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Contents

Thrice Monthly Volume 9 Number 26 September 16, 2021

EDITORIAL

- 7614 Advances in deep learning for computed tomography denoising
Park SB

REVIEW

- 7620 Spirituality, religiousness, and mental health: A review of the current scientific evidence
Lucchetti G, Koenig HG, Lucchetti ALG
- 7632 Role of hospitalization for inflammatory bowel disease in the post-biologic era
Soriano CR, Powell CR, Chiorean MV, Simianu VV

MINIREVIEWS

- 7643 Combined targeted therapy and immunotherapy for cancer treatment
Guo CX, Huang X, Xu J, Zhang XZ, Shen YN, Liang TB, Bai XL

ORIGINAL ARTICLE

Basic Study

- 7653 Mechanism of Jianpi Qingchang Huashi Recipe in treating ulcerative colitis: A study based on network pharmacology and molecular docking
Zheng L, Wen XL, Dai YC

Case Control Study

- 7671 Common bile duct morphology is associated with recurrence of common bile duct stones in Billroth II anatomy patients
Ji X, Jia W, Zhao Q, Wang Y, Ma SR, Xu L, Kan Y, Cao Y, Fan BJ, Yang Z

Retrospective Cohort Study

- 7682 Efficacy of roxadustat in treatment of peritoneal dialysis patients with renal anaemia
Zhu XW, Zhang CX, Xu TH, Jiang GN, Yao L

Retrospective Study

- 7693 Clinical metagenomic sequencing for rapid diagnosis of pneumonia and meningitis caused by *Chlamydia psittaci*
Yin XW, Mao ZD, Zhang Q, Ou QX, Liu J, Shao Y, Liu ZG
- 7704 Evaluation of the etiology and risk factors for maternal sepsis: A single center study in Guangzhou, China
Lin L, Ren LW, Li XY, Sun W, Chen YH, Chen JS, Chen DJ

- 7717 Influencing factors for hepatic fat accumulation in patients with type 2 diabetes mellitus

Wu MJ, Fang QL, Zou SY, Zhu Y, Lu W, Du X, Shi BM

- 7729 Clinical effect of peripheral capsule preservation in eyes with silicone oil tamponade

Jiang B, Dong S, Sun MH, Zhang ZY, Sun DW

- 7738 Potential effects of the nursing work environment on the work-family conflict in operating room nurses

Fu CM, Ou J, Chen XM, Wang MY

Observational Study

- 7750 Effect and satisfaction of outpatient services by precision valuation reservation registration

Jin HJ, Cheng AL, Qian JY, Lin LM, Tang HM

Randomized Controlled Trial

- 7762 Impact of intravenous dexmedetomidine on postoperative bowel movement recovery after laparoscopic nephrectomy: A consort-prospective, randomized, controlled trial

Huang SS, Song FX, Yang SZ, Hu S, Zhao LY, Wang SQ, Wu Q, Liu X, Qi F

META-ANALYSIS

- 7772 Comparison of different methods of nasogastric tube insertion in anesthetized and intubated patients: A meta-analysis

Ou GW, Li H, Shao B, Huang LM, Chen GM, Li WC

CASE REPORT

- 7786 Secondary injuries caused by ill-suited rehabilitation treatments: Five case reports

Zhou L, Zhou YQ, Yang L, Ma SY

- 7798 Gastric syphilis mimicking gastric cancer: A case report

Lan YM, Yang SW, Dai MG, Ye B, He FY

- 7805 Low-grade chondrosarcoma of the larynx: A case report

Vučković L, Klisic A, Filipović A, Popović M, Čulafić T

- 7811 Pediatric temporal fistula: Report of three cases

Gu MZ, Xu HM, Chen F, Xia WW, Li XY

- 7818 Treatment for CD57-negative $\gamma\delta$ T-cell large granular lymphocytic leukemia with pure red cell aplasia: A case report

