

## **Skin problems of the leg amputee**

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### **Introduction**

Lower-extremity amputees, the group with which this paper is concerned, include persons who have been subjected to gross anatomic loss of the lower limbs at widely varying levels, such as partial foot amputation, below-knee and above-knee amputations, knee or hip disarticulation, and hemipelvectomy. Amputation at each level is attended by distinctive problems of functional loss, fitting and alignment of the prosthesis, and medical difficulties, such as skin disorders, that are secondary to the use of the limb. These amputees require the continued care of prosthetists who construct the artificial limbs on which the amputees must depend for locomotion—and indeed, to a large degree, for social and economic rehabilitation—for the rest of their lives.

But the problems facing leg amputees are not wholly prosthetic. Many are clearly medical; for example, pain, circulatory problems, and skeletal changes. Many amputees also require the care of the dermatologist more or less frequently throughout their lives. The dermatologist is capable of rendering invaluable aid to the other members of the rehabilitation team, since he is in a position to be familiar with the problems of the skin that may result from wearing an artificial limb.

The skin of an amputee who wears a prosthesis is subject to many abuses. Most leg prostheses have a snugly fitting socket in which air cannot circulate freely and perspiration is trapped. The socket provides for weight-bearing; uneven loading may cause stress on localized areas of the stump skin. Examples of such stress are

intermittent stretching of the skin and friction from rubbing against the socket edge and interior surface. With certain types of prostheses, stump socks are worn for reduction of friction. In the above-knee amputee, pressure may be exerted on the adductor region of the thigh, the groin, and the ischial tuberosity—points of contact with the socket rim. If a suction socket is used for suspension, the stump is subjected to negative pressure as well. In the below-knee amputee, who usually still has the upper third of the tibia, pressures occur over the anterior tibial area and the sides and, sometimes, the end of the stump. In the conventional below-knee prosthesis, constriction of soft tissues of the thigh by the thigh corset may cause significant obstruction to venous and lymphatic drainage of the leg. In addition to the effects of pressure and friction, the amputee's skin is vulnerable to the possible irritant or allergenic action of the materials used in the manufacture of his prosthesis.

The state of the stump skin is of utmost importance in the amputee's ability to use a prosthesis. If good skin condition cannot be maintained despite daily wear and tear, the prosthesis cannot be worn, no matter how accurate the fit of the socket may be.

Since continued use of the prosthesis is so important in the amputee's rehabilitation, it is of vital concern to the physician and the prosthetist to prevent any disorder which may return him to crutches or bed rest. Some amputees may have no disorder of the stump skin for months or years, while others, whose skin has less tolerance for trauma, experience frequent difficulties. Even minute lesions are of great importance, since they may be the beginning of an extensive skin disorder which can bring mental, social, and economic disaster to an amputee.

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This article deals with the common skin problems associated with the wearing of a lower-extremity prosthesis. Twenty-five years ago the Biomechanics Laboratory, in conjunction with the Department of Dermatology at the University of California School of Medicine, in San Francisco, organized a group to investigate the cutaneous problems of the lower-extremity amputee. Amputees were referred to us by physicians and prosthetists for the study and treatment of unusual and persistent conditions that had not responded to conventional therapeutic measures. Approximately the same number of above-knee and below-knee amputees have been seen. Much of our experience was gained with amputees using suction-socket suspension, but the same or similar problems have been found in patients using conventional types of suspension.

The cutaneous disorders peculiar to lower-extremity amputees have been classified, as well as evaluated and treated in individual cases. Out of this study improved methods of treatment have evolved. These are summarized in this paper, after a brief discussion of the methods of stump hygiene that have been found most beneficial.

### Stump hygiene

We have found that poor hygiene is an important factor in producing some pathological conditions of the stump skin. Poor hygiene is largely responsible for bacterial and fungus infections, nonspecific eczematization, intertriginous dermatitis, and persistence of epidermoid cysts. Some patients fail to wash adequately either the stump or the socket, and maceration and malodour result. There has been no unanimity of opinion as to exactly what measures should be used routinely, and amputees have come to us with varied and often strange ideas about stump hygiene.

