Original Article

Improvement of satisfaction in burn patients receiving adjuvant hyperbaric oxygen therapy

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Abstract

Background: Hyperbaric oxygen (HBO) therapy is an adjuvant treatment in patients with burns. However, evidence regarding the effectiveness of the HBO therapy for the improvement of patient's satisfaction has seldom been discussed; thus, we share our experience in this topic.

Aim and Objectives: This study aimed to evaluate the improvement of burn patients' satisfaction after adjuvant HBO therapy.

Materials and Methods: This was a retrospective case–control study involving 35 burn patients admitted to our hospital without a history of chronic pain and burn treatments from 2012 to 2015. Group I consisted of 18 burn patients who received HBO therapy to manage burns. The HBO therapy was administered in the hyperbaric chamber and received 60 min of 100% oxygen at a therapeutic pressure at 50 feet for 20 sessions. Group II consisted of 17 burn patients without a history of HBO therapy. Age, gender, total body surface area (TBSA), scar progression, improvement of visual analogue scale score, satisfaction improvement, and infection rate were documented and analyzed.

Results: The mean age of Group I (37.0 ± 9.2) was significantly lower than that of Group II (49.4 ± 17.4) ($P = 0.015$). The mean improvement pain score in Group I (4.7 ± 1.1) was significantly higher than that of Group II (3.6 ± 0.9) ($P = 0.004$). The mean satisfaction improvement of Group I (3.4 ± 0.5) was significantly higher than that of Group II (2.9 ± 0.6) ($P = 0.009$). No significant difference was observed between gender, TBSA, debridement times, skin graft times, skin graft surface, infection rate, length of hospital stay, and progression of scar score in both groups, but there was a positive correlation between HBO therapy and the progression of scar score, so does the infection rate. There is no significant interaction between the two factors (HBO and age) on the improvement of pain score and improvement of satisfaction.

Conclusion: Evaluation of the results obtained in the study suggests that the HBO therapy has a significant improvement in the pain relieve and satisfaction improvement after control of age factor in patients with thermal burns.

Keywords: Burn injury, hyperbaric oxygen therapy, improvement of satisfaction

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INTRODUCTION

Thermal burns are associated with high morbidity and mortality. Burns are a complex and evolving injury with both local and systemic consequences. Burn severity increases when the burned area is >20% of the total body surface area (TBSA).[1] Treating burn patients is a difficult challenge that requires great efforts. Early treatment can significantly improve mortality rates. It involves appropriate fluid resuscitation, requiring attainment of resuscitation targets using consensus formulas for initial fluid administration, together with topical agents to control pain, reduce fluid loss, and prevent bacterial growth. Over the past two decades, early closure of full-thickness wounds has improved the outcome of extensive burns by preventing bacterial colonization and infection.[1] To improve the outcome in cases of thermal burns, the HBO therapy is used as an adjuvant therapy that has been well studied. The HBO therapy is the therapeutic administration of 100% oxygen at environmental pressures between 1.4 and 3.0 atmosphere absolute (ATA), for periods between 60 and 120 min once or more daily.[2] The Undersea and Hyperbaric Medical Society (UHMS) approved that acute thermal burn injury is the indication of HBO therapy. The HBO therapy as an adjuvant treatment for burn patients significantly reduces the length of hospital stay, and overall cost of care;[3] Evidence regarding the effectiveness of HBO therapy in improving patients' satisfaction by reducing wound pain or scar appearance has attracted less discussion; therefore, we share our experience in this topic.

MATERIALS AND METHODS

Setting

This study was carried out in the Diving and Hyperbaric Medicine Department of Zuoying Branch of Kaohsiung Armed Forces General Hospital. As a former Navy General Hospital, it features a Diving Medical Department and a Burn Care Team. A burn center is a specialized center that provides care to patients with burns and critical soft-tissue conditions and is responsible for caring for all burn patients in the Kaohsiung area. When treating burn patients, adjuvant HBO therapy is always considered. The treatment is completed in our facility approved for burn care according to a strict protocol. Emphasis is focused on patient's satisfaction about improvement in wound pain and burn scar after HBO therapy.