Xiao PP, Chen XY, Dong ZG, Huang JM, Wang QQ, Chen YQ, Zhang Y

- 7825 Rare neonatal malignant primary orbital tumors: Three case reports

Zhang Y, Li YY, Yu HY, Xie XL, Zhang HM, He F, Li HY

- 7833 Carbon ion radiotherapy for bladder cancer: A case report

Zhang YS, Li XJ, Zhang YH, Hu TC, Chen WZ, Pan X, Chai HY, Wang X, Yang YL

- 7840** Extravasation of chemotherapeutic drug from an implantable intravenous infusion port in a child: A case report
Ly DN, Xu HZ, Zheng LL, Chen LL, Ling Y, Ye AQ
- 7845** Chronic active Epstein-Barr virus infection treated with PEG-asparaginase: A case report
Song DL, Wang JS, Chen LL, Wang Z
- 7850** Omental mass combined with indirect inguinal hernia leads to a scrotal mass: A case report
Liu JY, Li SQ, Yao SJ, Liu Q
- 7857** Critical lower extremity ischemia after snakebite: A case report
Lu ZY, Wang XD, Yan J, Ni XL, Hu SP
- 7863** Migration of the localization wire to the back in patient with nonpalpable breast carcinoma: A case report
Choi YJ
- 7870** Uniportal video-assisted thoracoscopic surgery for complex mediastinal mature teratoma: A case report
Hu XL, Zhang D, Zhu WY
- 7876** Congenital disorder of glycosylation caused by mutation of *ATP6AP1* gene (c.1036G>A) in a Chinese infant: A case report
Yang X, Lv ZL, Tang Q, Chen XQ, Huang L, Yang MX, Lan LC, Shan QW
- 7886** Rare monolocular intrahepatic biliary cystadenoma: A case report
Che CH, Zhao ZH, Song HM, Zheng YY
- 7893** Hepatocellular carcinoma with inferior vena cava and right atrium thrombus: A case report
Liu J, Zhang RX, Dong B, Guo K, Gao ZM, Wang LM
- 7901** Delayed diagnosis of ascending colon mucinous adenocarcinoma with local abscess as primary manifestation: Report of three cases
Han SZ, Wang R, Wen KM
- 7909** Gastrointestinal bleeding caused by syphilis: A case report
Sun DJ, Li HT, Ye Z, Xu BB, Li DZ, Wang W
- 7917** Transient involuntary movement disorder after spinal anesthesia: A case report
Yun G, Kim E, Do W, Jung YH, Lee HJ, Kim Y
- 7923** Diagnosis and treatment of an inborn error of bile acid synthesis type 4: A case report
Wang SH, Hui TC, Zhou ZW, Xu CA, Wu WH, Wu QQ, Zheng W, Yin QQ, Pan HY
- 7930** Malignant fibrous histiocytoma of the bone in a traumatic amputation stump: A case report and review of the literature
Zhao KY, Yan X, Yao PF, Mei J

- 7937** Rare complication of acute adrenocortical dysfunction in adrenocortical carcinoma after transcatheter arterial chemoembolization: A case report
Wang ZL, Sun X, Zhang FL, Wang T, Li P
- 7944** Peripherally inserted central catheter placement in neonates with persistent left superior vena cava: Report of eight cases
Chen Q, Hu YL, Li YX, Huang X
- 7954** Subcutaneous angiolipoma in the scrotum: A case report
Li SL, Zhang JW, Wu YQ, Lu KS, Zhu P, Wang XW

LETTER TO THE EDITOR

- 7959** Should people with chronic liver diseases be vaccinated against COVID-19?
Chen LP, Zeng QH, Gong YF, Liang FL

ABOUT COVER

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Secondary injuries caused by ill-suited rehabilitation treatments: Five case reports

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Abstract

BACKGROUND

Increasing attention is being given to burn rehabilitation, and an increasing number of burn patients are undergoing rehabilitation. However, little attention has been given to secondary injuries caused by ill-suited rehabilitation practices. Patients, especially those in undeveloped countries, sustain injuries due to inadequate burn rehabilitation practices and the nonstandard implementation of rehabilitation treatments.

CASE SUMMARY

This study reports 5 cases of secondary injuries caused by ill-suited burn rehabilitation practices in our institute, including first web space contracture caused by a single orthosis treatment, finger deformity caused by improper compression therapy with a self-adhering bandage, developmental impairment of the affected limb caused by continuous improper compression therapy, and fracture caused by overly intensive rehabilitation exercise.

CONCLUSION

More attention should be given to burn rehabilitation to reduce the incidence of secondary injuries caused by ill-suited rehabilitation practices. Burn rehabilitation system should include specialized hospitals (burn rehabilitation centers), community hospitals, and family rehabilitation clinics. Precise instruments and equipment, accurate measurement methods, objective monitoring indicators and standardized guidelines and recommendations will help improve the quality of burn rehabilitation. Additionally, more attention should be given to burn rehabilitation in children.

