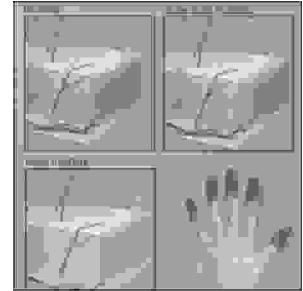


ORIGINAL

PROF-1034

FROSTBITE IN GANGRENE; ROLE OF CLASSIFICATION



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ABSTRACT... Objective: The objective of this study is to determine if classification of cases of frost bite in 1st, 2nd, 3rd and 4th degree have any predictive value on the future complications e.g. skin necrosis and gangrene. **Study design:** A non-interventional and descriptive study. **Place and duration of study:** The study was carried out at the Surgical Department, of Combined Military Hospital Gilgit from January 2002 to February 2005. **Material and methods:** All the patients who reported to the hospital with frost bite were admitted and enrolled in the study. The local examination of wound was done and all the physical signs were recorded. The frost bite was labeled according to the severity from 1st to 4th degree in accordance to the specified criteria. All the patients were placed on a standard treatment protocol comprising of injection of Benzyl Penicillin 10 lac U x 6 hourly, injection of Heparin 5000 IU s/c x 6 hourly and tablets Ibuprofen 400mg x 8 hourly for 5-7 days. The condition of wound was assessed daily till 8 weeks after admission. The end point of medical treatment was a clear demarcation of dry gangrenous and viable tissue, or the formation of moist gangrene or infection in frost bitten area which was spreading proximally. Once this condition was reached the patients were planned for amputation surgery. **Results:** Total numbers of patients included were 96. Among them 33 had 1st degree, 37 had 2nd degree, 16 had 3rd degree and 10 had 4th degree frost bite. All the 33 patients of 1st degree frost bite recovered well and were discharged from the hospital without any surgical intervention. 16 patients among the total 37 who sustained 2nd degree frost bite developed superficial ulcers over the skin. These patients required regular wound dressings and recovered well by 6 weeks of treatment without any limb loss. 7 out of total 16 patients of 3rd degree and all the 10 patients of 4th degree frost bite developed gangrenes. They were observed till 8 weeks and after that they underwent amputations. **Conclusion:** In accordance to the results it is concluded that most of the patients who had 3rd degree of frostbite and all the patients who sustained 4th degree frost bite developed gangrene by 8 weeks of hospitalization despite of the treatment. None of the patient of 1st and 2nd degree frostbite developed gangrene. Hence the initial assessment of a patient was very useful in predicting the chances of development of gangrene.

Key words: Frost bite, Gangrene, amputations

INTRODUCTION

Frost bite is the result of acute freezing of the tissues exposed to extreme degrees of cold. Exposure of only a few seconds is sufficient to cause it. High altitude, wind-chill, tissue hypoxia, poor acclimatization and improper clothing all contribute to the disease¹.

The parts of body which are least protected from cold are most affected. These include toes, fingers, ears, nose and cheeks. After initial pain and burning, the affected part becomes numb and white. On rewarming, erythema, pain and soreness start which persist for sometime and may be the only sequelae in mild cases. Blistering and deeper destruction of epidermis and dermis results in severely affected individuals. Such lesions may eventually lead to gangrene².

Although severity of frost bite can be assessed once the tissue is warmed, in accordance to the degrees¹⁻⁴, there have been no study in past to show whether the initial assessment has any predictive value on the future complications e.g. skin necrosis and gangrene. The present study was planned to address this question.

MATERIAL AND METHODS

This study was a non-interventional and descriptive study. To determine if classification of cases of frost bite in 1st, 2nd, 3rd and 4th degree have any predictive value in determining which cases would develop gangrene and end up in amputations.

The study was conducted at the surgical department of Combined Military Hospital Gilgit. The duration of the study was from January 1999 to September 2004. The study population was the army personnel who sustained frost-bite while they were serving in hilly areas of altitude beyond 10,000 feet and temperatures below -10°C. All the patients who reported to the hospital with frost bite were enrolled in the study. They were examined both systemically and locally. Any co-morbid condition was recorded. The local examination of wound was done and all the physical signs were recorded. The wound was labeled according to the severity from 1st to 4th degree in accordance to the following criteria²:-

1) First Degree

Erythema
Mild oedema

2) Second Degree

Blister formation
Substantial oedema
Induration

3) Third Degree

Hemorrhagic blister formation
Blue-grey discoloration of the skin
Deep burning pain

4) Fourth Degree

Skin and underlying tissue was very hard
Non-balancing cyanotic skin that eventually became dry, black and mummified
Mild pain
Mild oedema

The number of wounds in every patient was recorded and labeled in accordance to the degree of injury. The patients were kept in a warm environment and provided high-caloric diet.

