ORIGINAL ARTICLE

Comparison of tandir burns and other flame burns

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ABSTRACT

BACKGROUND: Because internal temperature of tandir may reach up very high levels, tandir burns, which is one of flame burns, may cause more morbidity and mortality than those of other flame burns. Therefore, we aimed to compare tandir burns with other flame burns in the present study.

METHODS: In this study, we compared tandir burns with other flame burns concerning age, gender, total burn surface area, burn depth, hospitalization times, hospitalization duration, surgical procedures performed, wound culture results, burn localization and mortality.

RESULTS: Tandir burn patients were treated in the hospital for an average of 27.6±9.5 days, while non-tandir burn patients were treated for a period of 16.5±12.5 days. A significant difference was found between the hospitalization periods of the two groups ($p<0.001$). Tandir burn, which is a type of flame burn, affects the women and children much more frequently than other flame burns ($p=0.0001$), causes deeper burns ($p=0.0001$), which requires more surgical intervention ($p=0.0001$) and causes more frequent wound site infection.

CONCLUSION: We think that it would be beneficial to treat high-temperature burns, such as tandir burns, as a separate group from other flame burns. We believe that further studies to be conducted in this field will bring new approaches to the treatment of tandir burns.

Keywords: Amputation; burn; flame burn; high temperature; tandir burn.

INTRODUCTION

Burns are one of the main causes of traumatic injuries that cause morbidity[1–4] and mortality[5] in all age groups. The diversity and frequency of etiological factors in burn trauma vary depending on the climate, as well as on industrialization, socio-economic, cultural and educational characteristics of each region. Although electricity and natural gas are commonly used for heating and cooking all over the world, fire is still used in some rural areas as the main source of heat for preparing food.

The tandir, also called tandoor in India and Pakistan, is widely used in wide geography, including West and South Asia.[6,7] Dakota hole fire used in North America is a miniature of tandir. This method is used for a variety of purposes, such as to warm up food, to make kebabs, as well as to bake bread in rural areas of eastern Turkey. The tandir is usually in the form of a well in the room or in the garden of a house, with a depth of about 150 cm and a diameter of 60 cm, and to ventilate the fumes, it will have a ventilator tube (Fig. 1). Wood and coal are burned inside it and food is cooked by either being hung or fixed to the walls of the well. The internal temperature of tandir can reach up to 470 °C (6). Therefore, it can be observed that tandir burns may cause more morbidity (Fig. 2) and mortality[8–11] as compared to other burns.

There is a study comparing tandir burns with other types of burns in the literature.[9] However, so far, to our knowledge, there has been no particular study comparing tandir burn, which is a type of a flame burn, with other types of flame burns. Comparing these two groups of burn trauma with similar mechanisms will enable us to better understand tandir burns that are encountered in common geography and

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Figure 1. Image of a tandir oven.

Figure 2. A tandir victim.

which also have severe medical consequences. To this end, in this study, we compared tandir burns with other flame burns concerning age, gender, total burn surface area, burn depth, hospitalization times, hospitalization duration, surgical procedures performed, wound culture results, burn localization and mortality.

MATERIALS AND METHODS

The patients utilized for this study were treated in the Burn Treatment Unit of Atatürk University Faculty of Medicine, between the years of 2011 and 2018. There were a total of 172 patients, including 55 with tandir burns (Group 1), 117 with flame burns (Group 2), who were included in this study. Data were collected retrospectively by scanning patient files, automation records and other files of the burn unit.

Total burn surface areas (TBSA) were divided into four categories as 1–10%, 11-20%, 21–30% and more than 30% of TBSA. The groups were compared concerning age, gender, TBSA, burn depth, hospitalization times, hospitalization duration, surgical procedures performed, wound culture results, burn localization and mortality.

In the study, all data were expressed as mean±SD. Differences between the two groups (tandir burns and flame burns) were analyzed using the independent Student's t-test. Chi-square tests were used for the categorical variables where appropriate. All statistical calculations were done using the program SPSS for Windows (version 11.00; SPSS, Inc., Chicago, IL). Differences were considered statistically significant at levels of probability of $p<0.05$.