Study design

This study was a retrospective case–control study.

Study population

After chart being reviewed, the study population consisted of 35 burn patients admitted to our hospital from 2012 to 2016 with a potential for HBO therapy. Most of the patients were local inhabitants in the Kaohsiung area. Furthermore, they had no previous or current history of pain disorders and no known neurologic, psychiatric, or rheumatologic clinical features associated with chronic pain.

Selection criteria

Inclusion and exclusion criteria were applied at the chart being reviewed.

Inclusion criteria

Patients with burn injuries admitted to our hospital without a history of chronic pain and burn treatments were included in the study.

Exclusion criteria

The following groups of persons were not included in this study:

1. Persons who died during treatment
2. Persons with excessive comorbidities
3. Persons with a burn injury area >60% of the TBSA
4. Persons suffering from septic shock
5. Persons with unstable vital signs.

Ethical approval

The study was approved by the Institutional Review Board of Kaohsiung Armed Forces General Hospital.

Procedure

The burn patients were divided into two groups and both groups underwent regular wound dressing and surgery. Group I consisted of 18 burn patients who received regular HBO therapy. We conducted the treatment under modified US Navy Treatment Table 6 [Figure 1],[4] the therapy was performed in a multiplace HBO chamber (CX2, Comex, France). For handicapped patients, we conducted the treatment in monoplace HBO chamber (PAH-S1-3800, PAHI, Taiwan). In the first stage, compression was performed with room air at a rate of 5 feet/min. In the second stage, to enhance oxygen delivery, we achieved therapeutic pressure at 50 feet (2.5 atmospheres) through face masks with pure oxygen for 25/25/10 min periods, then space out by 10 min of room air each. The reason for room air was preventing oxygen toxicity. In the third stage, decompression was performed with pure oxygen at a rate of 1.66 feet/min in the prevention of decompression sickness. Elapsed time for each session was 120 min, and 20 sessions were performed for each patient. We extended the course based on the patient's response. Furthermore,

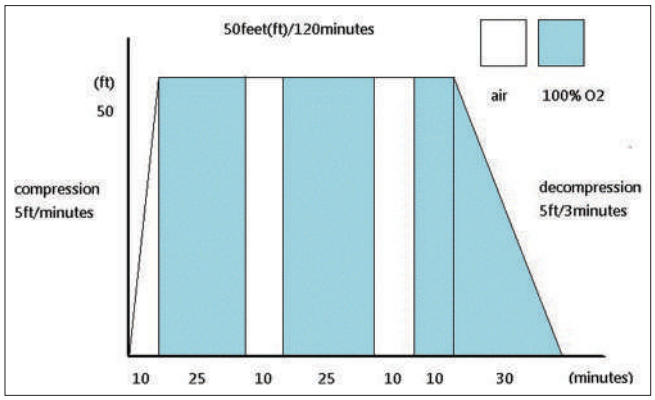

Figure 1: Modified US Navy Treatment Table 6. Blank: air, light blue: 100% oxygen, horizontal axis: minutes, vertical axis: pressure (feet)

our staff and facility were approved by the Association of Hyperbaric and Undersea Medicine of the Republic of China. Group II consisted of 17 patients who also received burn treatments at our hospital but without HBO therapy. Patients were randomly selected. All patients received various wound treatments including dressing, pain control, infection control, and if needed, surgical intervention such as debridement and skin grafts. HBO sessions, age, sex, inhalation injury status, TBSA, length of hospital stay, scar locations, and scar characteristics were documented. The scar condition was evaluated using the Vancouver Scar Scale (VSS) [Table 1] and was documented at the following periods: preoperation and at 1, 2, 3, and 4 weeks postoperation.[5] The progression of VSS score was defined as changes in the scar scores before and after operation. Pain condition was assessed using the visual analog scale [Figure 2] at preoperation and 1, 2, and 3 weeks postoperation.[6] The improvement of visual analog scale (VAS) score was defined as changes in pain scores before and after completing the therapy regimen (3 weeks postoperation). Data regarding the improvement of patient's satisfaction was documented by our chief attending physician in the prevention of systemic error. The patients were asked to mark the satisfaction score about current health status on a scale of 1–10 in our hospital before and after the whole course of treatment, and the differences of this subjective score were graded as follows: grade I improvement is defined as poor (<25%), grade II improvement is defined as fair (25%–50%), grade III improvement is defined as good (50%–75%), and grade IV improvement is defined as excellent (>75%).[7]

