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UNIVERSITE DE LAUSANNE - FACULTE DE BIOLOGIE ET DE MEDECINE

Département Femme Mère Enfant
Service de chirurgie de l'enfant et de l'adolescent

Surgery of burns sequelae in developing countries

THESE

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et présentée à la Faculté de biologie et de médecine de
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Surgery of burns sequelae in developing countries

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Vice-Directeur de l'Ecole doctorale*

SURGERY ON BURNS SEQUELAE IN DEVELOPING COUNTRIES

CHIRURGIE DES SÉQUELLES DE BRÛLURES DANS LES PAYS EN DÉVELOPPEMENT

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SUMMARY. The purpose of this study is to analyze the effectiveness of surgery and follow-up of children operated on for burn sequelae. For many years, we have organized two missions per year to Benin and Togo, one for surgery and one for follow-up. We analyzed the files of children born in Africa and victims of burns from the years 2002 to 2011. Children were referred through a non-governmental organization (NGO) and assessed in Africa by local paediatricians before and after surgery. Treatment consisted in operating on burn sequelae such as contractures, hypertrophic scars and hard cords. Impaired mobility was our only indication for the operation. We kept a database on all patients. Sixty files were reviewed, of which fifty were deemed suitable for analysis. The most common methods of surgery were skin grafting and Z-plasty. There were no complications, such as infection or graft/flap necrosis after immediate surgery. Long-term follow-up revealed a recurrence of hypertrophic scarring (47%), retractions (24%) and hard cords (2%) due to a lack of occupational therapy and physiotherapy treatment. Partnership with an NGO and a local team allows us to treat children with burn injury sequelae in Western Africa. A continued and often long-lasting follow-up by occupational therapists and physiotherapists is highly mandatory in order to guarantee good long-term results. In 2010, we initiated local rehabilitation therapy.

Keywords: burn, treatment, follow-up, Africa

RÉSUMÉ. Le but de cette étude est d'analyser l'efficacité de la chirurgie et le suivi d'enfants opérés pour des séquelles de brûlures. Nous avons analysé les dossiers d'enfants africains, victimes de brûlures depuis l'année 2002 jusqu'en 2011. Pendant de nombreuses années, nous avons organisé deux missions par an au Bénin et au Togo, une pour la chirurgie et une pour le suivi. Les enfants nous étaient confiés par une O.N.G. et examinés en Afrique par des pédiatres locaux avant et après la chirurgie. Le traitement chirurgical s'adressait aux séquelles de brûlures telles que rétractions, cicatrices hypertrophiques et brides. La perte de mobilité fut notre unique indication. Nous avons une base de données sur tous les patients. 60 dossiers furent revus mais 50 retenus pour l'analyse. Les traitements les plus fréquents furent la greffe de peau et les plasties en Z. Il n'y a pas eu de complications, ni infection ou nécrose de la greffe ou du lambeau après chirurgie immédiate. Le suivi à long terme a montré une récurrence des cicatrices hypertrophiques (47%), des rétractions (24%) et des brides (2%), et ceci dû à une absence d'ergothérapie et de physiothérapie. La coopération avec une O.N.G. et une équipe locale a permis de traiter ces enfants présentant des séquelles de brûlures en Afrique de l'Ouest. Un suivi continu et souvent long par les ergothérapeutes et les physiothérapeutes est indispensable, si l'on veut garantir de bons résultats à long terme. En 2010 nous avons initié localement un traitement par rééducation fonctionnelle.

Mots-clés: brûlures, traitement, suivi, Afrique

Introduction

Burns are the most common form of injury in the paediatric population, especially among children under five years of age. They are the second most common cause of accidental death in children in developed countries.^{1,2} There are various kinds of burns: heat burns, chemical burns resulting from contact, ingestion or inhalation, electrical burns, abrasion burns, or ingestion of acids and alkalis.³⁻⁵ A correlation of burn depth and size allows an estimation of its severity and will determine treatment and follow-up. Scald burns are common in children.

Serious burns, including second degree burns that cover more than 10% of the total body surface area (TBSA) of a

child, burns that involve the face, genitals, hands or feet, burns that cross a joint or totally encircle an extremity, and inhalation burns should as a rule be referred to a specialized burn centre. Serious burns often require hospitalization and may need surgery and skin grafting.^{6,7} Skin grafting is usually elected after seven to ten days for children suffering from more than one second and third degree burn. It reduces scar activity and the ensuing risk of scar retraction and impaired mobility.

