Medical Journal of the
Islamic Republic of Iran

Volume 15
Number 3
Fall 1380
November 2001

EFFECT OF SMOKING ON AUTOGRAFT TAKE IN BURN WOUNDS

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ABSTRACT

Early wound excision and grafting of burn wounds is regarded not only as the method of choice in speeding up the healing process in deep burns, but also limits contracture and infection. On the other hand, smoking has generally been implicated in the delay of the healing process in a variety of surgical procedures. In this study we report the outcome of a cross-sectional study of all the 395 medical records of adult patients who underwent split-thickness autografting during a six month period (Sep. 1999 to March 2000) in Taleghani Burn Center, Ahwaz. The subjects, both male and female, who underwent autografting for deep burns, were allocated into smoker and nonsmoker groups. The results showed that rejection of the autografts was significantly more widespread and more common among cigarette smokers. The extent of rejection was 6.7±0.5% of the graft area as compared to 2.9+0.3% in the control group ($p<0.01$). The incidence of rejection and successful take was 66.6 and 28.7% respectively among the cigarette smoking group (O.R. 4.95). The reason for the increase in rejection may be due to the toxic constituents in cigarette smoke. We recommend that smokers be encouraged to abstain from smoking prior to and post-burn grafting surgical procedures, which may be a useful preventive measure. Further research in this field is undergoing in order to assess the effectiveness of this recommendation in reducing the incidence of graft rejection.

MJIRI, Vol. 15, No. 3, 129-132, 2001.

Keywords: Smoking, Autograft, Rejection, Burn wound.

INTRODUCTION

Early closure of the burn wound is the main aim of treatment in burn patients. Many techniques have been developed which have made survival from large total body surface area burns possible.[1] In addition, it is now generally accepted that not only can early excision and grafting of partial and deep burn wounds in comparison with more conservative measures bring about more rapid healing, but also this method can reduce the incidence of wound infection and the degree of contracture.[2]

The skin grafting technique is unique in the overall strategies of wound care in that it employs a direct method for treating a disease process.[3] Autografting is a process by which normal skin is transferred from one site and used as a substitute for the burned site on the same patient. It is normally prepared by excision using the "shaving" technique.[1]

It is generally accepted that skin substitutes, such as allografts and xenografts, need not be permanent as it is even undesirable to be so; such grafts are degraded at a

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slower rate and allowed to perform their necessary functions before being removed or replaced.[4] However, it is crucial that they resist bacterial degradation as this can lead to further complications of skin infection.[2]

One of the causes that can lead to rejection of a graft may be due to delay in angiogenesis or neovascularization,[5] as this may be of paramount importance in nourishment of the wound. Other factors attributed to graft rejection are Langerhans- and endothelial cell-derived class II antigens, cytotoxic T-lymphocyte response, development of seroma and hematoma,[6] inappropriate graft securing at the site and infection of the graft.

Smoking is yet another potential risk factor in wound healing. Smoking has a variety of local and systemic effects which contribute to its deleterious actions.[7] Locally, it reduces proliferation of fibroblasts and macrophages, reduces oxidative enzymatic activities, and causes local vascular thrombosis.[8] Systematically, it increases platelet adhesiveness and induces vasocontriction. Therefore, it seems that the overall effect, by whatever the cause, is the induction of tissue ischemia and inhibition of reparative functions of the cellular constituents responsible in the wound healing process.

Previous studies have shown delayed healing and rejection of grafts among smokers in a variety of clinical settings.[8-11] However, to our knowledge, no documented work has been reported on the effects of smoking on the take of autografts in burn patients. In this cross-sectional study we compared the results of split-thickness autograft take among smokers and non-smokers.

PATIENTS AND METHODS

In this cross-sectional study, 395 medical records belonging to all adult male and female patients who were hospitalized over six months (September 1999 to March 2000) in Taleghani Burn Center, Ahwaz, were studied. In order to reduce the effects of possible confounding factors, the selection criteria were limited to adult patients who had undergone autografting for their inflicted burns, and excluded those patients who were suffering from acute or chronic metabolic or systemic diseases.

When the burn wounds were sufficiently granulated and had no signs of infection, using an Eschmann handheld dermatome, split-thickness skin (0.017 inch) was removed from the lateral and/or anterior thigh of the patient and tranferred to the recipient areas and fixed in place with 4/0 chromic catgut suture and dressed with a layer of petrolatum-coated gauze. The same person, throughout the period of the study, prepared all the donor sites. The bandages were changes 4 days later and twice more, on alternative days. After the seventh day, the patients were advised to wash the wound with baby shampoo and apply a thin layer of vitamin A and D ointment on alternative days.

The take was considered successful when the meshed grafts were found to remain adherent, showing sings of established neovascularization and neoepithelialization without evidence of detachment or infection.[5,12] Rejection was considered when a part of the skin graft had degenerated, developed necrosis, or when no adhesion was observed. Overall, rejection was considered when the site required regrafting. The extent of rejection was quantified using a ruler. Cephalothin was administered in a bolus 1g I.V. dose immediately after grafting, and cephalexin was given orally, when the condition of the patient was stable, 500 mg every six hours for 5 to 10 days. In addition, the etiologies of burns were collected and recorded. The results were statistically analyzed using unpaired Student's t-test, and the odds ratio was calculated using comparison of proportions test.