A simple hygienic programme with use of a bland soap or sudsing detergent has often had a preventive or a therapeutic effect on a cutaneous disorder. For example, this treatment has been found to be curative for some persistent eczematoid eruptions of the stump. Soaps or detergents that contain chlorhexidene or hexachlorophene have bacteriostatic, in addition to cleansing action and thus help reduce the possibility of infection. Amputees should be advised to purchase a plastic squeeze bottle of

liquid detergent containing an antimicrobial which is relatively inexpensive and available in drugstores without a prescription. Some amputees prefer to use cake soap containing an antibacterial substance. They should be instructed in the use of such agents.

The cleansing routine should be followed nightly or every other night, depending on the rate of perspiration, the degree of malodour, and the bathing habits of the person. The stump should not be washed in the morning unless a stump sock is worn, because the damp skin may swell, stick to the socket, and be irritated by friction during walking. For the same reason the best time to cleanse the socket is also at night. If a stump sock is worn, it should be changed every day and should be washed as soon as it is taken off, before perspiration is allowed to dry in it. If the sock dries with a "dog ear", a rubber ball can be inserted to give it shape.

### Stump oedema syndrome

When an amputee first starts to wear a suction-socket prosthesis, his skin must adapt to an entirely new environment. He can expect oedema, reactive hyperemia, reddish-brown pigmentation resulting from capillary hemorrhage and, occasionally, serous exudation and crusting of the skin of the terminal portion of the stump. These changes are the almost inevitable result of the altered conditions forced on the skin and the subcutaneous tissues. They are relatively innocuous, do not usually require therapy, and can be partially prevented by gradual compression of the stump tissues with an elastic bandage or "shrinker" sock prior to use of the prosthesis. An incorrectly fitted socket may predispose the leg amputee to this disorder by imposing a pressure distribution that disturbs circulation. Oedematous portions of the skin of the distal part of the stump may become pinched and strangulated within the socket (Fig. 1, left) and may ulcerate or become gangrenous as a result of the impaired blood supply.

Biopsies have shown that the brown pigmentary changes so often seen on the distal portion of the stump are due to hemosiderin deposited within the tissue (Fig. 1, right). It is thought this disorder is vascular in origin, a venous and lymphatic congestion producing the oedema and hemorrhage. Superficial erosion of the distal stump skin is not uncommon, and, in

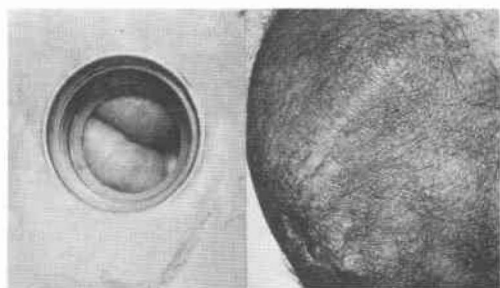


Fig. 1. Left, stump oedema seen through the socket valve. Right, hyperpigmentation of stump skin secondary to chronic stasis.

rare instances, deep ulcers can result from the poor cutaneous nutrition.

Therapy by the dermatologist requires teamwork with the orthopaedic surgeon and prosthetist. This includes elimination of all mechanical factors contributing to the oedema, such as choking by the socket and poor fit and alignment. Excessive negative pressure in a suction-socket prosthesis will also contribute to circulatory congestion and oedema. Treatment should be directed toward better support of the distal soft tissues.

### Cutaneous problems

**Contact dermatitis.** We have seen a number of patients with contact dermatitis of the amputation stump (Fig. 2, left). In these amputees this disorder was usually caused by contact of the skin with chemical substances that acted either as primary irritants or as specific allergic sensitizers. Varnishes, lacquers, plastics, or resins may be used in finishing the sockets of leg prostheses. We have had to learn about the materials used in different types of prostheses in order to understand and treat the problem adequately. We have also had to analyze the different conditions of heat, humidity, and friction in the socket, since these are related to the intensity of the reaction.

Epoxy resins are frequently used to improve the appearance of a socket and to render it impervious to external agents. These resins, if incompletely cured in their manufacture, may produce a primary irritant dermatitis, as well as cause a specific allergic reaction. Some amputees use a foam-rubber cushion, others a plastic-covered pad, on the bottom of the socket. A number of the cements and volatile substances used to repair prostheses are also capable of

producing either an irritant reaction or allergic sensitization. Any of these agents is capable of producing a contact dermatitis of the stump skin after weeks, months, or even years of use. In some instances we found only by a carefully taken history that the use of a new cream, lubricant, or cleansing agent coincided with the onset of the dermatitis.

