection. As a primary route of burn infection, burns wound, and especially deep burn wounds, are significantly related to the prognosis of burn victims.

Both tissue ischaemia and hypoxia develop in infected epidermal tissue in deep burn wounds, which may lead to fascial space syndrome, owing to compression of the extremities by necrotic eschar, and/or dyspnoea, due to chest compression. Ischaemic and hypoxic burn tissue is liable to be infected by bacteria and toxin.

The burn eschar is essentially necrotic tissue that is beneficial to the growth and proliferation of bacteria. In addition, burn toxin and multiple putrefied products can be released from necrotic eschar, leading to the development of systemic infection and intoxication. Special attention to the hazardousness of deep burn wounds and their removal and active and effective coverage as early as possible are therefore key steps if we are to free burn patients from the threat of infection and to raise their cure rate.

With regard to the development of burn wound management in the past 44 years, the preservation of burn eschar was recommended in the 1960s. Subsequently, in the 1960s and 1970s, small stamp-shaped pieces of autoskin were inlaid into artificial holes made in large sheets of alloskin, or mixed autoskin with alloskin or reticular autoskin was grafted onto the burn wounds. In the 1980s, microskin grafting was first reported by Zhang in China, and this greatly improved burn wound management methods and upgraded the quality of burn patient treatment. Above all, improvement in burn patient treatment was not separate from progress in burn wound management.

On the basis of our experience in the management of burn patients over several decades, some burn wound management methods have been suggested by our institute, also with reference to the successful experiences of national and foreign colleagues. The newly suggested methods were first tested in animals and then introduced to burn patients. All the methods helped to improve burn patient treatment in our institute.

Clinical data, methods, and results

A total number of 12,568 burn patients were ad-
mitted to our burn institute between 1958 and 2002, of whom 8788 were male and 3780 female. Of these, 11,441 (91.03%) presented burn injuries in a TBSA of less than 50%, while only 1127 (8.97%) had a burned TBSA of more than 50% (Table 1).

The patients were divided into three groups according to the time periods, i.e. first period (Group 1) from 1958 to 1980, second period (Group 2) from 1981 to 1990, and third period (Group 3) from 1991 to 2002. The general data of the patients are given in Table I and treatment results in Table II.

Table III presents a comparison of the hospitalization time in days and the number of operations of the patients in the three periods.

Table IV - Comparison of escharectomy en masse (EM) with

<table>
<thead>
<tr>
<th>Group</th>
<th>Hospitalization days</th>
<th>Number of operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31.4 ± 6.9</td>
<td>1.6 ± 0.5</td>
</tr>
<tr>
<td>2</td>
<td>28.9 ± 9.3</td>
<td>2.0 ± 0.9</td>
</tr>
<tr>
<td>3</td>
<td>21.2 ± 10.2</td>
<td>1.7 ± 0.7</td>
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Table IV shows that compared with results of traditional multiple times of wound escharectomy, the incidence of internal organ injury, the number of operations, and hospitalization time were reduced and the cure rate increased in patients undergoing escharectomy en masse.

The wound-healing time in burn patients receiving recombinant human growth hormone (rhGH) injections subcutaneously at a dose of 0.2-0.4 mg/kg/d application in both the operation and the non-operation groups (Tables V, VI).

The wound-healing time in burn patients receiving epithelial growth factor (EGF) was much shorter than in patients not receiving EGF in patients with

Table V - General condition and effects of rhGH on healing

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Age (yr)</th>
<th>TBSA (%)</th>
<th>FTS (%)</th>
<th>Healing days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Op</td>
<td>25</td>
<td>27.6 ± 17.3</td>
<td>31.4 ± 10.9</td>
<td>22.6 ± 38.3</td>
<td>6.2 ± 3.4</td>
</tr>
<tr>
<td>RHGH 0.2</td>
<td>33</td>
<td>28.5 ± 14.2</td>
<td>20.3 ± 11.5</td>
<td>19.1 ± 10.5</td>
<td>6.9 ± 3.7*</td>
</tr>
<tr>
<td>RHGH 0.4</td>
<td>33</td>
<td>21.2 ± 12.0</td>
<td>14.3 ± 11.6</td>
<td>26.7 ± 10.8</td>
<td>5.5 ± 3.2*</td>
</tr>
</tbody>
</table>

Table VI - Effects of epithelial growth factor (EGF) on burn

<table>
<thead>
<tr>
<th>Burn wound treatment</th>
<th>Superficial 2nd-degree burn</th>
<th>Deep 2nd-degree burn</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGF applied</td>
<td>63</td>
<td>10.2 ± 1.76</td>
</tr>
<tr>
<td>Without EGF</td>
<td>30</td>
<td>13.1 ± 2.12**</td>
</tr>
</tbody>
</table>

**P < 0.01
either superficial or deep partial-thickness burns (Table VII).

The healing time in the donor site of split-thickness skin was much shorter in patients with razor-thick skin (usually scalp skin) coverage than in the donor site without razor-thick skin coverage (5.31 days ± 2.11 vs 15.31 ± 5.91, p < 0.01) (Figs. 1, 2).

Statistical analysis

All the data were processed by the SPSS program. ANOVA was carried out.