RESULTS

Among the 395 medical records studied, 150 (98 males, and 52 females) of the patients were found to be cigarette smokers and the remaining 245 (142 males and 103 females) were nonsmokers. There was no significant difference between smoking status and sex. The age ranged from 20 to 60 years old with a mean age of approximately 45 years in both groups. The recipient sites were the hands, the opposite legs or thighs, abdomen and the chest.

The etiologies of the burns were found to be due to direct flame in 85% of cases, 10% due to hot liquids (water, milk, or food) and 5% due to electrical burns and attempted suicides.

Table I: The incidence of rejection and successful take of autografts among cigarette smokers and nonsmokers.

Smoking status	Rejection (%)	Successful Take (%)	Total (n)
Smokers	64 (66.6)	86 (28.7)	150
Non-smokers	32 (33.3)	213 (71.3)	245

Odds ratio= 4.95 (95% CI for OR= 2.94-8.36)

Rejection, when it occurred, was more pronounced among the cigarette smoking group. Rejection among the smoking group was within the graft area with a calculated percentage mean of 6.7±0.5% of the graft size, while for the nonsmoker group, it was confined within the boundary of the graft and was smaller with a mean of 2.9±0.3% of the grafted area, showing a significant difference of $p<0.01$, using unpaired t-test.

66.6 and 28.7%, respectively, of rejected and successful take grafts were in the smoking group, producing an odds ratio of 4.95 (Table I), suggesting a deleterious effect of smoking on autograft take.

DISCUSSION

The results from this study confirmed previous studies on the deleterious effects of smoking on wound healing carried out in a variety of different clinical settings,[8-11] and demonstrated that autografting of burn patients was accompanied with significantly more rejections as compared with nonsmokers among the adult population.

By the nature of this study, the presence of confounding factors, the main ones being the differences in the etiologies of the burn wounds, age and gender, may have influenced the conclusions in this study. Attempts to reduce these confounding factors, where possible, have been made. The confounding factor of the etiology of the burn normally has an influence on initial granulation tissue formation and its readiness for grafting. Since all burn wounds were allowed to reach this stage of maturation before attempting to proceed to the grafting procedure, this factor has to a great extent been reduced to a minimum. In addition, the wide range of age groups selected is another possible drawback; however, since the mean age in both groups was almost similar (45 years), as close a matching as possible was made and this factor may have been nullified. Another possible confounding factor is the low number of female smokers, but this was inevitable, since female smokers are fewer in our society. Since the aim of the present study was to study the effects of smoking on the graft take as a whole in all the adult population who fitted our criteria in the limited time span considered, we had to take account of both sexes in order to have a sufficient number of samples. The effect of gender in the take of grafting among smokers warrants further investigation.

Previous reports found impairment of wound healing at lower extremities,[9] intraoral bone grafting,[10] face-lift and breast surgery,[8] and pressure ulcers,[11] among cigarette smokers. The mechanism(s) suggested for smoking as a potential risk factor in the impairment of wound healing have been attributed to its toxic constituents, nicotine, carbon monoxide, and hydrogen cyanide.[8-9] Nicotine has vasoconstrictor effects at the dermal level and increases platelet adhesion, both contributing to the thrombotic actions resulting in occlusion of blood supply and tissue ischemia at the graft site.[8] In addition, nicotine has anti-proliferative effects on fibroblasts, blood cells and macrophages.[8] Carbon monoxide causes reduction of oxygen transport and metabolism. Hydrogen cyanide is a well known inhibitor of oxidative actions at the cellular level and therefore inhibits the enzymatic actions necessary for the reparative process. Perhaps a combination of these factors have contributed to differences in the greater incidence of rejection and its being widespread within the boundaries in the control smoking group, compared to its confinement within the boundaries in the control nonsmoking group observed in this study. The overall effect from these combined constituents seems to synergistically exacerbate the deleterious actions of graft take and eventually may lead to tissue necrosis.

In this study, rejection was defined by loss of parts of the autografts to an extent requiring regrafting. 66.6% of rejected grafts were from the smoking group. On the other hand, only 28.7% of the successful takes were in the smoking group. This figure compared with other reported studies on intraoral bone grafting which was also shown to be lower in smokers.[10] In their studies, Jones and Triplett[10] found that 80% of smokers and 10% of nonsmokers had rejection of intraoral bone grafts. The greater percentage of rejection among the former group, compared to our findings, may be due to direct actions of the smoke constituents on the operated oral sites.

In conclusion, the delay in healing and increase in the rate of rejection may be due to the fact that in burned hospitalized patients, where the body's physiological and immunoloigcal functions are already compromised, smoking seems to further diminish the healing process and the take of the graft. Smoking seems to amplify the rejection process. It is recommended that smokers be encouraged to refrain from smoking prior to and for some time following grafting, at least until healing has reached a satisfactory stage. Further work is being undertaken in order to assess the "preventive" effects of this recommendation on the take of autografts among cigarette smoking patients currently referred to this center.

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