The patient reached the hospital after 24 hours of sustaining frost bite due to the specific terrain of the area, so the first aid measures were administered before the hospital admission.

After admission a battery of investigations were performed on each patient. The investigations included blood complete picture, serum renal and liver function tests, urine routine examination and bacterial culture from the wounds.

All the patients were placed on a standard treatment protocol comprising of injection of Benzyl Penicillin 10 lac units x 6 hourly, injection of Heparin 5000 IU s/c x 6 hourly and tablets Ibuprofen 400mg x 8 hourly for 5-7 days. The patient received injection Dicloran or Morphine on required basis.

The blisters, if present were drained by derroofing. The wound were dressed with anti-bacterial ointment daily. The condition of wound was assessed daily till 8 weeks after admission. The patients who developed skin ulcers were treated conservatively and discharged from the hospital till complete healing with advice not to serve in cold hilly areas in future.

The end point of medical treatment was a clear demarcation of dry gangrenous and viable tissue, or the formation of moist gangrene or infection in frost bitten area which was spreading proximally. Once this condition was reached amputation surgery was performed.

RESULTS

Total numbers of patients included were 96. Among them 34.4% (n=33) had 1st degree frost bite, 38.4% (n=37) had 2nd degree frost bite (Fig 1), 16.7% (n=16) had 3rd degree (Fig 2) and 10.4% (n=10) had 4th degree frost bite (Fig 3) (Table-I).

Severity of frost bite	No of pts	%age
First degree	33	34.4%
Second degree	37	38.5%
Third degree	16	16.7%
Forth degree	10	10.4%

Most of the patients were of young age as they were healthy soldiers. There were 66 patients (68.7%) who were between 20-25 years, 9 patients (9.5%) between 26-30 years, 13 patients (13.5%) between 31-35 years and 8 patients (8.3%) between 36-40 years (Table-II).

None of the patient was a resident of that area and did not have any co-morbid condition. 40 out of the total were regular smokers. All the patients sustained frostbite in hilly areas at altitude beyond 10,000 feet. The environmental temperature was -10°C and below.

All except 4 patients had one of his limb involved. Both

feet were involved in 33 patients (39.4%), both hands in 15 patients (15.6%), one foot in 29 (30.2%), one hand in 11 (11.5%), both feet and one hand in 2 (2.1%), both hands and face in 2 patients (2.1%), ears were involved in 3 patients (3.9%) and nose was involved in 1 patient (1%) (Table-III).

Age group	No of pts	%age
20-25 yrs	66	68.7%
26-30 yrs-	9	9.5%
31-35 yrs	13	13.5%
36-40 yrs	8	8.3%

Sites	No of pts	%age
Both feet	33	34.4%
Both hands	15	15.6%
One foot	29	30.2%
One hand	11	11.5%
Ears	3	3.1%
Face and Nose	1	1.0%
Both feet and one hand	2	2.1%
Both hands and face	2	2.1%

All the 33 patients of 1st degree frost bite recovered well after medical treatment in 3-6 weeks and were discharged from the hospital without any surgical intervention. 16 patients among the total 37 who sustained 2nd degree frost bite developed superficial ulcers over the skin. These patients required regular wound dressing, escharotomy and debridment. All of them recovered well by 8 weeks of treatment without any limb loss.

Seven out of total 16 patients of 3rd degree frost bite

developed gangrene by 8 weeks and after that they underwent amputations of 1-3 toes or fingers. None of them had any amputation beyond wrist or ankle. Rest of the patients of 3rd degree frost bite developed skin ulcers which responded to medical treatment and daily dressings.



Fig-1 Second degree frost bite of nose and fingers

All the 10 patients of 4th degree burn developed gangrene by 8 weeks (Figure 3) and were subjected to amputation. Among these, 5 patients had transmeta tarsal and 2 patients had amputation of thumb and fore finger of one hand. One of the patients lost his ear and one had amputation of the tips of the nose. Rest of the 3 patients had amputation of finger and toes only.

It is quiet obvious from the results that the gangrene

developed only in patients who were initially assessed to be suffering from 3rd or 4th degree frost bite and never in patients who were categorized in 1st and 2nd degree. Hence the initial assessment of patients according to degree of severity has a positive predictive value in determining who will develop gangrene.