Key Words: Ill-suited rehabilitation treatments; Injury; Burn rehabilitation system; Burn; Case report

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Core Tip: Functional reconstruction and rehabilitation are dynamically developing processes. Burn rehabilitation treatment should encompass the whole process from the time of the injury to when the patient returns to society, and appropriate rehabilitation measures should be taken at different stages of burn treatment. Rehabilitation therapists should systematically study clinical knowledge related to burns and explore the timing and use of various rehabilitation treatment techniques with clinical treatment to improve their professional level of rehabilitation. Moreover, the establishment of a national burn rehabilitation society and other academic organizations to further promote the popularization, development, standardization and improvement of burn rehabilitation treatment is warranted.

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INTRODUCTION

With improvements in healthcare, the chances of survival and rehabilitation after burn injury have increased substantially. In the comprehensive treatment of patients, burn rehabilitation, which is gradually being offered to an increasing number of patients, with almost all patients now receiving rehabilitation, is initiated after the completion of burn treatment as well as during the late, middle, and even early stages of burn treatment[1-3]. The current global consensus is that functional exercise and rehabilitation should start early in the burn treatment course, especially in patients with severe burns[4-7]. Preventing postburn deformities is more beneficial than correcting deformities after they occur[8]. Burn rehabilitation is an emerging discipline that has gradually developed in recent years, especially in China, which has the largest population of burn patients, but treatment concepts and operational specifications for burn rehabilitation are not aligned with actual clinical processes, resulting in secondary injuries, increased pain, additional medical visits, increased costs, and even severe irreversible consequences[9-11]. This study reports 5 typical clinical cases treated in our center in recent years to provide a reference for burn rehabilitation personnel regarding possible injuries that may occur in the process of burn rehabilitation.

CASE PRESENTATION

Chief complaints

All 5 patients were male, with ages ranging from 2 years to 31 years; all of the patients were burned by flame. The patients had hypertrophic burn scars and functional impairments.

History of present illness

They underwent different burn rehabilitation techniques and sustained secondary injuries due to these techniques (Tables 1 and 2).

History of past illness

No special circumstances.

Personal and family history

All 5 patients have no special personal and family history.

Physical examination

Hypertrophic burn scars and functional impairments.

Table 1 General characteristics of the 5 cases

	Sex	Age (yr)	Cause of injury	Total body surface area (%)	Main body parts	Skin grafting	Rehabilitation issues
Case 1	Male	31	Flame	72	Hands	Split-thickness skin grafting	Hypertrophic burn scar, flexion deformity, narrowing of the first web space
Case 2	Male	2	Flame	2	Left hand	Split-thickness skin grafting	Hypertrophic burn scar, left syndactyly
Case 3	Male	6	Flame	Unknown	Face	No skin grafting	Hypertrophic burn scar of the jaw
Case 4	Male	3	Flame	Unknown	Right lower limb	Mesh grafting	Hypertrophic burn scar
Case 5	Male	11	Flame	71	Lower limbs	Skin grafting	Flexion contracture of bilateral popliteal fossa caused by scar contracture

Table 2 Main rehabilitation measures and the injuries of the patients

	Main rehabilitation measures	Main problems	New injuries	Remedies	Outcomes
Case 1 (Figure 1)	Compression therapy; Functional orthosis	Orthotic device was not adjusted properly	Significantly reduced first web space angle, thumb abduction and flexion contracture of metacarpophalangeal joint	Added an extension position orthosis that was alternated with a functional orthosis	Appearance and function of the hands were improved significantly
Case 2 (Figure 2)	Compression therapy, home rehabilitation, regular follow-up	Wrong wrapping method, excessive compression, not followed regularly	Syndactyly, hyperplasia, and hypertrophy of the distal soft tissue of the fingers on the left hand	Educated the parents about rehabilitation training, demonstrated correct wrapping methods, surgically corrected syndactyly, followed up regularly	The finger webs were evenly spaced, and the soft tissue hypertrophy of the little finger was alleviated
Case 3 (Figure 3)	Compression therapy with elastic headgear	Elastic headgear was worn too long, size was not adjusted in time; not followed regularly	Restricted development of alveolar bone; restricted mouth opening and occlusal dysfunction	Provided modified elastic headgear in time and optimized the wearing scheme; followed up every month	Restricted mouth opening was relieved; occlusal function returned to normal, and the facial appearance was significantly improved
Case 4 (Figure 4)	Compression therapy	Elastic bandage was applied with too much pressure for a long time	Limb muscle atrophy	Adjusted the compression intensity of the elastic bandage, strengthened functional exercise of the affected limb, performed massage and kerotherapy to promote blood circulation	Deformity of the lower leg was improved slightly
Case 5 (Figure 5)	Functional exercise, antiscar treatment	Violent correction of lower limb flexion deformity	Femoral fracture	Immobilized the affected limb with a plaster cast	The fracture gradually healed

FINAL DIAGNOSIS

Case 1

Seventy-two percent total body surface area burned (Figure 1).

