Letter to the Editor

Thermographic analysis of facially burned patients

Sir,

The skin temperature of a healthy human body exhibits a contralateral symmetry. A relationship exists between facial blood flow and surface temperature. We have analyzed a 24 year-old male patient with severe cosmetic and functional facial burn sequelae (Fig. 1). He was submitted to several reconstructive operations, including skin grafts (for both superior and inferior eyelids, frontal and right zygomatic regions, as well as nasal dorsum) and use of dermal regeneration templates – Integra® (lower lip, mental region, neck and both hands) in order to improve his appearance, but a disfigured face remains. The patient does not consider facial transplantation at the present time, and other options should be investigated.

Thermographic measurements were taken 5 years after injury using a FLIR SC7000 thermography camera (FLIR Systems, Wilsonville, OR, USA) with a Hot Metal colored lens filter which was previous configured to a 30–40 °C temperature range. The subject sat on a chair at a distance of 1.5 m from the camera and was asked to perform four facial expressions: facial expression at rest, with eyes closed, eyes wide open and smile.

Data management was performed with Altair 5.91.010 software (FLIR Systems, Wilsonville, OR, USA). An analysis mask was established over the facial areas of interest: 1, right forehead; 2, left forehead; 3, right orbit; 4, left orbit; 5, nose; 6, right labial commissure; 7, left labial commissure; 8, mouth (SDC1). For each area the mean temperature and its standard deviation were calculated, as well as the maximum and minimum values (Table 1).

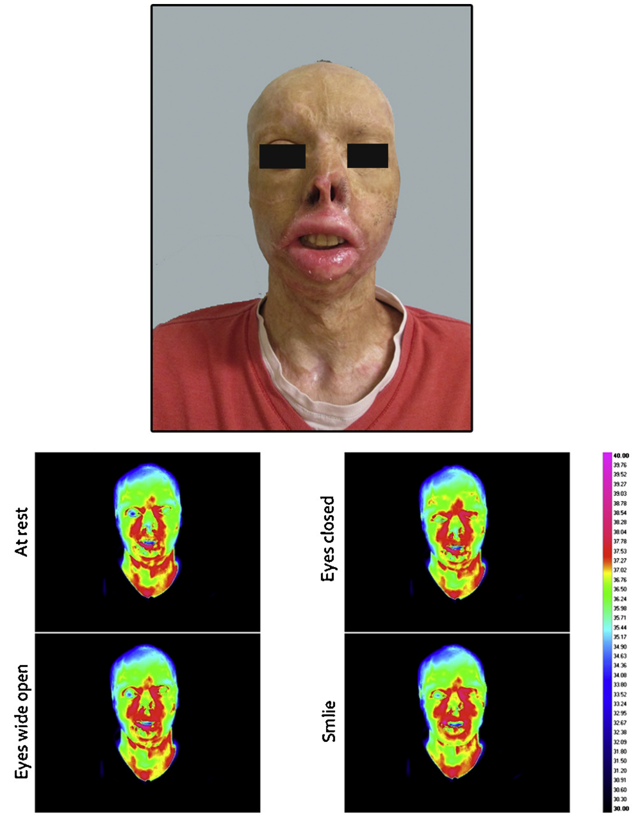

Fig. 1 – Male patient, 24 years old, with severe sequelae of thermal burns (55 percent total burn surface area); thermographic analysis was performed during four facial expressions: rest, eyes closed, eyes wide open and smile.

Table 1 – Average, minimum, maximum temperatures and standard deviation recorded in each area represented by its order number during the facial expressions. All values are shown in Celsius degrees. SD, standard deviation.