Since this was a retrospective study, all data above were well documented in the charts and were collected by a research assistant when carrying out our research. In the study, all patients with wound swelling, positive wound, or blood cultures were documented as having wound infection.

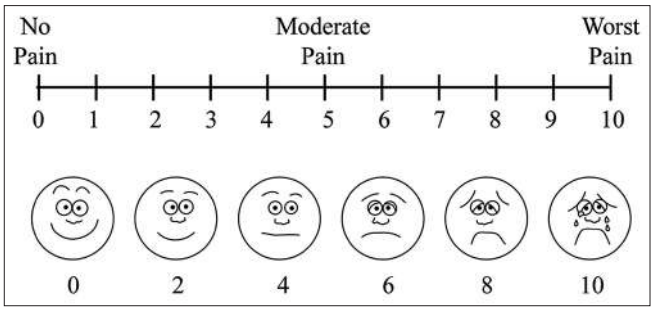

Figure 2: Visual analog scale

Table 1: Vancouver Scar Scale

Pigmentation	Vascularity	Pliability	Height
0, Normal	0, Normal	0, Normal	0, Normal
1, Hypopigmentation	1, Pink	1, Supple	1, <2 mm
2, Hyperpigmentation	2, Pink to red	2, Yielding	2, 2-5 mm
	3, Red	3, Firm	3, >5 mm
	4, Red to purple	4, Banding	
	5, Purple	5, Contracture	

Data analysis

A frequency table was constructed to show the distribution of the HBO therapy group and another group without HBO therapy. The Chi-square analysis was used to test the association between Group I and Group II. The odds ratio was used to determine the improvement in HBO therapy subjects. The Student's *t*-test and two-way ANOVA were used to test the differences between the means of continuous variables such as age, TBSA, scar improvement, improvement of VAS score, satisfaction improvement, and infection rate. The statistical analyses were performed using the Excel software and SPSS version 22 (SPSS Inc., Chicago, Illinois, USA), with a significance level at $P < 0.05$.

RESULTS

A total of 35 burn patients were enrolled in this study, of which 18 were in Group I and 17 in Group II. Their wounds were mostly located in the extremities [Table 2]. Each group consists of 15 males (Group I – 88.2%; Group II – 83.3%). There was no significant difference in sex between the two groups ($P = 0.528$). The mean age of Group I (37.0 ± 9.2 years) is significantly lower than that of Group II (49.4 ± 17.4 years) ($P = 0.015$). The mean TBSA of wounds in Group I was 22.4% ± 10.8% and 25.4% ±11.7% in Group II, which showed no significant difference ($P = 0.432$). The mean improvement in the pain score in Group I (4.7 ± 1.1) was significantly higher than that of Group II (3.6 ± 0.9) ($P = 0.004$). The mean debridement time in the Group I was 22.4 ± 10.8 as compared to that of 25.4 ± 11.7 in the Group II, which showed no significant difference ($P = 0.432$). The mean skin graft times in Group I were 2.7 ± 1.6 and 1.8 ± 1.6 in Group II, which

