Introduction

Burns are still a major health problem in developing countries. The reasons for the high incidence include widespread ignorance of fire prevention, the rapid increase of poor socio-economic conditions, and the persistence of old traditions and customs.

In Cambodia and Bangladesh the most frequent causes of burns are accidents in the home, the use of outdoor coal fires or gas stoves, and land mine explosions. Additionally, there is the serious problem of chemical burns due to acids as the result of quarrels or domestic law suits. These are serious and debilitating lesions and their frequent non-treatment may cause terrifying scars.

The risk of keloids is extremely high in these populations because of genetic factors (dark complexion).

In this study we analysed 200 patients with post-burn scars. The purpose of our study was to present the environmental factors and the demographic characteristics associated with burn damage in Cambodia and Bangladesh, and to show that with good technical skills it is possible in these countries to obtain the same results as those obtained in modern well-equipped medical facilities.

Materials and methods

This study was carried out in civilian war victim hospitals in Battambang and in Dhaka in 2002 and 2003. Altogether, 200 post-burn patients with scars were retrospectively analysed in detail. Patient age ranged from 3 to 60 yr. Both sexes were represented, with a predominance of males.

Fig. 1 illustrates the annual distribution of burn admissions. In the first quarter we treated 18 burns sequelae cases (9%), in the second quarter 53 cases (26.5%), in the third quarter 20 cases (10%), and in the fourth quarter 109 cases (54.5%). This last highest proportion occurred during hot and moist climatic conditions.

Our particular interest was in serious post-burn injuries with severely compromised functionality. The method of rating whole person impairment (WPI) used in this study is that described by the American Medical Association.

There are five classes of skin rating, ranging from 0 to 95% impairment.

a) Class I (0-9 % WPI) - patients in whom signs and symptoms of skin disorder are present or intermittently present, who have no limitations in their daily activities, and who require either intermittent or no medical treatment.

b) Class II (10-24% WPI) - patients with present or intermittently present signs and symptoms whose performance of some activities of daily life is limited and who
require intermittent constant treatment.

c) Class III (25-54% WPI): signs and symptoms are intermittently present, the performance of many activities of daily life is limited, and treatment needs may be intermittent to constant.

d) Class IV (55-84% WPI): signs and symptoms of skin disorders are constantly present; the patients are limited in many activities of daily life, their treatment needs may be intermittent to constant, and they may require home confinement.

e) Class V (85-95% WPI): constant signs and symptoms of skin disorder, limitation of most daily activities, and occasional to constant home confinement for intermittent to constant medical treatment.

The medical treatment of WPI includes rehabilitation care with "passive and active physical exercises" in order to attenuate post-burn skin scar adherence.\textsuperscript{15-18} In our experience these procedures are important in post-burn care at a later moment after surgical procedures in order to restore a normal anatomy as early as possible.\textsuperscript{22-26}

The surgical techniques used to correct burns sequelae include skin expander insertion, dermoabrasion, autologous skin graft insertion, local or distance pedicle flaps, Z-plasty, and microsurgical free flaps.\textsuperscript{20-33} To compensate for the backward technology in Cambodia and Bangladesh, we used surgical procedures based on Z- or W-plasty, autologous skin grafts, and local and pedicle flaps.

These techniques, compared with the other above-mentioned surgical procedures, are rapid and simple in their execution, have low morbidity and a low incidence of complications, are well tolerated by patients, and offer good final results (Figs. 2a, b, c).

**Results**

The following parameters were evaluated retrospectively:

1. age
2. sex
3. causes of burns
4. organs affected by burns
5. size of burns

1. Age

The present study covers 57 children between the ages of 0 and 10 yr (28.5%), 88 adolescents and young adults aged between 11 and 40 yr (44%), and 55 patients aged over 40 yr (27.5%) (Table I).

2. Sex

Among children (0-10 yr), males were predominantly affected, with a male:female ratio of 3:1. Among adolescents, males were also more affected than females (male:female = 2:1). Among adults aged 20-40 yr, males and females were equally affected (male:female = 1:1). Among patients aged over 40 yr, there was a male predominance, with a male:female of 3:2 (Table I).
3. Causes of burns

The most frequent cause of burns was flame in accidents in the home, which were more common in females aged 18-40 yr. Flame burns were caused by direct flame injury, clothes catching fire during cooking, outdoor coal fires, and gas stove explosions. A small proportion of burns - more frequent in males - are due to land mine explosions in civil wars, an ever-present risk in these countries still today. It is calculated that in Cambodia there are 5,000,000 mines in the fields. A high percentage, more frequent in females, is represented by chemical burns from acids. This is a widespread custom practised for sentimental reasons (adultery and resistance to sexual relations) and because of judicial matters and domestic lawsuits (Table II).

Table II - Classification of most frequent burn causes

<table>
<thead>
<tr>
<th>Cause</th>
<th>Male</th>
<th>Female</th>
<th>Total number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flame</td>
<td>11</td>
<td>60</td>
<td>71</td>
<td>35.5</td>
</tr>
<tr>
<td>Mine explosion</td>
<td>37</td>
<td>30</td>
<td>67</td>
<td>33.5</td>
</tr>
<tr>
<td>Acids</td>
<td>22</td>
<td>40</td>
<td>62</td>
<td>31.0</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>130</td>
<td>200</td>
<td>100</td>
</tr>
</tbody>
</table>

4. Organs affected by burns

The parts of the body most affected were the hands, the scapulohumeral and popliteal joints, the inguinal folds, the eyelids, the oral cavity, and the nostrils (Table III).