	1	2	3	4	5	6	7	8
At rest								
Average	36.84	36.77	37.34	37.20	35.45	37.00	36.80	36.60
Min.	33.64	34.02	34.91	34.80	33.40	35.66	35.59	34.89
Max.	37.79	37.74	38.73	38.67	37.90	37.94	37.78	37.94
SD	0.67	0.62	0.72	0.73	1.03	0.49	0.51	0.57
Eyes closed								
Average	36.93	37.06	36.92	36.89	35.48	36.95	36.82	36.56
Min.	33.79	34.53	34.59	34.66	33.42	35.50	35.57	34.63
Max.	37.99	37.96	38.57	38.57	37.98	37.92	37.79	37.92
SD	0.76	0.54	0.85	0.82	1.10	0.53	0.52	0.60
Eyes wide open								
Average	36.60	36.66	37.52	37.39	35.36	37.02	36.83	36.67
Min.	32.56	33.85	35.45	35.36	33.33	35.54	35.53	34.85
Max.	37.81	37.78	38.76	38.72	37.98	38.03	37.86	38.04
SD	0.88	0.69	0.65	0.68	1.03	0.52	0.54	0.58
Smile								
Average	36.69	36.70	37.29	37.22	35.40	37.16	36.93	36.88
Min.	33.55	33.95	34.81	35.04	33.41	35.63	35.57	34.62
Max.	37.71	37.68	38.70	38.67	37.97	38.68	38.33	39.06
SD	0.68	0.64	0.74	0.80	0.93	0.60	0.65	0.81

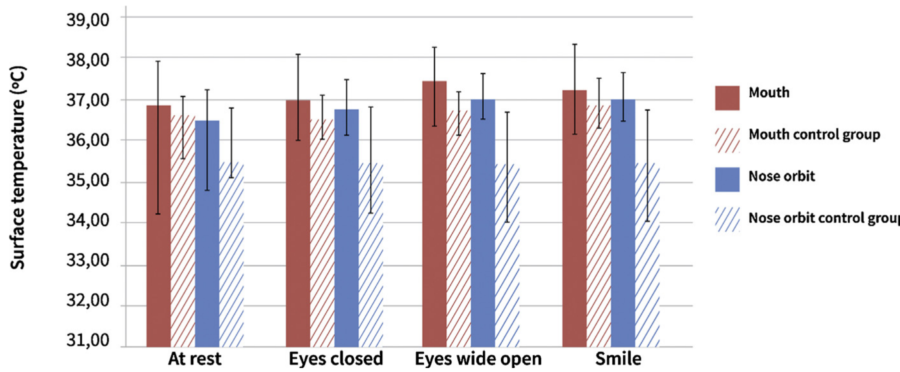

Fig. 2 – Average temperature and standard deviation in the nose (area 5) and mouth (area 8) areas during the four facial expressions. The hatched bars represent the mean values and standard deviations of the control group for the same task.

When comparing the measures to a control group (28 normal subjects), he showed a tendency for balanced contralateral surface temperature values, as well as low bilateral forehead values, and high right and left commissure surface temperature values (SDC 2 and 3). The extension of the commissure excursion in this patient is clearly superior to that of the midpoints or Cupid's bow, which may be explained by cicatricial retraction of the central part of the patient's lips. This fact may be responsible for the higher surface temperature values comparatively to the remaining central/inferior face, where minimal muscular activity was detected. High temperature values of the nose were also detected when compared to normal population, and the surface temperature rose during air passage (Fig. 2). This may be explained by the partial nasal destruction (burns sequelae), and lack of normal anatomical structures, including mucosa, cartilage and bone.

This preliminary study was performed to determine the usefulness of thermography in the evaluation of facial skin temperature changes during the accomplishment of different facial expressions in healthy subjects and compare them with patients with facial disfigurement. A relationship exists between the facial blood flow and the skin temperature, and thermal imaging has been used to identify perforators in different anatomic regions [1]. A thermal dysfunction may be noted in the presence of muscular disarrangement/damage, facial paralysis, scarring, or inflammation.