The treatment of burns is a delicate art, especially in children. Scar tissue and skin grafts in children have a tendency to overreact and to create a hypertrophic scar with an unsightly appearance and a risk of impaired mobility. Children with burns should be followed regularly by the surgeon, nurse, phys-

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iotherapist and occupational therapist as prevention is better than surgery. Prevention includes skin massage, use of pressure garments, use of topical steroids or injected steroids, and discussion/work with physiotherapists and occupational therapists. If prevention therapy during the first six to eight months is not successful, surgery may be necessary prior to scar maturation.⁸

The Department of Paediatric Surgery at the University Hospital in Lausanne (CHUV) has been providing medical support to Benin and Togo since 1980 by organizing yearly surgical missions and follow-up of operated children. Our surgical missions are based on a partnership between the CHUV, the NGO "Terre des hommes" (Tdh) and the Paediatric Hospital of Sedo-Goho in Abomey, Benin, in Zou and Colline Province, which has more than 900.000 inhabitants.

Our Paediatric Surgery Department provides medical and nursing personnel for the mission, assumes a large part of the costs of the mission, in particular travel and accommodation expenses, purchases and brings the drugs that will be needed, and procures and ships the material required. It also keeps a computerized database, created more than ten years ago, which holds the files of more than 1400 children, their medical history, type of surgery and follow-up reports. The Department of Anaesthesiology in Lausanne provides medical and nursing anaesthesiology personnel, assumes part of the costs of the mission, in particular travel expenses, and procures the material it needs.

The Tdh Foundation plays a major role in the preparation and execution of the mission. It ensures the necessary coordination with the local paediatric centre and local authorities; it assumes part of the costs of the mission and provides social workers responsible for finding the patients in the villages, and others who will be present for the whole duration of the mission and will carefully prepare families for their children's follow-up care; organizes local transport for the mission participants and is responsible for the transfer of material in loco.

The Paediatric Hospital of Sédo-Goho (*Fig. 1*), built in 1997 in Abomey, Benin, selects the children and sorts them according to their pathology in preparation for the surgical mission. It provides the premises for consultations, reserves the operating theatres, offers hospital accommodation for the patients, provides laboratory personnel for evaluating the patients, supports the training abroad of a Beninese surgeon,

protects the medical material and sterilizes it. Three local paediatric surgeons spent a year in Switzerland at the CHUV (respectively 1989-1990, 2006-2007 and 2014-2015) to complete their training.

As paediatric surgeons in Benin, we treat malformations of the face, such as clefts, the urological tract, such as hypospadias, the hand, the digestive tract, and other miscellaneous cases requiring general paediatric surgery.

The purpose of this study is to provide the results and follow-up of children operated on for sequelae of burn injuries in West Africa.

Material and methods

In this retrospective study, we reviewed data for all children treated for burn sequelae at the same hospital in Abomey, Benin, and operated on by the same Swiss medical team from January 2002 to December 2011. Most of the children on whom we operated suffered from malformations (facial clefts, hand and foot malformations, ano-rectal malformations, urinary tract malformations) or from sequelae of the accident (burn) that can have serious health consequences and lead to the child being socially isolated. The paediatrician of the Paediatric Hospital of Sedo-Goho in Abomey selected the children and sorted them according to their pathology in order to prepare the mission.

The September mission to both Benin and Togo allowed us to examine new children in preparation for the future surgery mission in January. At the same time, we checked on the children who had undergone surgery during previous missions to provide long-term follow up. We managed the database (File-maker) of all patients.

During the second mission in January, physicians from our Paediatric Surgery and Anaesthesiology Departments made up the medical and nursing personnel for local collaboration in Abomey. We first checked on the children seen during the September mission. Surgery was carried out intensively over ten days, with eight to nine operations performed daily by the surgical team. A local surgical team of four Beninese surgeons was always present and participated in the surgery. Two local anaesthesiology nurses were also present during the mission.

Impaired mobility was our only indication for the operation. In Africa, burns generally occur after contact with scald-



Fig. 1 - The paediatric hospital in Abomey, Benin.