Table 2: Characteristics of burn patients in Group I and Group II

Group I (HBO)							
HBO (sessions)	Age/Sex	Inhalation injury	Infection	TBSA	Interval (day)	Scar location	Scar characteristics
+ (82)	35/female	-	+	21	35	Left ankle	Hypertrophy
+ (20)	33/male	-	-	15	25	Right wrist	Firm
+ (20)	55/male	+	-	15	24	Right wrist	Firm
+ (13)	42/male	-	-	28	33	Left knee	Firm
+ (23)	31/male	-	+	34	48	Right hand	Hypertrophy
+ (18)	34/male	+	+	55	57	Right leg	Firm
+ (25)	30/male	+	-	12	30	Right wrist	Firm
+ (42)	48/male	+	-	12	50	Right wrist	Firm
+ (26)	29/male	-	-	15	22	Right leg	Flat
+ (27)	29/male	-	-	17	22	Back	Flat
+ (36)	29/male	-	-	28	38	Left knee	Firm
+ (58)	38/female	-	+	21	40	Right leg	Firm
+ (30)	46/male	+	-	25	25	Right hand	Hypertrophy
+ (10)	43/male	-	+	12	20	Left leg	Hypertrophy
+ (29)	24/female	+	-	12	22	Left ankle	Flat
+ (20)	55/male	-	-	28	36	Right leg	Firm
+ (20)	34/male	+	+	25	37	Right hand	Firm
+ (20)	31/male	-	-	28	37	Right thigh	Hypertrophy
Group II (non-HBO)							
-	41/female	+	+	40	43	Right wrist	Firm
-	64/male	+	-	28	48	Right wrist	Hypertrophy
-	39/male	+	-	25	22	Right wrist	Firm
-	39/male	+	-	20	18	Right wrist	Flat
-	28/male	+	-	5	14	Right hand	Flat
-	41/male	-	-	15	29	Left leg	Hypertrophy
-	72/female	+	+	20	39	Right wrist	Firm
-	60/male	+	+	40	36	Right wrist	Firm
-	59/male	-	-	15	31	Right leg	Hypertrophy
-	29/male	-	-	21	15	Left thigh	Hypertrophy
-	40/male	-	-	30	24	Back	Firm
-	27/male	-	-	30	24	Left hand	Flat
-	71/male	-	+	40	36	Right hand	Firm
-	64/male	-	-	20	29	Right hand	Firm
-	58/male	-	+	50	64	Right thigh	Firm
-	20/male	-	-	18	25	Right wrist	Hypertrophy
-	78/male	+	-	15	39	Wrist	Firm

HBO: Hyperbaric oxygen, TBSA: Total body surface area, Infection: Positive culture and with clinical symptoms, +: With, -: Without

showed no significant difference (P = 0.098). The mean TBSA of skin grafts was 12.7% ±12.2% in Group I and 9.7% ±11.5% in Group II, which showed no significant difference (P = 0.466). The mean length of stay for Group I was 33.4 ± 10.7 days and 31.5 ± 12.8 days for Group II, which has no significant different (P = 0.644). We also recorded the improvement of scar score before and after therapy using the VSS. The mean progression of scar score was 0.7 ± 1.2 in the Group I and 1.6 ± 1.5 in Group II, which revealed no significant difference (P = 0.059). The mean grade of satisfaction improvement in Group I (3.4 ± 0.5) was significantly higher than that of Group II (2.9 ± 0.6) (P = 0.009) [Tables 3 and 4]. All patients in Group I had a Grade III improvement (>50%) rating, whereas only 14 patients in Group II had a Grade III improvement rating. The estimated odds ratio between Group I and Group II was 1.214 [Table 5]. Group I had an infection rate of 38% while Group II had 47%, which revealed no significant difference (P = 0.8097).

Due to the mean age of HBO group was lower than the nonHBO group, we conducted multiple variant analysis to control confounding variables which defined aged-group as patients above 41 years old. There was no significant interaction between the two factors (HBO and age) on the improvement of pain score and improvement of satisfaction (P = 0.663 and 0.913, respectively), which indicated that age was not a confounding factor. The P value for management was 0.003, which indicated that the HBO therapy was associated with improvement of pain score. The P value for management was 0.017, which indicated that the HBO therapy was associated with improvement of satisfaction [Table 6].