Case 2

Hypertrophic burn scar and syndactyly on the left hand (Figure 2A).

Case 3

Hypertrophic scars of the jaw after a burn (Figure 3A).

Case 4

Hypertrophic scar on the right lower limb (Figure 4).

Case 5

Large-area burn and flexion contracture of the bilateral popliteal fossa caused by scar



Figure 1 Treatment with an improper brace led to secondary deformity and malfunction of both hands. A: Simple fixation in a functional position

in the early stage; B: Reduced thumb abduction and flexion; contracture of the metacarpophalangeal joint; C: Alternating use of 2 orthotic devices in functional and straight positions; D: At 4 mo after treatment, flexion of the metacarpophalangeal joint, first web space contracture, and thumb abduction all improved significantly.



Figure 2 Improper rehabilitation at home led to distal deformities of the fingers. A: Four days after the burn; B: At 7 mo after the burn, syndactyly of the third and fourth fingers and abnormal growth of the distal soft tissue of multiple fingers were observed; C: At 8 mo after the burn (1 mo after syndactyly repair), syndactyly was corrected, and distal soft tissue deformity of multiple fingers was alleviated; D: At eleven months after the burn (3 mo after syndactyly repair) (left) and at 14 mo after the burn (6 mo after syndactyly repair) (right), the above deformities had obviously improved.

contracture (Figure 5A).

TREATMENT

Case 1

Split-thickness skin grafting.



Figure 3 Abnormal mandibular development due to improper compression therapy occurred because regular follow-up was not adhered to as suggested. A: Three years after the burn injury; B: After 2 year of compression therapy using elastic headgear and before scalp tissue expansion (5 year after the burn); C: Scalp tissue expansion following 2 year of compression therapy using elastic headgear (5 year after the burn); D: Two years after regular follow-up and regular adjustment of the headgear for compression therapy (7 year after the burn).

Case 2

Compression therapy with a self-adhering bandage, range-of-motion exercises for the hand joints, home rehabilitation, and regular follow-up (which was not adhered to by the patient's parents) comprised the rehabilitation regimen.