Table I - Burn characteristics and surgical treatment of our 50 children

Area	n.	Split-thickness graft	Full-thickness graft	Z plasty
		34		28
		n = 12 (36%)	n = 22 (64%)	
Face	12	12%		
Neck	6			20%
Limbs	12	15%	20%	
Hands	28	11%	30%	68%
Feet	6	2%	10%	
Trunk	4			12%

Table II - Post-operative complications according to graft site

Grafts	n. = 34 (%)	Complications	n.
Hand*	14 (41%)	Hypertrophic scarring	8
		Retraction	6
		Hard cords	4
Limbs	12 (35%)	Hypertrophic scarring	8
		Retraction	2
Face	4 (12%)		
Feet	4 (12%)		

* Some patients with hand burns had skin grafts at more than one site on the hand.

ing hot water or small fires built in front of the house and used for cooking, or after gas explosions. No special treatment is given to burned children except for bandages to protect the burned skin. The risk of hypertrophic scar formation, skin retraction and impaired mobility for nearby articulations is therefore very high. Prevention, including daily massage of the skin, use of pressure dressings or garments and work with physiotherapists and occupational therapists does not exist in this part of Africa.

Signed informed consent for this study was obtained by the local paediatrician who represents the local institutional Human Research Board.

The Fisher Exact Test was used for statistical analysis with $p < .05$ considered as significant.

Results

The files of 50 children who had suffered burns were analyzed. Twenty-eight patients (56%) were female and 22 (44%) were male. Mean follow-up was 3.6 ± 2.5 years. All burn accidents happened at home or in the village. Most burns were due to flame injuries when cooking meals or to diesel oil explosions. At the time of injury, the patients were treated by local teams. Age at the time of the burn ranged from 6 months to 9 years, with a median age of 2 years. Age at our first medical evaluation ranged from 10 months to 17 years, with a median age of 4 years.

The anatomical sites of the burn injuries are described in *Table I*.

For all patients, the indication for surgical management was contractures with compromised function. All procedures were carried out under general anaesthesia. The surgical procedures performed were skin grafts, with full-thickness graft in 22 patients (64%) and split-thickness graft in 12 patients (36%). Forty-one percent of the 34 grafts were applied on the hands, 35% on limbs, 12% on the face and 12% on the feet (*Table I*). Mean age of the children at surgery was 3.25 ± 2.3



Fig. 2 – Six-year-old girl suffering from a burn due to an explosion. The four extremities were burned as well as her face and neck. She couldn't eat, drink or walk in 2010. Lower right, left arm and forearm operated on and grafted (thin graft).



Fig. 3 - The same girl, grafted on all four extremities, wears a cast on her left arm and forearm, which was made locally by our occupational therapist teaching a nurse (upper left).

years. Twenty-eight Z-plasties were done, 68% on the hands, 20% on the neck and 12% on the trunk (*Table I*). Sixteen children wore a splint for 15 days after their operation, none wore pressure garments.

We had no infection and no loss of graft during the immediate post-operative period. Longer-term post-operative complications after skin grafts did occur, namely hypertrophic scarring (47%), retractions (24%) and hard cords (2%) (*Table II*). Long-term, post-operative follow up after Z-plasty showed no hypertrophic scarring or retraction.

One child was transferred to Switzerland (in 2005). Both legs had been burned, and she needed several grafts. In 2010, another child burned severely on her legs and arms was first grafted on her left arm and forearm in Benin, then on her legs in 2011, and on her right arm and forearm in 2012 (*Figs. 2 and 3*). She was then transferred to Switzerland in 2013 for final surgical correction and follow-up with intensive occupational therapy and physiotherapy.

Discussion

Our study shows that foreign surgical missions collaborating with local medical teams to treat children in developing countries such as Benin and Togo are highly beneficial. However, as is also the case in developed countries, the functional results of this particular surgery cannot be truly evaluated until months after the surgery.⁸ The success of burn surgery should not be measured solely on the basis of a first surgical result, but also on the long-term results. Unfortunately, our evaluation of this essential aspect of burn repair shows that functional results after local surgery were not good enough. Even after successful surgery, long-term results were sometimes disappointing because of the lack of rehabilitation treatment afterwards. Therefore, since 2010 we have been organising local post-surgery rehabilitation therapy and courses held by our occupational therapist.