DISCUSSION

Burns are complex and dynamic injuries with a central zone of coagulation necrosis, bound by a stasis zone, and surrounded by a zone of hyperemia.[8] Poor tissue perfusion can potentiate a progressive ischemic process. There are significant experimental data supporting the adjuvant

Table 3: Results for Group I and Group II

Variables	Group I (HBO) (*n*=18)	Group II (non-HBO) (*n*=17)	*P*
Sex (male) (%)	88.20	83.30	0.528
Age	37.0±9.2	49.4±17.4	0.015
TBSA (%)	22.4±10.8	25.4±11.7	0.432
Improvement of pain score	4.7±1.1	3.6±0.9	0.004
Debridement times	1.1±0.5	0.8±0.7	0.179
Skin graft times	2.7±1.6	1.8±1.6	0.098
Skin graft TBSA (%)	12.7±12.2	9.7±11.5	0.466
Length of stay (days)	33.4±10.7	31.5±12.8	0.644
Progression of scar score	0.7±1.2	1.6±1.5	0.059
Improvement of satisfaction	3.4±0.5	2.9±0.6	0.009
Infection rate (%)	38	47	0.8097

HBO: Hyperbaric oxygen, TBSA: Total body surface area

Table 4: Evaluation of improvement after burn injury treatment by patient satisfaction

Improvement	Patient numbers	
	HBO	Non-HBO
Grade 4, excellent (≥75%)	44.4% (8/18)	11.8% (2/17)
Grade 3, good (50%-75%)	55.6% (10/18)	70.6% (12/17)
Grade 2, fair (25%-50%)	0.0% (0/18)	17.6% (3/17)
Grade 1, poor (≤25%)	0.0% (0/18)	0.0% (0/17)
Mean grade	3.4	2.9

HBO: Hyperbaric oxygen

Table 5: Odds ratio of satisfaction improvement between the Group I and Group II

	Pain		
	Significant improvement of satisfaction	No significant improvement of satisfaction	Total
HBO			
HBO			
Count	18	0	18
Percentage within HBO	100.0	0.0	100.0
Non-HBO			
Count	14	3	17
Percentage within HBO	82.4	17.6	100.0
Total			
Count	32	3	35
Percentage within HBO	91.4	8.6	100.0

Risk estimate			
	Value	95% CI	
		Lower	Upper
OR	1.214	0.974	1.513
Number of valid cases	35		

CI: Confidence interval, OR: Odds ratio, HBO: Hyperbaric oxygen

use of HBO therapy in burn patients, which is thought to improve microcirculation of the wounded area while decreasing wound depth and size.

Animal studies

The rapid formation of edema in the area of burn injury is due to the increased capillary permeability, diminished oncotic pressure, increased interstitial oncotic pressure, shift in the interstitial space compliance, and lymphatic damage, and other unaffected tissue swelling.[9] Neutrophils are the major source of oxidants and the primary mechanism underlying ischemia/reperfusion injury. However, HBO therapy could inhibit neutrophil attachment to the blood vessel walls. In addition, hyperbaric oxygen (HBO) therapy has shown to reduce edema and preserve microcirculation in burn wounds, through vasoconstriction through enhanced oxygen delivery, a direct osmotic effect, and the inactivation of white blood cell adhesion.[10,11] Restoration of organized capillary arcades and intact circulation in HBO-treated animals were noted in patients receiving HBO therapy.[12] The HBO-treated animals showed preservation of dermal elements, no conversion of partial to full-thickness injury, and preservation of adenosine triphosphate levels, which preserve energy sources for the sodium pump. Sodium pump failure results in the ballooning of endothelial cells, which occurs after a burn injury and leads to massive fluid losses.[13] In 2005, a randomized controlled study evaluated the effects of the HBO therapy on the healing of burn wounds and found that this treatment had a beneficial effect on postburn edema ($P = 0.022$) and neoangiogenesis ($P = 0.009$).[14] As regards inflammation and pain, the HBO therapy also increased the mitochondrial function and improved neurotransmitter abnormalities. In one animal study, hyperbaric pressure without additional oxygen decreased the tumor necrosis factor-alpha levels.[15] The HBO therapy also decreased the prostaglandin E2 production, decreasing inflammation, pain, and edema.[16]