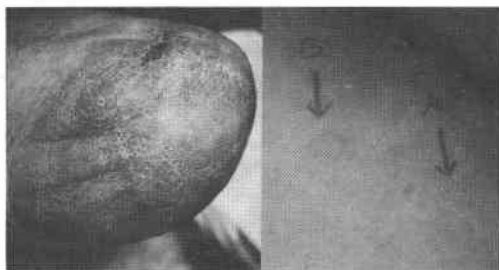


Fig. 2. Left, contact dermatitis of distal stump skin due to Naugahyde pad in bottom of socket. Right, positive patch test (B) on arm from pad. (A) is negative control.

When contact dermatitis is suspected, every attempt should be made to determine the contactant. Patch tests are most informative in pinpointing specific substances as the cause of dermatitis of the stump (Fig. 2, right). Because patch testing with strong concentrations of known primary irritants will result in reactions on any skin, solutions of such substances are first diluted according to published lists in order to prevent a false-positive reaction and possible injury to the skin.

The following sources of contact dermatitis have been proved in a number of our patients:

Ambroid	Platon
C-8 epoxy resin	rayon
polyethylene	sizing in new stump sock
foam-rubber pads	T-161 cement
McCloskey's trans-parent lacquer	Fuller Synalac No. 7790
tincture of Merthiolate	Saran (auto seat cover)
adhesive tape	Aerowax
	Naugahyde

Removal of the suspected contactant resulted in a cure, and subsequent patch testing identified the offending agent.

In those instances of contact dermatitis where the irritant has not been obvious and patch tests have been inconclusive, temporary symptomatic therapy has alleviated the symptoms. Cool compresses, bland antipruritic lotions, and the

topical use of hydrocortisone or similar corticosteroid preparations have been beneficial.

### *Nonspecific eczematization*

Nonspecific eczematization of the stump skin has been seen in a number of instances as a persistent, weeping, itching area of dermatitis over the distal portion of the stump. The lesions at times are dry and sealy and at other times become moist without apparent reason. The condition often fluctuates over a period of months or years and may be a source of much anxiety to the amputee.

We have tried to find the cause of this dermatitis through a complete study of the patient—history, physical examination, laboratory tests, and subsequent observation of the clinical course of the condition. We have been able at times to elicit a significant history of recurrent allergic eczema and in some cases to demonstrate active eczematous lesions on other portions of the body to account for the eruption on the stump. In other instances the eczema has been secondary to poor fit or alignment of the prosthesis or to oedema and congestion of the terminal portion of the stump, so that only with the alleviation of these problems has the condition cleared. Temporary symptomatic topical treatment with hydrocortisone or other corticosteroid preparations is effective, but the condition frequently recurs unless its cause can be eliminated.

### *Epidermoid cysts*

A number of authors have described the appearance of multiple cysts, commonly called post-traumatic epidermoid cysts, in the skin of amputees' stumps in association with the wearing of an artificial limb. They occur most frequently in above-knee amputees in the areas covered by the upper medial margins of the prosthesis (Fig. 3, left), but they have also been seen in other areas and in below-knee amputees (Fig. 3, right). Usually the cysts do not appear until the patient has worn a prosthesis for months or years.

Characteristically, in the above-knee amputee small follicular keratin plugs develop in the skin of the inguinal fold and of the adductor region of the thigh along the upper edge of the prosthesis.

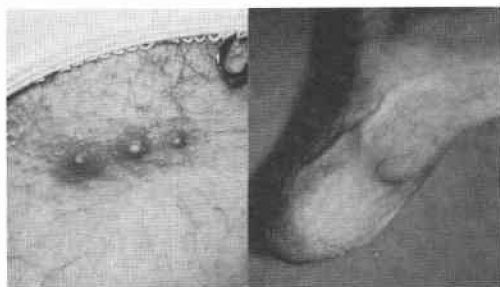


Fig. 3. Left, adductor cysts on thigh of above-knee amputee. Right, below-knee amputee with epidermoid cyst (outlined).

Similar plugs may appear over the inferior portion of the buttock where the posterior brim, or ischial seat, of the prosthesis rubs. Through the process outlined below, some of these plugs may become deeply implanted and develop into cysts (Fig. 4, left). These lesions may become as large as 5 cm in diameter. They are seen as round or oval swellings deep within the skin, and with gradual enlargement become sensitive to touch. The skin may break down and erode or ulcerate. If irritation by the prosthesis is allowed to continue, the nodular swelling may suddenly burst and discharge a purulent or serosanguinous fluid. The sinus discharge may become chronic and thus make it impossible for the patient to use his prosthesis. Frequently, scars remain after the cysts have healed. If the break takes place within the deeper portion of the skin, subcutaneous intercommunicating sinuses may develop.