Therapies applied to burned children aim to improve the quality of the scar, thus diminishing the risk of unsightly scarring, scar retraction and impaired mobility. A long-lasting follow-up is necessary and improves not only the quality of the skin but also mechanical recovery (elasticity of the scar and mobility of articulations). The goal of our missions is to achieve better cosmetic and functional results. The therapists concerned with skin repair are the paediatric surgeon, the occupational therapist, the physiotherapist and the nurses. Therapists must be sure that the quality of the skin is good and strong enough before rehabilitation begins. The therapist's goal after a burn is to achieve a flat, soft, smooth, pliable scar.

The first step in skin repair is wound closure. The next step is management of scar formation. At this point, the skin has the capacity to stimulate fibroblasts in very high quantity, especially in children, with the risk of creating a hypertrophic scar and consequent retraction or impaired articulation. This phase normally has an average duration of 18 months, with scarring activity reaching its maximum intensity between three and six months. The scarring process may be impaired and amplified, thus creating an uncontrolled hypertrophic scar called a 'keloid'. This is why the final result of skin repair depends on treatment during the first two years following the burn.

Treatment during the scarring phase starts with the use of progressive skin massage. Massage must be given gently for a few minutes, twice daily. This should be done for a minimum of one year, with a critical period between one and eight months after injury. Pressure on the scar, starting about four to six weeks after injury, may be useful to keep it flat, soft, smooth and pliable. Elastic pressure garments are worn no earlier than about two months after injury to avoid damaging a fragile graft or newly-healed tissue. Pressure garments need to be replaced every two to three months to adapt to the growth of the child. An insert placed between the garment and the scar may, along with the garment, reinforce the pressure.

During rehabilitation, mobility exercises under the guidance of a physiotherapist help to soften the skin and increase

mobility by enhancing scar elasticity. They also help to maintain muscle balance. Therapists should always perform mobility exercises on several joints when the pressure garments are removed. Because many children cannot naturally fully overcome the contracting force of a scar or are unable to cooperate, a gentle sustained stretch can be useful also. Physiotherapists should not perform aggressive mobility exercises as this may traumatize the child and the tissue, thereby increasing scarring.

Splinting during rehabilitation is used to maintain mobility by counteracting the force of a contracting scar. Splints are usually worn daily and adapted by the occupational therapist according to the child's age. They are secured with an elastic bandage. Serial casting with either plaster or synthetic material is also effective in helping children to regain motion lost to scar contraction.

Finally, psychological repair of burns, one of the most common household injuries, is another part of the battle, as these injuries can have emotional and psychological repercussions, not only for the child but for the whole family.

Even when surgery is performed under good conditions, continued and often long-lasting treatment of children with burns is mandatory and requires appropriate follow-up by occupational therapists and physiotherapists in order to guarantee good long-term results. In 2010, we initiated rehabilitation therapy in West Africa with our occupational therapist, who takes care of the children after surgery and organizes courses on the care of burned children, with explanations for the medical team and parents (*Fig. 3*). Prevention information before scar retraction should be addressed directly to the parents, all nationalities and socio-economic levels included, so that they will be aware of the daily care of a scar a few months after surgery.

Medical missions cannot be limited to performing operations and then leaving. The best organizations are those that integrate the indigenous socio-medical community by working together with physicians, nurses and social workers in a personal and collaborative manner.⁹⁻¹¹ The aim is to share our professional experience with local medical teams so that they can then organize their work and pursue it on their own.^{12,13} Our goal, therefore, is to improve the efficacy of medical care by offering further training to local surgeons, providing medical supplies, and giving advice on general organization. The creation of an independent surgical centre with local professionals who can perform operations and plan the follow-up on their own must also be included. This goal is possible only if local physicians are supported by local authorities.

Our main goals for the coming years are to continue our close collaboration with the Paediatric Centre of Sedo-Goho in Abomey, secure our achievements, put together competent local anaesthesiology and surgical teams to give local medical personnel the means to become progressively more independent, reduce the number of patients transferred to Switzerland, and raise funds to ensure the continuity and autonomy of our surgical missions.

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