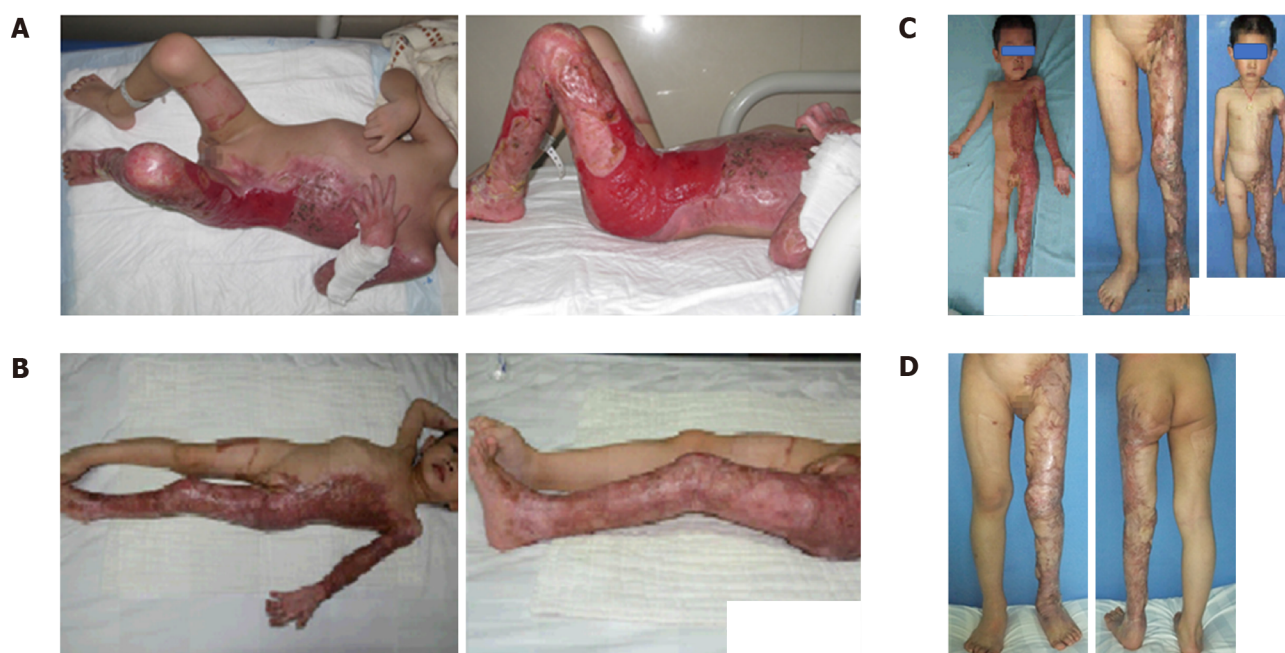


Figure 4 Improper home rehabilitation treatment led to severe dystrophy of the affected limb. A: During the burn wound repair period; B: Seven months after the burn; C: Nine months (left) and 18 mo (right) after the burn; D: Five years after the burn.

Case 3

Compression therapy with elastic headgear performed at home.

Case 4

An elastic bandage applied with pressure.

Case 5

Skin grafting, functional exercise, occupational therapy, physical therapy, and antiscar treatment.

OUTCOME AND FOLLOW-UP

Case 1

Outcome: Although the wound healed, hypertrophic burn scars, flexion deformities, and narrowing of the first web space developed. He received the following rehabilitation regimen: Compression therapy with a self-adhering bandage and bedside range-of-motion exercises and a functional orthosis at night and while at rest (the wrist was placed in the palmar flexion position, the finger webs were spaced with sterile gauze, the metacarpophalangeal joint was maintained in a natural position of 40°-50° of flexion, the interphalangeal joints were fully extended, and the thumb was fixed in opposition to the fingers with abduction (Figure 1A)).

Follow-up: Several weeks later, flexion-adduction deformity of both thumbs and flexion contracture of the metacarpophalangeal joint gradually appeared, and the first web space angle and thumb abduction were significantly reduced (Figure 1B). The orthosis was immediately adjusted. An additional orthosis was used to fix the fingers in the extension position, and the thumb was abducted (Figure 1C). The functional orthosis and the extension position orthosis were worn alternately on the subsequent days. Approximately four months later, the appearance and function of the hands improved significantly (Figure 1D).

Case 2

Outcome: Because of ischemia and hypoxia caused by improper wrapping (using a self-adhering bandage starting from the middle of the fingertip) and too much pressure, excessive cell proliferation, hypertrophy and syndactyly occurred in the distal soft tissue of the fingers of the left hand. Abnormal tissue exceeded the