Discussion

The clinical data reviewed in this study showed that an increasing number of burn patients - and in particular severely burned patients - were admitted to our burn institute. But it was also found that the cure rate of burn patients - and again that of severely burned patients - increased in recent years. The average hospitalization time was clearly reduced. The incidence of internal organ injury and systemic infection decreased with escharectomy en masse. Surviving patients underwent fewer operations and their hospitalization time shortened significantly. The wound healing rate of burn wounds with or without surgery increased and evidently accelerated after the administration of rhGH. The wound healing rate was also accelerated by external application of EGF on the burn wound. The progress in the burn wound management in recent years can be summed up as follows:

Active operation

Early post-burn escharectomy en masse was employed in major burn patients. The operation was performed in patients with relatively stable haemodynamic indices in whom all third-degree burn wound was removed and covered as completely as possible with auto- and/or alloskin in one operation. It was found that the incidence of systemic infection and internal organ injury decreased and that the cure rate increased significantly after escharectomy en masse. It was also found in experiments on animals that escharectomy en masse as early as 3 h post-burn did not aggravate burn shock but was beneficial to the improvement of cardiac function, to correction of acidosis, and to control of the development of the post-burn systemic inflammatory response syndrome (SIRS) and of multiple organ dysfunction syndrome (MODS).

Post-burn severe MODS was one of the main causes of burn mortality. It was found in previous studies that continuous post-burn low reperfusion led to dysfunction of the microcirculation, damage to the local barrier function, and a decrease in the systemic defensive function, which eventually led to severe infection and SIRS. All these changes induced alterations in the cellular structure and the functioning of the vascular endothelia, ultimately causing the incidence of early post-burn internal organ injury. Burn wounds with massive necrotic tissue were the origin not only of bacterial multiplying but also of inflammatory mediators. The massive production of inflammatory mediators from macrophages and lymphocytes induced by endotoxin from bacteria and by burn toxin from necrotic burn wound eschar was able to inhibit the host immune system. Escharectomy en masse in the early post-burn stage removed burned and necrotic tissue as early as possible and ameliorated post-burn SIRS.

Systemic application of rhGH

Burn wound healing as early as possible is always a key step in burn management. Persistent burn wound led to the patients’ being liable to infection, internal organ injury, malnutrition, and delayed wound healing. This caused a drop in the burn cure rate and in therapeutic quality. Wound closure as soon as possible was therefore a key step in controlling post-burn development of complications and mortality. Growth hormone (GH) is an important hormone in vivo for promoting growth and development and regulating the systemic metabolism. Clinical investigations and animal experiments showed that GH was able to accelerate
protein synthesis, improve nitrogen balance, promote tissue repair, and modulate systemic immune function. RhGH was produced by gene engineering technology and was similar to natural GH with regard to its pharmacological role and pharmacokinetics. In this study, after the use of rhGH in burn patients it was found that rhGH was safe and effective. Furthermore, wound healing time shortened and the incidence of systemic infection and internal organ injury clearly decreased. Patients receiving rhGH stayed a shorter time in hospital.

**External application of EGF on the burn wound surface**

Recombinant human epithelial growth factor (rhEGF) was constructed by gene engineering technology, in which artificial EGF gene fragments were cloned in *Escherichia coli* and highly expressed before being purified and processed to be a multi-peptide factor that can promote epithelium growth. RhEGF was proved to be mitogenetic to multi-originate epithelia. It enhanced the synthesis of glucose, protein, DNA, and RNA, induced cell division, and modulated cellular proliferation and differentiation. Above all, rhEGF promoted wound healing and shortened the hospitalization time of burn patients, following routine burn wound management. We found in our study that rhEGF speeded up wound healing in second-degree degree (superficial and deep partial-thickness) burn wounds, chronic burn wounds, and donor sites of split-thickness skin. Wound closure in deep partial-thickness burn wounds was up to 3.5 days shorter than in control (*p < 0.05*) after rhEGF treatment.

**Razor-thick scalp skin harvesting with scalp haemostatic band and coverage of split-thickness skin donor sites with super-thin razor-thick skin³⁶**

After application of a rubber scalp haemostatic band around the skin harvesting area, sterile normal saline was injected into subcutaneous scalp space in order to expand the scalp to make it easier for the surgeon to take super-thin razor-thick scalp skin (*Figs. 3, 4*). The harvested scalp skin was applied to the donor site of split-thickness skin. After a week or so, the split-thickness and scalp donor sites healed simultaneously.

**Conclusion**
riable avec de la peau mince comme un rasoir sur la guérison des lésions et les résultats généraux thérapeutiques. Ils ont trouvé un incrément dans le nombre des patients brûlés hospitalisés dans leur unité des brûlures pendant les dernières décennies. Le taux global de guérison, et en particulier celui des grands brûlés, a présenté un incrément significatif avec l’amélioration de la gestion des brûlures. La durée de l’hospitalisation et du temps de guérison des lésions a été réduite. Les Auteurs, dans leur analyse, trouvent que l’escharrectomie en masse effectuée aussitôt que possible, l’application systématique de l’hormone de croissance et l’application externe du facteur de croissance épithé-