RESULTS

Mean ages of the groups were found 12.98±22.09 (1–76) and 27.07±18.06 (0–76) in Group 1 and Group 2, respectively ($p=0.001$). Percentages of the patients' age 10 years or below were 78.1% (43 cases) in Group 1 and 19.6% (23 cases) in Group 2. Group 1 consisted of 28 (50.1%) male, 27 (49.9%) female patients and group 2 consisted of 92 (78.7%) male and 25 (21.3%) female patients. In Group 1, only 2 of 12 patients over the age of 10 were male. A statistically significant difference was found between the two groups in terms of gender distribution ($p=0.0001$). In Group 1, female cases were significantly higher than male cases (Table 1).

While all of Group 1 consisted of tandir burns, the causes of burns in Group 2 were recorded as flammable liquids, such as gasoline-thinner (42 patients), flammable gas flare (33 patients), fire flame (32 patients), ignition of clothing (seven patients) and bomb-dynamite explosion (3 patients).

In group 1, the most commonly, the hands, feet, forearms, legs and gluteal regions of patients burned. Extremity burns were not present in only three of the 55 cases (5.45%). In all of the remaining 52 cases (94.55%), burns were present in at least one extremity (Table 2). A certain localization did not stand out in Group 2. Considering the burn distribution of extremities, in Group 2, it was found that the burn rates of the hands and feet and the right-left extremities were very close to each other.

The burn surface width of the majority of patients in both groups was between 1–20%. In group 1 patients, the deepest burns were second-degree burns (40.2%) and in group 2, superficial second-degree burns (48.6 %). Third-degree burns occurred in 34.2% of patients in group 1 and in 12.1% of patients in group 2. Patients in Group 1 had significantly deeper burns ($p=0.001$), while the mean burn surface was close to each other in both groups and was around 14% ($p=0.782$) (Table 1).

Although most hospitalization in group 1 was observed to be clustered in June-July-August, hospitalization in group 2 distributed homogeneously throughout the year.

The mean hospitalization duration was found to be 34.2±24.22 (1–106) days in Group 1 and 23.5±18.28 (1–84) days in Group

Table 1. Comparison of the group data

Variables	Group 1	Group 2	p
Mean age (years), mean±SD	12.98±22.09	27.07±18.06	=0.0001
0–10 (years), %	78.1%	19.6	
Gender, n (%)			
Female	27 (49%)	25 (21.4%)	=0.0001
Male	28 (50%)	92 (78.6%)	
Total body surface area	14.8% (mean)	14.4% (mean)	=0.782
1–10%, n (%)	19 (34.5)	47 (40.2)	
11–20%, n (%)	23 (41.8)	46 (39.4)	
21–30%, n (%)	9 (16.4)	17 (14.5)	
>30%, n (%)	4 (7.3)	7 (5.9)	
Burn degree, n (%)			
1st	3 (3.7)	14 (9.5)	=0.0001
2nd (superficial)	18 (21.9)	72 (48.6)	
2nd (deep)	33 (40.2)	44 (29.8)	
3rd	28 (34.2)	18 (12.1)	
Operations, n (%)			
Auto-grafting	36 (65.4)	40 (34.1)	=0.0001
Reconstruction	11 (20)	6 (5.1)	
Fasciotomy	7 (12.7)	1 (0.8)	
Amputation, n (%)	31 (Six patients) (10.9)	0 (0)	
Mean length of stay (days)	34.2	23.5	=0.005
Mortality, n (%)	1 patient (1.8)	2 patients (1.7)	

2. There was a statistically significant difference between the two groups concerning hospitalization durations (p=0.005).

Burn patients underwent debridement/escharotomy under operating room conditions as indicated accompanied by standard dressing-medical treatment. In 65.4% of patients in group 1 and 34.1% of patients in group 2, split or full-thickness skin grafts were applied and burn wounds were closed. In 20% of those in group 1 and 5.1% of those in group 2 patients, flap surgery was performed since tissue defects were too deep to be closed with skin grafts. Seven patients in group 1 and one patient in group 2 were diagnosed with compartment syndrome. Thus, emergency fasciotomy was performed. Six patients (10.9%) underwent 31 finger amputations in group 1 due to burn complications, while none of the patients in group 2 had to undergo finger amputation (Table 1). Patients in Group 1 were observed to undergo more surgical operations in a statistically significant manner (p=0.001).