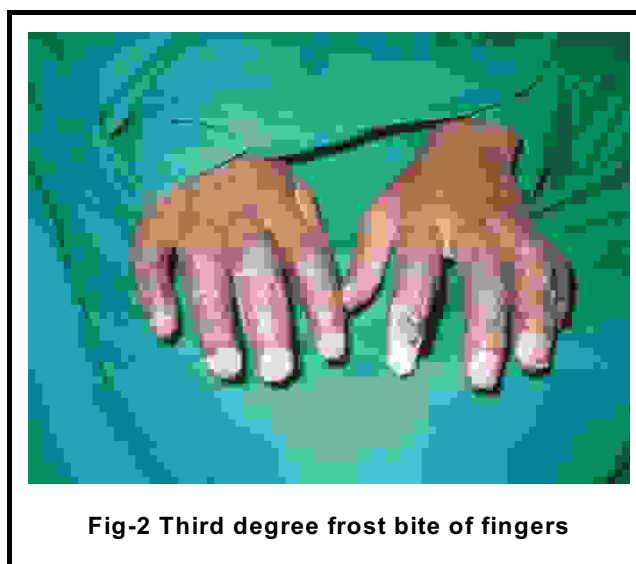


Fig-2 Third degree frost bite of fingers

DISCUSSION

Frost bite, the most common type of freezing injury, is defined as freezing and crystallizing of fluids in interstitial and cellular spaces due to prolonged exposure to freezing temperatures. Frost bite occurs when skin is exposed to temperature lower than -10°C , resulting in vasoconstriction. The resultant decrease in blood-flow does not deliver sufficient heat to the tissues to prevent the formation of ice crystals. The cases are observed in winter. It is most prevalent among mountain climbers, in soldier serving at high altitude, homeless individuals, those with psychiatric disorders and alcohol intelligence. Smoking, malnutrition, infections, peripheral vascular diseases, diabetes mellitus and previous cold injury are contributing factor³. High-altitude mountaineering frostbite, a variant of frost bite that combines tissue freezing with hypoxia and general body dehydration, has a worse prognosis⁴.

Frost bite is a disease of morbidity and not mortality (except when it is associated with other hypothermic

insult to the body that is cerebral oedema, pulmonary oedema, or septicemia). A clear understanding of pathophysiology and hence the treatment, can limit the morbidity⁵.

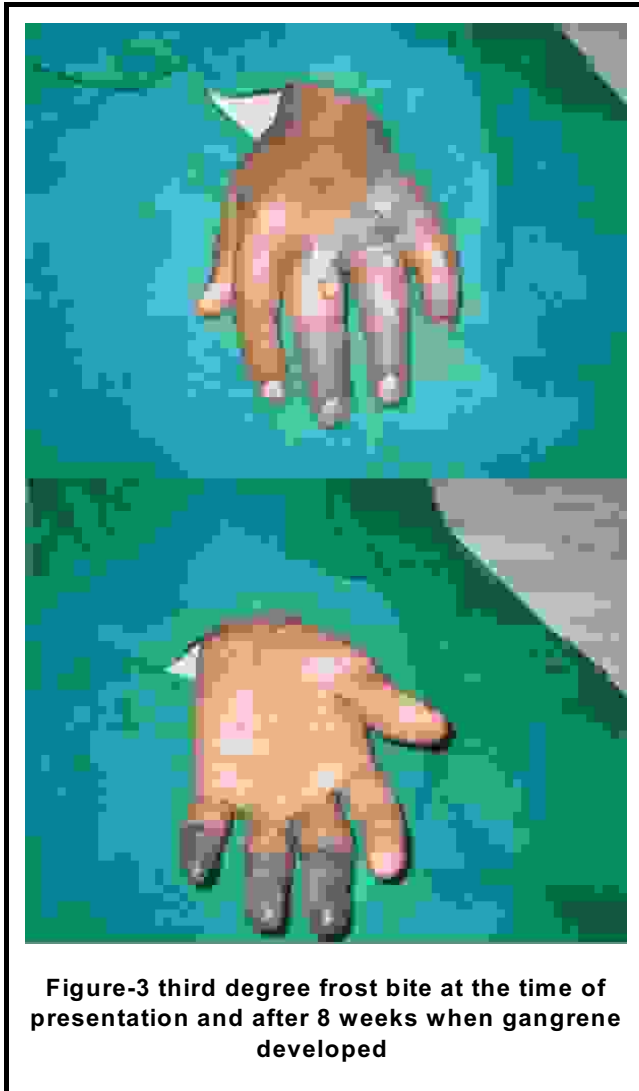


Figure-3 third degree frost bite at the time of presentation and after 8 weeks when gangrene developed

In frost bite cold exposure leads to tissue freezing, causing ice crystals formation which disrupts the cell membranes produces local vasoconstriction that results in tissue hypoxia causing protein denaturing and inhibition of DNA synthesis⁶. The picture is further complicated by release of inflammatory transmitters which cause tissue damage⁷.