While superficial partial-thickness burns generally heal by re-epithelialization with minimal scarring, deeper wounds can form hypertrophic or retracted scars, often requiring surgical excision and grafting to prevent a suboptimal result. This technology could also be used to assist in timing of scar revision surgery or indeed the predictability of wound healing. It can be applied for assisting laser treatment of keloids and hypertrophic scars, since the laser will not reach the deep layer of scars if they have a thick collagen layer, and high temperatures are required to thermally denature collagen fibers [2]. Thermography can detect physiological changes such as increased blood flow or heat. For example, a small, pinhead size tumor that has been growing for about 2 years is large enough to develop its own blood supply (angiogenesis). While some screening exams, such as a mammogram, can detect anatomical changes in the breast tissue, thermography is the only technology currently in place that can detect such changes, and although it is not approved as a replacement cancer detection method, thermography has been approved by the FDA as an adjunct diagnostic tool to mammograms. It can be effective in other types of cancer screening and for detection of recurrences.

Thermography is based on the measurement of burn wound temperatures as an indicator of their depths. By exploiting the notion that deeper wounds are colder than more superficial ones because of less vascular perfusion near the wound surface, thermography is able to inversely correlate temperature with depth, and can be used in the acute setting. However, evaporative loss of heat to the environment causes wounds to be interpreted as falsely deep, introducing systematic errors. In addition, best results occur when thermography is done within 3 days of sustaining the burn, before the wounds begin to granulate.

This method has several advantages: it is easy to perform, non-invasive and relatively cheap to achieve. The essential drawback of thermography is the incapacity to measure temperature changes within deep tissues as it only measures heat emission from the skin, and the low temperature readings in fat tissue which can limit its use in obese subjects. The combination of thermographic and ultrasonographic assessments is expected to increase the accuracy of the early detection of deep tissue injuries [3], and further studies are needed.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.burns.2015.10.021.

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Letter to the Editor

Hot pot burns and the dangers of portable gas stove

Dear Editor,

The hot pot, or more commonly known as 'steamboat' in South East Asia, is a popular Asian dining culture. It dates back a thousand years ago from Mainland China and has since evolved with different adaptations in various Asian culture. In general, the traditional hotpot consist of a savoury soup stock placed in a pot set up in the centre of the dining table, which is brought to boil and continuous simmer, then which various ingredients will be placed into the pot to cook.

In the past, traditional hotpot was heated by burning coal or charcoal. Propane gas tank was also commonly used but was however bulky, heavy, and required the use of a gas connector to the stove. When portable butane gas stove was introduced in the last two decades, it became a popular and convenient choice not only for household and restaurant users, but also for camping enthusiasts. These portable gas stoves are powered by disposable butane gas canisters, it is lightweight, handy, and cost-effective, however it may also pose significant safety risk when not handled properly.

Fig. 1 – A blown-up butane gas stove and canister.

In April 2015, a gas explosion occurred in a Chinese steamboat restaurant at Beach Road, Singapore [1]. The disposable butane gas canister was found to be blown apart at scene (Fig. 1). Prior to the explosion a victim recalled the stove giving out an unusual 'clicking noise' and repeatedly switched off on it's own and despite this, diners were reassured to continue eating. Five of the victims were brought to Singapore General Hospital, most suffering from superficial scald burns, two ladies however suffered deep burns of the face and upper limbs requiring surgery.

There has been other incidents reported in Australia for faulty butane gas stove too, ranging from mild scald burns to severe burns. This prompted a ban of the product in New South Wales early this year as they did not meet the minimum safety requirement [2]. Butane is a highly flammable gas and gas explosion occurs when the canister is overheated or when there is failure of the shut-off valve. Such combustion is usually high impact, and besides an explosion, the boiling content of pots and pans may splatter and cause scald burn too.

As hotpot dining is popular in Asian countries, and commonly utilizes a portable gas stove, we find it imperative for users to be aware of it's potential hazards and preventive measures.

- These stoves are meant for short period cooking, overusing it may cause overheating. Always follow the manufacturers instruction manual and not to tamper the stove or gas canister. Empty gas canister should be appropriately disposed.
- Always ensure adequate air flow around the stove. Do not use a large diameter pan or large pot, and avoid aluminium foiling around the stove that may cause trapping of heat.