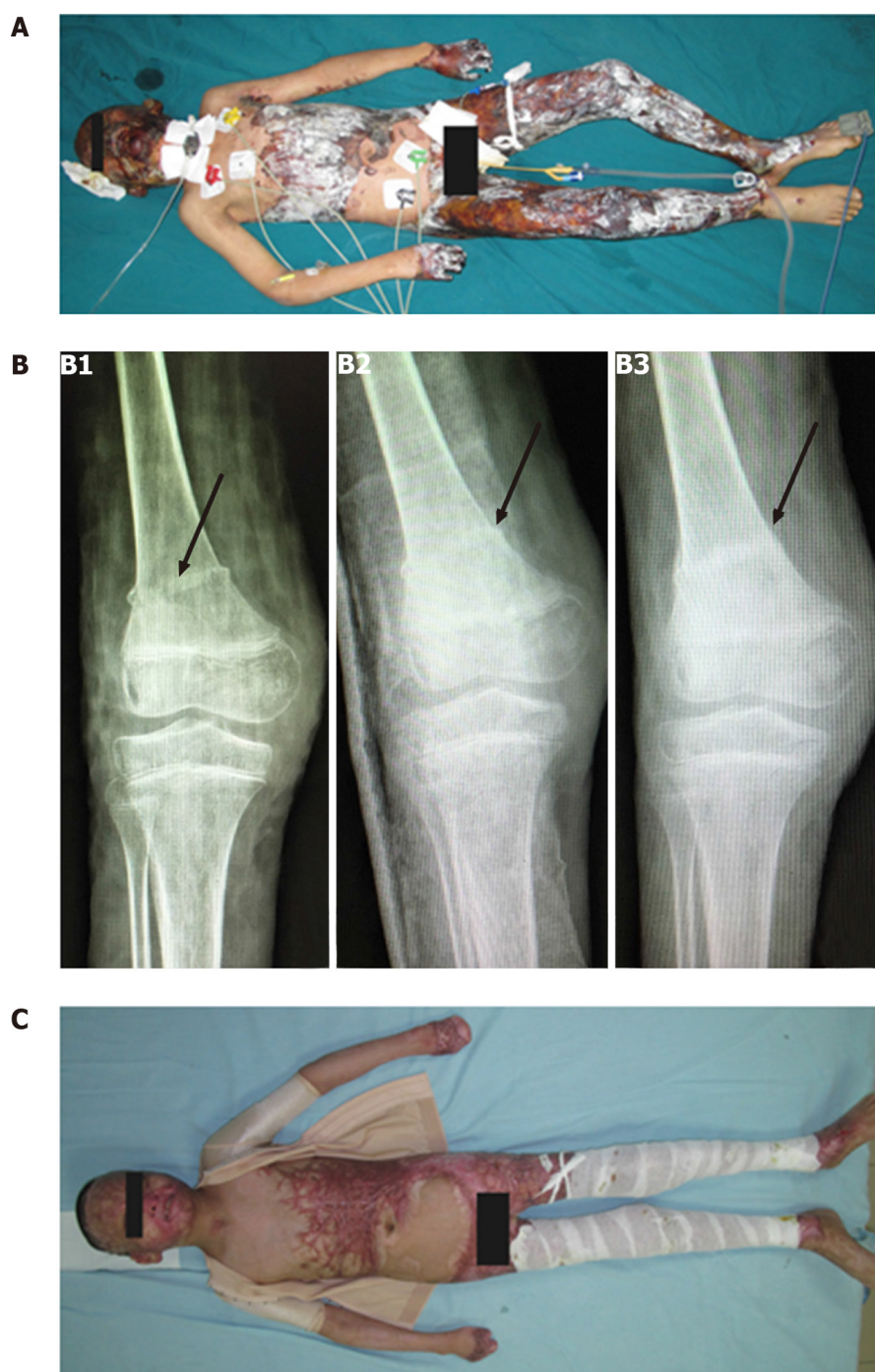


Figure 5 Fracture by ill-suited burn rehabilitation. A: Large-area burns on the body of the child on admission on January 12, 2016; B: Right femoral fracture on August 1, 2016 (B1); 10 d after plaster immobilization (B2); the fracture was almost healed 1 mo after immobilization (B3); C: Scars on September 7, 2016.

boundary of the nail bed, especially in the little finger. The patient did not regularly attend follow-ups. X-ray examination showed significant hyperplasia of the soft tissue beyond the distal phalanx of the left little and ring fingers, with these fingers being significantly longer than the corresponding fingers of the right hand (Figure 2B).

Follow-up: Syndactyly was surgically corrected, and pads were placed between the fingers to provide compression. The parents received training on the appropriate wrapping method (*i.e.*, wrapping the self-adhering bandage starting from the distal end of the fingernail with proper compression to ensure that the skin of the fingertip was pink after bandaging) and were advised to attend the follow-ups regularly. Several months later, the finger webs were evenly spaced, and soft tissue hypertrophy of the little finger was alleviated (Figure 2C and D).

Case 3

Outcome: Due to the lack of regular follow-up, the elastic headgear was worn for too long, and the size was not adjusted in a timely manner. The development of alveolar bone was restricted and led to mandibular adduction deformity and occlusal dysfunction. Mouth opening was also restricted; the distance between the upper and lower lips was 2 cm, and the distance between the corners of the mouth was 4 cm (Figure 3B).

Follow-up: To address these issues, elastic headgear of an appropriate size was immediately provided to increase local compression of the lower jaw and provide circumferential compression of the head. An optimized wearing scheme was provided and relevant precautions were taken to balance pressure treatment and occlusal function training. Regular follow-up every month was planned. Seven years later, the restricted mouth opening was relieved. Moreover, the occlusion was alleviated, and the facial appearance had significantly improved (Figure 3C and D). During rehabilitation, the child underwent a tissue expander flap repair operation because of scalp scar hyperplasia and hair loss.

Case 4

Outcome: The limb muscle was atrophied because the elastic bandage was applied too tightly for prolonged period of time (Figure 4A and B).