Table III - Classification of parts of body affected

<table>
<thead>
<tr>
<th>Part of body</th>
<th>Male</th>
<th>Female</th>
<th>Total number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands</td>
<td>50</td>
<td>42</td>
<td>92</td>
<td>46.0</td>
</tr>
<tr>
<td>Scapulohumeral joint</td>
<td>25</td>
<td>4</td>
<td>29</td>
<td>14.5</td>
</tr>
<tr>
<td>Popliteal joint</td>
<td>0</td>
<td>9</td>
<td>9</td>
<td>4.5</td>
</tr>
<tr>
<td>Inguinal folds</td>
<td>0</td>
<td>11</td>
<td>11</td>
<td>5.5</td>
</tr>
<tr>
<td>Eyelids</td>
<td>4</td>
<td>18</td>
<td>22</td>
<td>11.0</td>
</tr>
<tr>
<td>Oral cavity</td>
<td>4</td>
<td>14</td>
<td>22</td>
<td>11.0</td>
</tr>
<tr>
<td>Nose (nostrils)</td>
<td>4</td>
<td>11</td>
<td>15</td>
<td>7.5</td>
</tr>
</tbody>
</table>

5. Size of burns

With regard to the size of the burns, we classified them in five groups, on the basis of WPI:

Class I: 34%
Class II: 20%
Class III: 28%
Class IV: 10%
Class V: 8%

Discussion

The main objective of this study is to demonstrate that in underdeveloped countries like Bangladesh and Cambodia it is possible, using basic surgical techniques, to obtain results in the correction of chronic burn damage that are equivalent to those obtained in modern, well-equipped medical structures. The best way to compensate for lack of technology is to perform early, simple, and reliable surgery with a low rate of morbidity and post-operative complications, yet without sacrificing good cosmetic results. The surgical procedures we performed were based on Z- or W-plasty, autologous skin grafts, and local and pedicle flaps (Table IV). The presence of fibrous tissues and retraction and a compromised vascular condition can have negative consequences on the results of the surgery performed. The most frequent post-operative complications we encountered were skin necrosis (5 patients, 2.5%), hypovascularization of wound edges (3 patients, 1.5%), non-take of skin grafts (4 patients, 2%), and infection (2 patients, 1%) (Table V).

Table IV - Surgical procedures used

<table>
<thead>
<tr>
<th>Surgical procedure</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z- and W-plasty</td>
<td>95</td>
</tr>
<tr>
<td>Pedicle flaps</td>
<td>40</td>
</tr>
<tr>
<td>Skin grafts</td>
<td>65</td>
</tr>
</tbody>
</table>

Table V - Post-operative complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin necrosis</td>
<td>5</td>
<td>2.5</td>
</tr>
<tr>
<td>Ischaemic flaps</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>Non-take of skin grafts</td>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>Infections</td>
<td>2</td>
<td>1.0</td>
</tr>
</tbody>
</table>

The sex and age of patients are linked to developmental and behavioural patterns, and are important determinants of risk in serious burn injury. The majority of the study population in our investigation were male, a finding that was consistent with other reports. We found that the risk of severe burn injury decreased with age in female children. In males, although the rate of risk fell in the 5-9 years age group compared to younger boys, it increased again after 10 years of age, reaching the highest peak in the group aged 20-40 years. At this stage of life, people are more exposed to burn injury both at home and in the...
work environment. Many studies on children have demonstrated that boys are more often the victims of burns associated with bone and joint deformities caused by delayed surgical treatment and by subsequent alteration of normal bone development - we observed deformity of the radius and the metacarpophalangeal joints, deformity of the jaw and oral cavity secondary to neck burns, and deformity and deflection of the vertebral column (Figs. 3a,b).

Another important finding in our study was a high percentage of chemical burns (31%). Females were more frequently involved than males, in a proportion of 2 to 1. The agents responsible for this type of burn were mainly acids (hydrochloric acid, sulphuric acid, nitric acid, phosphoric acid, and acetic acid) and organic solvents such as phenol. The tissue damage caused by these substances appears to be related to the action of cation hydrogen, which determines severe alteration of the tissue proteins, as in fourth-degree burns in muscles and bones (Fig. 4).

The most frequent complication is local infection.
The incidence of wound infection is very high in Bangladesh and Cambodia, mainly owing to the local social and economic situation; also, personal hygiene very often appears to be inadequate, while weather conditions facilitate bacterial growth. Such factors are rarely present in countries with a moderate climate, as in Europe and North America.

Conclusions

The factors and demographic characteristics of burn damage differ from region to region, and it is therefore very important that every country should carry out epidemiological studies with the aim of promoting education campaigns on care and on the prevention of the commonest causes of burns, in order to reduce their incidence in the population. This is also true of Cambodia and Bangladesh, but the message rarely reaches members of the poorest and least educated social classes, who are so numerous in these countries.

Our experience in the treatment of burns sequelae has enabled us establish the following guidelines:

a. priority treatment of fibrous tissue retraction, especially when this affects the eyelids, nostrils, mouth, and extensor folds;

b. use of the simplest and fastest surgical techniques such as skin grafts, which are still considered to be the first choice, followed by local and pedicle flaps and Z- and W-plasties;

c. use of absorbable monofilament sutures, as these present a lower risk of infection and do not need to be removed.

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