Clinical studies

The potential benefits of HBO therapy include edema reduction, tissue preservation, improved host defense, promotion of wound closure, morbidity and mortality reduction, and shorter hospitalization and medical cost.[17] Furthermore, the HBO therapy up-regulates enzymes that can aid in the detoxification problems.[18] In another human study, HBO therapy at 2 atmosphere (ATA) showed an anti-inflammatory activity by inhibiting the interferon-gamma-c release.[19] The anti-inflammatory effect of HBO therapy is due to the relief of hypoxia and the downregulation of hypoxia-inducible factor 1-alpha.[20] Jeffrey *et al*. conducted a prospective, randomized, double-blinded trial involving HBO therapy for burn wounds that revealed 42% hyperemia reduction, 35% reduction in lesion size, and 22% decrease in wound exudation. Niu *et al*. in their study reported a large clinical outcome series showing a statistically significant reduction in mortality ($P = 0.028$) in 266 severely burned patients who received HBO therapy, compared to 609 control patients, also noting a lower infection rate in

Table 6: Multiple variant analysis to control confounding variables which defined aged-group as patients above 41 years old

	Age group (mean±SD)				Multiple variant analysis of variance, *F* (*P*)		
	≤41		>41				
	Management		Management				
	HBO	Non-HBO	HBO	Non-HBO	Interaction	Age group	Management
Pain score	4.50±1.17	3.56±1.01	5.00±0.89	3.75±0.71	0.194 (0.663)	1.001 (0.325)	9.996 (0.003)
Satisfaction	3.50±0.52	3.00±0.71	3.33±0.52	2.88±0.35	0.012 (0.913)	0.589 (0.449)	6.360 (0.017)
Box's test of equality of covariance matrices[a]							
Box's M	10.546						
F	1.021						
df1	9						
df2	4516.519						
Significant	0.420 NS						

SD: Standard deviation, HBO: Hyperbaric oxygen, NS: Not significant, the level of significance was 0.001(0.420>0.001). [a]: Box's test was not significant, so the design is balanced

HBO group.[4] Cianci *et al*. described a significant reduction in the length of hospital stay in burn patients with a TBSA of up to 39% and a reduction in the need for surgery, including grafting, in a series of HBO-treated patients with 40%–80% burns as compared to the non-HBO-treated controls.[21] However, in 1997, Brannen *et al*. in their study reported a randomized prospective trial regarding HBO treatments of burn injury and noted no difference in outcomes including mortality, number of operations, or length of stay. A 1974 prospective randomized controlled double-blind trials of four groups of patients stratified by the percentage of the TBSA burned showed a reduction in the healing time ($P < 0.005$), reduction in fluid requirements, and mortality.[22] A total of 22 clinical trials reported in this study meet the American Heart Association level of evidence criteria, with 20 of them revealing benefits from the use of HBO in thermal injury. Improved healing and reduction in hospital stay, morbidity, mortality, and hospital-related complications were mentioned.

Ray *et al*. analyzed a series of severely burned patients with inhalation injury, thermal injury, and adult respiratory distress syndrome; they noted earlier weaning from the mechanical ventilation in the HBO-treated group as compared to the control group (5.3 vs. 26 days, respectively; $P < 0.05$) with no deleterious effects from the HBO therapy. In addition, a significant reduction in the cost of care per case was noted in the HBO-treated patients ($P < 0.05$).[23]

HBO, as adjuvant therapy, has provided surgeons with an alternative treatment option, especially for patients with deep second-degree burns or burn injury in all four extremities. The UHMS approves the treatment of patients with burns, following a strict protocol, which involves the use of HBO at 2 ATA for 90 min twice daily. With proper wound care using topical antimicrobial agents, bedside and enzymatic debridement, and adjuvant HBO therapy, surgeons can better define the extent and depth of injury and promote rapid wound heal. Dehydration could be a problem for patients with extensive burn injuries, and increasing fluid intake during ascent may help compensate for any hypovolemia unmasked after HBO exposure. In larger TBSA burns, especially of the head and neck, otic barotraumas may cause complications, and early otolaryngology (ear, nose, throat) consultation is suggested.[24]