Hands and feet are involved in about 90% of the cases

of frost bite⁸. Other sites include lips, tip of the nose and ears⁹.

Frost bite injuries are classified in four degrees according to the depth/severity of the tissue involved. In 1st degree, only skin is involved and in the 4th degree, full thickness of the tissues including muscle tendons and bones are involved. Others classify it into superficial (corresponding to 1st and 2nd degree) and deep injury (corresponding to 3rd and 4th degree². These classifications are useful in describing what is seen clinically, but there have been no study to predict the extent of future tissue damage on the basis of initial assessment of the patient. The present study is first of its kind in which it is highlighted that the extent of tissue damage in accordance to the classification does have a predictive value in deciding who will develop the complication of gangrene resulting in amputation.

The patient always gives history of exposure to cold for a prolonged period. Immediately after injury the area feels cold and numb with variable degree of pain. The nature of pain changes into throbbing when the tissue is warmed. Physical signs are in direct proportion to the degree of frost bite. In mild cases there is only erythema and slight oedema. If the injury is of moderate intensity then there may be pain and formation of clear or haemorrhagic blisters. In severe cases there is induration and non-balancing cyanotic discoloration of the skin that eventually became dry, black and mummified¹⁰.

Frost bite is a clinical diagnosis. Laboratory studies are helpful in identifying systemic complications such as wound infections, sepsis or hypothermia. Blood complete picture help in identifying haemoconcentration, Liver function tests identify hepatic dysfunction, urine analysis detects myoglobinuria and bacterial culture detects wound infections. In first 2-3 weeks no imaging technique e.g. thermography, angiography, plethysmography, radioisotope scanning etc. would reliably predict tissue demarcation. Radiography begins to identify frost bite bony abnormality 3 months after the injury¹¹.

Main stay in the treatment is reversing the pathological effect of ice crystal formation, vasoconstriction and

release of inflammatory materials. It comprises of immediate care phase and the hospital care phase which continues for several weeks¹². As the patient of frost bite is received immediate warming is done in water at strictly controlled temperature of 104-108°F (40-42°C) for 15 to 30 minutes¹³. Water outside the range can further exacerbate the tissue damage. A red-purple appearance and the pliable texture of the involved area is a sign to stop re-warming. NSAIDs are given. The most favored one is Ibuprofen 12 mg/kg/day to gives systemic anti-prostaglandin effect¹⁴. The patient may be given narcotic analgesics on required basis and immunized against tetanus. Splinting, elevation and wrapping the affected part is done in a loose, protective dressing.

After hospital admission, the patient is nursed in a warm environment with high caloric diet and strict avoidance of smoking. Analgesics like Ibuprofen and Morphine is advised. Antibacterial prophylaxis is considered because post-thaw oedema predisposes to infections. The choice of antibiotic is penicillin in injectable form¹⁵.

All blisters except hemorrhagic one are decapitated and locally Aloe Vera cream/steroid cream are applied every six hourly. Daily hydrotherapy adds to wound debridement^{10,13,14}. Escharotomy/Fasiotomy may be needed if the circulation is impaired or compartment syndrome develops^{10,13,14}. Definite amputation is delayed till the definite demarcation develops between viable and non viable tissues, which may take 12 to 45 days¹⁶. Others wait for auto amputation of the toes and fingers (as it leaves longer stump¹⁷). Early amputation is considered if liquefaction, moist gangrene or infection develops in frostbitten area¹⁸.

New and ancillary modalities have been suggested with variable success. These include medical sympathectomy with intravenous reserpine 0.5 mg into affected terminal artery. This relieves pain and reduces the oedema¹⁹, thrombolysis using intra-arterial tissue plasminogen activator (t-PA)²⁰, Limaprost (prostaglandin E-1 analogue) as a therapeutic vasodilator to increase peripheral blood flow²¹, alpha-blocker Buflomedil to increase peripheral flow, low molecular weight dextran to decrease RBC clumping, Arachidonic acid cascade inhibitors,

Hepranization²² and Hyperbaric oxygen²³.

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