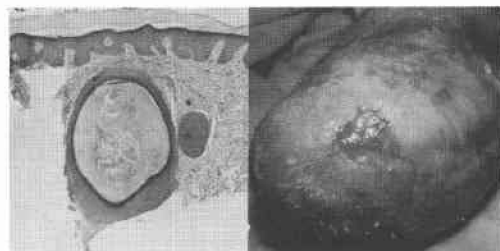


Fig. 4. Left, low-power photomicrograph of early epidermoid cyst. Right, distal stump ulcer.

Some investigators regard the cysts as sebaceous adenomata and speak of sebaceous adenitis as being of frequent occurrence in the adductor region of the thigh. These and similar lesions have also been described in the hands and fingers after trauma.

It appears that the condition is one in which the surface keratin and epidermis become invaginated, acting as a "foreign body". Under the influence of friction and pressure from the prosthesis the keratin plug and its underlying epidermis are displaced into the corium. The result is a production of nonspecific inflammation and implanted epidermoid cysts. These cysts can remain quiescent for a long period of time or can, with secondary bacterial invasion by *Micrococcus* (*Staphylococcus*) *pyogenes* var. *aureus* or other skin pathogens, become abscessed and produce the characteristic clinical picture.

Either surgical incision and drainage or excision of the chronic, isolated, noninfected nodule may give temporary relief, but there is no completely satisfactory method of treatment. In the acutely infected phase, hot compresses and antibiotics (selected through bacterial studies and sensitivity tests of the cystic fluid) are indicated. As the process localizes, incision and drainage may be temporarily beneficial. The chronic problem can, in some instances, be improved or successfully eliminated by proper fit and alignment of the prosthesis.

At the present time we are applying various topical agents in an effort to prevent or retard the inflammation that follows the formation of the keratin plug, which may be the precursor of the epidermoid cyst. We have attempted to develop a stump sock or adductor rim sock for use with the suction-socket prosthesis to prevent cyst formation. Various substances have been tried as socket liners for reduction of friction over pressure areas. Polytetrafluoroethylene film (Teflon) has been found to be the most satisfactory for this purpose. Hydrocortisone or its derivatives have been injected into the cysts and their channels. Inunction of hydrocortisone preparations in areas of maximum friction has also been tried. This was found to reduce inflammation, as anticipated, and to provide symptomatic relief though only temporarily. In our experience, there is still no completely satisfactory method of treatment, and each case is a therapeutic challenge.

### *Pyodermas*

Folliculitis and furuncles are often encountered in amputees with hairy, oily skin, since the condition is aggravated by the use of an artificial leg. It is usually worse in summer, when

increased warmth and moisture from perspiration promote maceration of the skin in the socket, which in turn, favors invasion of the hair follicle by bacteria. Ordinarily, this process is not serious, but sometimes it progresses to formation of furuncles, cellulitis, or an eczematous, weeping, and encrusted superficial pyoderma.

Folliculitis and furuncles may be the result of poor hygiene of the stump or the socket. In 10 lower-extremity amputees, the bacterial flora of the skin of the stump was compared with the flora of the skin of the opposite, normal limb. All subjects wore prostheses and followed a satisfactory routine of stump hygiene. The stump skin was found to harbour a bacterial flora considerably more abundant than that of the skin of the contralateral leg.

In several patients chronic recurrent folliculitis was essentially cured by having the amputee adhere to the routine hygienic programme previously described. In other instances therapy may need to include wet dressings, incision and drainage of boils after localization, oral or parenteral use of antibacterial substances, or local application of bactericides.

Some manufacturers of plastics and resins for use in artificial limbs are now experimentally incorporating bacteriostatic substances into their products to aid in preventing bacterial infection by reducing the total bacterial count. Porous laminates with bacteriostatic additives are being investigated; such agents, by allowing more air about the stump skin, may help to reduce excessive perspiration and resultant bacterial and/or fungus infection.