The HBO therapy is a potential treatment modality for a broad range of ailments, including chronic pain, and reduces pain in animal models. Early clinical research indicates that the HBO therapy is useful in modulating human pain.[25] A study conducted by Katznelson *et al*. revealed a reduction in pain, swelling, and allodynia and an improvement in skin color and range of motion in patients with complex regional pain syndrome after 3 weeks of HBO therapy.[26] Kiralp *et al*. conducted a small, double-blind, randomized, placebo-controlled study on 71 patients with a 6-weeks history of traumatic complex regional pain syndrome of the upper extremities. They found lower pain scores and improvements in edema and range of motion in patients who were treated with HBO as compared to the control group ($P < 0.001$).[27] Lin *et al*. conducted a longitudinal, prospective study and found that the subjects' overall quality of life (QOL) scores were higher after HBO therapy as compared with their scores before the HBO therapy. The improvement of problematic wounds also reflected higher QOL scores.[28] Our findings showed improved pain score and satisfaction, similar results were reported Blixen *et al*. indicated that patients can improve their ability to control their condition or reduce pain, which increases their degree of life satisfaction.[29] Efrati *et al*. demonstrated that HBO therapy rectifies pain processing by decreasing hyperactivity and blood flow in the posterior brain regions and elevating the activity and blood flow in the prefrontal cortex.[30] This result suggests that an improvement in wound condition significantly

affects patient's QOL. However, Giorgio Oriani (2012, 601) advocates that repeated exposure to HBO therapy increases the risks of myopia, cataracts, and scotomas and therefore should be considered a contraindication for elderly patients.

The study showed that the HBO group was mostly consisting of patients in the younger age group. This means that our study has either a relatively small sample size or excessive comorbidities in the elder patients who meet the exclusion criteria. Other possible reason may be related to the fewer side effects in younger patients. The side effects are often slight and reversible but could worsen and become life-threatening. Geriatric patients often had hearing problems, which could lead to poor pressure equalization in the chamber. Although no QOL questionnaire was administered in our study, improvements in the VAS and pain scale imply an improvement in the QOL condition. In the future, these studies can be further evaluated using more detailed QOL questionnaires. There are many factors affecting the improvement of satisfaction in burn patients, in our study, no significant differences in TBSA, number of surgeries, size of graft area, length of hospital stay, infection rate, and progression of scar score exist between group I and group II, this may be due to the small sample size. However, there was a positive correlation between HBO therapy and the progression of scar score, so does the infection rate. Better progression of scar score and infection rate may contribute to better satisfaction. On the other hand, this is a retrospective study, we could only categorize the patients who fitted our criteria into two groups from 2012 to 2016, but there are various factors that affected each other; therefore, obvious differences between the two groups could not be observed. The study showed that the HBO group had better pain relieve and satisfaction improvement, it may be only due to the gratification of receiving HBO therapy. However, there are some complications for HBO therapy such as barotrauma, sinus or tooth squeeze, these conditions will affect satisfaction; further studies need to be done. There are two reasons why we excluded persons with excessive comorbidities; first, if the patient had excess comorbidities, loss to follow-up during the study could be expected. Second, after well explain the risk for HBO therapy, most of the patient with excess comorbidities could not tolerate and refuse the management. We performed a propensity score analysis, but due to small sample size, only 3 fuzzy matches were found, and it was not statistically significant. In our hospital, HBOT treatments cost at least $2000 New Taiwan Dollar per session; although, no difference in hospital stay and number of debridement and skin graft exist, HBO can improve pain score and patient satisfaction in our study. Thus, the cost-effectiveness of the HBO therapy would need further discussion. In the future, the clinical trials with large sample size and different types of burn injury should be considered.

CONCLUSION

Evaluation of the results obtained in our study suggests that the HBO therapy has a significant improvement in the pain relieve and satisfaction improvement after control of age factor in patients with thermal burns. Hence, HBO therapy, as an adjuvant treatment, could be helpful for pain control and satisfaction associated with burn injuries.

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Conflicts of interest

There are no conflicts of interest.

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