Follow-up: After adjusting the compression intensity of the elastic bandage and strengthening functional exercise of the affected limb, as well as providing massage and kerotherapy to promote blood circulation for 5 years, the deformity of the lower leg was slightly improved (Table 3, Figure 4C and D).

Case 5

Outcome: During rehabilitation provided by his parents, violent correction of the lower limb flexion deformity led to femoral fracture (Figure 5B1 and B2).

Follow-up: The fracture gradually healed after immobilization in a plaster cast for one month (Figure 5B3), and the scar was reduced (Figure 5C).

DISCUSSION

In the 5 cases reported herein, ill-suited rehabilitation treatment led to secondary injuries, including serious deformities and irreversible developmental disorders. In patient 1, the therapists focused on fixation in the functional position and neglected to apply an orthosis in the extension position; this was due to a lack of therapist experience or a lack of communication between the therapist and surgeon. In patients 2 and 5, lack of family rehabilitation knowledge and rehabilitation skills were the primary causes of the secondary injuries. In patients 3 and 4, the balance between physiological development and compression therapy was not well managed. All the patients except for patient 5 did not regularly attend follow-ups according to the guidance provided by their physicians. Burn rehabilitation in China is suboptimal due to serious challenges, such as a lack of full-time personnel, a lack of public acceptance of burn rehabilitation regimens, inadequate burn rehabilitation systems, the concept of “self-sufficiency, decentralized development”, insufficient social support, limited input from governmental and nongovernmental institutions, low social awareness, and a lack of volunteers and social workers. There are also other serious deficiencies in innovative and effective treatment proposals and means, multidisciplinary cooperation, and systematic scientific and objective evaluation systems[12,13].

It should be emphasized that the burn treatment process is extremely complicated and long. Burn rehabilitation should encompass the whole process from the time of the injury to return to society, and appropriate rehabilitation measures should be implemented at different stages during burn treatment. Rehabilitation therapists should systematically study clinical information related to burns and explore the timing and use of various rehabilitation techniques together with clinical treatments to improve rehabilitation outcomes. Precise instruments and equipment, accurate measurement methods, and objective monitoring indicators are effective in improving the quality of burn rehabilitation. For example, accurate pressure measurement can reduce complications associated with pressure treatments, objective angle measurement can accurately indicate the effect of joint rehabilitation, and intelligent rehabilitation instruments can reduce damage in the process of joint training. In addition,

Table 3 The status of the patient at the follow-up visit at 5 year after the burn

Body part	Left circumference (the injured side, cm)	Right circumference (cm)
Ankle joint	20	19
Thickest part of the calf	20	25
10 cm below the knee	21.2	21
Thickest part of the thigh	30	33
Leg length	65.5	67

standardized guidelines and recommendations for burn rehabilitation will help reduce the risk of secondary damage in the process of burn rehabilitation.

Burn rehabilitation involves teamwork. The multidisciplinary team should comprise burn surgeons, rehabilitation physicians, rehabilitation therapists, nurses, family members of the patient and the patient[14]. Personnel specializing in burn rehabilitation, orthopedics, psychology, sports medicine and other relevant disciplines should be recruited through interdisciplinary consultations and multi disciplinary team. The burn department should initiate the establishment of a flexible and interdisciplinary burn rehabilitation team to establish rehabilitation approaches for burn patients and a relatively stable multidisciplinary diagnosis and treatment guidelines. Moreover, the establishment of a national burn rehabilitation society and other academic organizations to further promote the popularization, development, standardization and improvement of burn rehabilitation is warranted.

A three-level burn rehabilitation system comprising a specialized hospital (burn rehabilitation center), community hospital, and family rehabilitation clinic will help alleviate and improve the current challenges of burn rehabilitation in China (Figure 6). In this system, well-equipped professional burn rehabilitation centers, as the first and highest level of the system, can also be established as regional burn rehabilitation training bases with the support of the state or social institutions. Their main tasks are the early rehabilitation of burn patients and the administration of important key treatments, excluding surgical treatment. In addition, the development of novel innovations, the formulation and promotion of standards, and training on and the popularization of burn rehabilitation knowledge and skills should be implemented to provide rehabilitation guidance for community health care institutions and families. Community health centers mainly treat patients requiring burn rehabilitation who are transferred from professional burn rehabilitation centers. They provide general or burn-related rehabilitation, including functional exercise, and technical guidance for family members, but they do not perform surgery. As the terminal treatment unit, family rehabilitation clinics are mainly responsible for regular and ongoing general rehabilitation, including functional exercise, which is needed by all burn rehabilitation patients. Studies have shown that family involvement in burn rehabilitation has positive impacts on a patient's return to society and physical, social, and psychological wellbeing[15]. However, family involvement in rehabilitation requires the participation and assistance of professional rehabilitation institutions, governments, and social agencies; publicization of the concept of family involvement in burn rehabilitation, popularization of relevant knowledge and skills, and the formation of feedback and guidance mechanisms to promote family involvement in burn rehabilitation. For both outpatients and inpatients in our unit, many brochures on burns, scars and rehabilitation were provided to improve knowledge and provide guidance to benefit the patients and their families. Of course, it is important to encourage and prompt additional medical personnel to engage in burn rehabilitation work, increase the number of employees, and alleviate the current shortage of human resources.