Table 2. Localization of tandir burns

Tandir burn location	n	%
Hand	48	20.3
Forearm	25	20.3
Arm	18	20.3
Foot	48	20.3
Leg	49	20.3
Thigh	5	20.3
Hip	21	20.3
Genital	2	0.8
Trunk	7	20.3
Face	7	20.3
Head	4	1.6
Neck	2	0.8
Total	236	100

Wound infection developed in 23 cases (41.8%), including multiple microorganisms in 13 cases in group 1 and in 19 cases (16.2%), including nine multiple microorganisms in group 2. Statistically significant wound site infection was seen in group 1 (p=0.002). In both groups, pathogenic microorganisms that reproduce most in culture were found to be *Pseudomonas aeruginosa, Methicillin-resistant coagulase-negative Staphylococci* (MRCNS) and *Escherichia coli* (Table 3).

One patient (1.8%) was lost in group 1 and two patients (1.7%) in group 2.

Table 3. The distribution of organisms isolated from burn patients

Microorganisms	Group 1		Group 2		p
	n	%	n	%	
P. aeruginosa	9	22.5	10	30.23	=0.002
Methicillin-resistant coagulase-negative Staphylococci (MRCNS)	10	25	3	9.12	
Escherichia Coli	5	12.5	5	15.05	
Enterobacter	4	10	1	3.04	
Acinetobacter	4	10	2	6.08	
Enterococcus	1	2.5	1	3.04	
Methicillin-sensitive coagulase-negative Staphylococci (MSCNS)	1	2.5	2	6.08	
Others	6	15	9	27.36	
Total	40	100	33	100	

DISCUSSION

Mostly, the use of the tandir may lead to the children being injured due to its location on the ground and the lack of a protective barrier on it (Fig. 3).[8–11] In parallel with the literature, in our study, the mean age in tandir burn group was found to be 12.98±22.09, and the rate of patients under the age of 10 was found to be 78.1%. On the other hand, the mean age in the flame burn group was found to be 27.07±18.06 (0–76). In tandir burns, patients were in a much smaller age group than other flame burns. This was especially since the tandir was located at the homes of the patients. Thus, children and women were more often exposed to burns than adult men who went to work.

Although the ratio of men and women in the tandir burn group was very close to each other, only two of the 12 patients over the age of 10 were male. This result again suggests that women who cook the bread and children are more likely to fall into the tandir. The number of female cases in other tandir burn studies also supports this idea.[8–11] On the other hand, in the flame burn group, 78.7% and statistically significantly more male cases were present in line with burn etiology (gasoline, diesel fuel, flammable gas and explosives). Since the tandir is in the form of a hole made in the ground, the lower and upper extremities of the body are most commonly affected as a result of falling into it.[11,12] In our study, at least one extremity burn was present in approximately 95% of the cases. As such, it would not be wrong to treat tandir burns as extremity burns. This also explains why the morbidity rate of tandir burns is high. In other flame burns, it was observed that there was no specific localization for the burn, while the hands, feet, forearms, legs and gluteal regions burned most commonly in the burn group due to tandir burns.

Figure 3. Schematic view of tandir.

In tandir burns and other flame burns, the mean burn surface was close to each other. Although the rate was around 14%, the deepest burns were of the second degree (40.2%) in tandir burn patients and of superficial second-degree burns (48.6%) in other flame burn patients. In addition, third-degree burns were higher in tandir burns than other flame burns (34.2%, 12.1%). We think there are two possible reasons for this. Firstly, while it is possible for the survivor to escape from the burning environment and protect himself/herself in other flame burns since the patient falls into a burning pit in the form of a well, it takes more time for him/her to get out of/be taken out of there and he/she is exposed to heat for a longer duration. It was shown as the second reason that the temperature in the tandir rises up to 470 degrees. This heat level, which is higher than other flame burns, causes deeper burns in the case.

In other flame burns, the hospitalization was homogeneous throughout the year, but the hospitalization in tandir burn was most commonly in June-July-August. During these months, children were more exposed to burns due to the

summer holidays. The school appeared as a factor protecting children from trauma.

According to the literature, tandir burns need longer inpatient treatment compared to non-tandir burns.[9,11] In our study, tandir burns (34.2 days) required inpatient treatment longer than other flame burns (23.5 days). We believe this result arises from tandir burns being more severe burns.

Approximately two-fold autograft, four-fold flap and seven-fold fasciotomy were performed in patients with tandir burns. Amputation was not required in any patient with other flame burns, while 31 finger amputations were performed in six (10.9%) patients with tandir burns. In similar studies, the amputation rate was found to be 11.3% and 14.2%, respectively.[10,11]

In parallel with other tandir burn studies,[8,9] the most common pathogenic agents were found to be *Pseudomonas aeruginosa* and MRCNS. Tandir burns developed more wound site infections than other flame burns. Because tandir causes deeper burns than other flame burns, this causes the wound site infection to be seen more frequently.

Although the mortality rate was higher in tandir burns concerning non-tandir burns in the literature,[9,11] it was close to each other in our study (1.8%, 1.7%).

Conclusion

The frequency and diversity of etiological factors in burn trauma varies depending on the climate, as well as the industrialization, socio-economic, cultural and educational characteristics of each region and it may arise from flame, scalding, electricity, radiation or chemical agents.[7,13] Flame is one of the most common causes of burns.[13] Tandir, a traditional oven, causes flame burns, since it is widely used in rural areas in eastern Turkey. The severity of the damage doubles as the temperature increases every 10 °C since the possibility of chemical reactions causing destruction of tissue structures is doubled.[14] Since the tandir is shaped like a jug, it concentrates on the heat in the pit and may reach a temperature of 470 °C. In addition, the tandir design incorporates all the primary forms of heat transfer, namely radiation, conduction and convection.[6] Therefore, tandir causing flame burns may cause deeper burns than other flame burns since it has much higher temperatures. Depth of burn was important predictors of patient survival.[13] Having a deeper depth of burn leads to a longer treatment period, more reconstructive surgery, and to more limb amputation, which leads to a more costly treatment.[15] It affects children at the beginning of their lives and causes permanent physical and psychological problems. Lifting the tandir off the ground, blocking it with barriers around or completely prohibiting it, will prevent the occurrence of irreversible traumas since tandir has the potential to cause more severe burns, as stated above.

As a result, tandir burn, which is a type of flame burn, affects the women and children much more frequently than other flame burns, causes deeper burns, requires more surgical intervention, causes more frequent wound site infection and causes longer hospitalization duration. Therefore, we think that it would be beneficial to treat high-temperature burns, such as tandir burns, as a separate group from other flame burns. We believe that further studies to be conducted in this field will bring new approaches to the treatment of tandir burns.

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ORİJİNAL ÇALIŞMA - *ÖZET*

Tandır yanıkları ve diğer alev yanıklarının karşılaştırılması

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AMAÇ: Bir tür alev yanığı olan tandır yanığı, tandırın çok yüksek sıcaklığa çıkabilmesi nedeniyle daha fazla mortalite ve morbiditeye neden olmaktadır. Bu nedenle, bu çalışmada tandır yanıkları ve diğer alev yanıklarını karşılaştırmayı amaçladık.
GEREÇ VE YÖNTEM: Bu çalışmada tandır yanıkları ile diğer alev yanıklarını yaş, cinsiyet, toplam yanık yüzey alanı, yanık derinliği, yatış zamanları, yatış süreleri, yapılan cerrahi işlemler, yara kültür sonuçları, yanık lokalizasyonu ve mortalite açısından karşılaştırdık.
BULGULAR: Tandır yanıklı hastaların ortalama hastanede kalma süresi 27.6±9.5 gün idi. Buna karşın tandır dışı yanıklı hastaların ortalama hastanede kalma süresi ise 16.5±12.5 gün idi. Bu iki grup arasında hastanede kalma süreleri arasında anlamlı derecede farklılık saptandı ($p<0.001$). Bir alev yanığı türü olan tandır yanıkları, diğer alev yanıklarına göre kadın ve çocukları çok daha sık etkilemekte ($p=0.0001$), daha derin yanıklara sebep olmakta ($p=0.0001$), daha fazla cerrahi müdahale gerektirmekte ($p=0.0001$) ve daha sık yara yeri enfeksiyonuna neden olmaktadır.
TARTIŞMA: Tandır gibi yüksek dereceli yanıkların, diğer alev yanıklarından ayrı bir grup olarak ele alınmasının faydalı olacağını düşünüyoruz. Bu konuda yapılacak başka çalışmaların tandır yanıklarının tedavisi konusunda yeni yaklaşımlar getireceğine inanıyoruz.
Anahtar sözcükler: Alev yanığı; amputasyon; tandır yanığı; yanık; yüksek sıcaklık.

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