Improper burn rehabilitation leads to more serious or even irreversible secondary damage in children with burns than in adults. For example, patient 4 experienced limb dystrophy, and patients 2 and 3 exhibited skeletal and soft tissue developmental malformations. We should pay more attention to burn rehabilitation in children. Under the premise of early rehabilitation, combined with the characteristics of children's growth and development and specific rehabilitation needs, we should establish meticulous individualized treatment courses, increase the frequency and duration of follow-up, and adjust treatment plans and approaches, such as changing the pressure of clothing or adjusting the parameters of braces, in a timely manner.

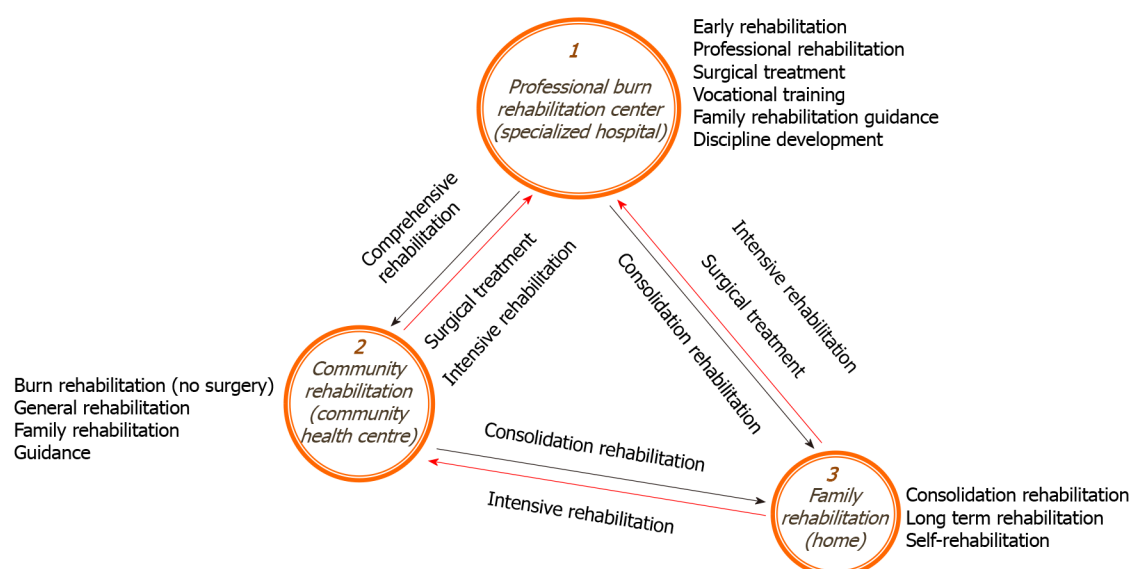


Figure 6 Three-level burn rehabilitation treatment system. Consolidation rehabilitation: Repetitive rehabilitation therapy without a new treatment program; Intensive rehabilitation: The addition of new treatment approaches or the modification and adjustment of treatment approaches for some conditions; Comprehensive rehabilitation: Professional burn rehabilitation and general rehabilitation treatment. Surgical treatment includes surgical correction or functional reconstruction.

CONCLUSION

In summary, more attention should be given to secondary injuries caused by ill-suited rehabilitation. The three-level burn rehabilitation system, standardized treatment guidelines and recommendation, precision instruments and equipment, accurate measurement methods, objective monitoring indices, good multidisciplinary cooperation and the academic study of burn rehabilitation will benefit burn rehabilitation patients. Burn rehabilitation training may be a good starting point for the establishment of the three-level system. Additional attention should be given to burn rehabilitation in children.

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