### *Fungus infections*

Superficial fungus infections of the stump skin may be difficult to eradicate completely because of continued moisture, warmth, and maceration in the prosthetic socket. Tinea corporis and tinea cruris usually appear only on the part of the stump or thigh enclosed by the socket. The diagnosis may be confirmed by culture and microscopic demonstration of the fungus filaments in scales or vesicles removed from a lesion. Therapy consists of the application of fungistatic creams and powders for an extended period of time. The oral antifungal antibiotic, griseofulvin, may be of benefit in recurrent

*Trichophyton rubrum* infections which have not responded to topical therapy.

#### *Intertriginous dermatitis*

Intertriginous dermatitis is an irritation of those skin surfaces which are in constant apposition and between which there is hypersecretion and retention of sweat. This condition usually occurs in the inguinal or crural areas, but on occasion it occurs in the folds of the end of the stump where two surfaces of the skin rub each other and where the protective layer of keratin is removed by the friction. Continued friction and pressure from the socket may result in lichenified and pigmented skin. A chronic disorder may develop, with deep, painful fissures and secondary infection and eczematization. Hygienic measures to cleanse the apposing folds and the use of drying powders or lotions are beneficial. Often these problems may be corrected by proper prosthetic fit and alignment.

#### *Chronic ulcers*

Chronic ulcers of the stump may result from bacterial infection or from poor cutaneous nutrition secondary to an underlying vascular disorder or to localized pressure from a poorly fitting prosthesis (Fig. 4, right). Malignant ulcers can develop within old, persistent stump ulcerations; therefore, every effort should be made to treat the condition before it becomes chronic. With repeated infection and ulceration of the skin the amputation scar may become adherent to the underlying subcutaneous tissues, a condition which invites further erosion and ulceration. Continued wear and tear from the use of a prosthesis may necessitate surgical revision in order to free the scar in the bound area.

#### *Tumours*

Tumours of the stump skin may be benign or malignant. We have seen benign hyperkeratoses and have removed viral verrucae from the stump skin. Simple cutaneous papillomas are easily removed. A cutaneous horn on the amputation stump has been reported by others, and we have removed one from a below-knee amputee wearing a conventional prosthesis.

#### *Verrucose hyperplasia*

A verrucose condition of the skin of the entire distal portion of the stump has been seen in a

number of instances (Fig. 5). This disorder has been described as *verruca vulgaris*, but in biopsies taken by us the pathological picture of viral verrucae has not been seen. The condition has been thought by some to be associated with malignancy. Among patients with verrucose hyperplasia, we have found only one such instance. In a 40-year-old male patient with extensive ulceration and infection of the stump skin and verrucose hyperplasia of long duration, a squamous cell carcinoma developed in the skin and extended into the bone.

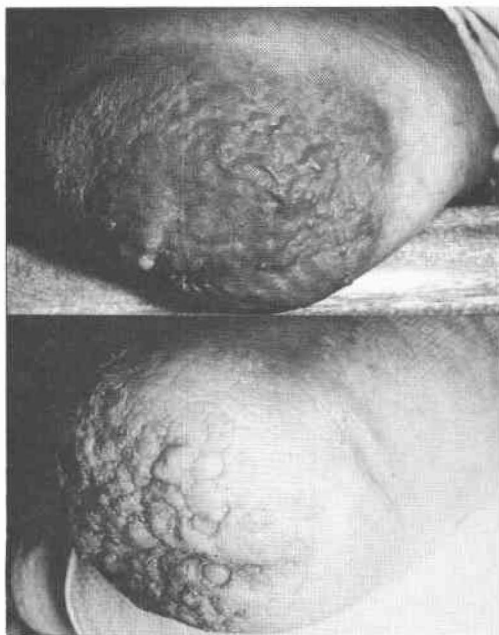


Fig. 5. Top, terminal lymphatic stasis of distal stump skin of above-knee amputee; this may precede verrucose hyperplasia. Bottom, verrucose hyperplasia of distal stump skin in a below-knee amputee.

A number of our patients had had verrucose hyperplasia for months or years. Many had made the rounds of general physicians, dermatologists, prosthetists, and orthopaedic surgeons. They had been treated with topical preparations and by various types of radiotherapy without effect. Systemic antibiotics and other oral medications had been of only temporary benefit.

It was only through trial and error that we found external compression to be the best method of treatment, in combination with adequate control of bacterial infection. In the below-knee amputees seen by us who had this



condition, the distal part of the stump was oedematous; the stump dangled freely in the socket. When support of the stump end was provided in the socket by means of a temporary platform built up with foam-rubber cushions, the verrucose condition was reduced. The greater the compression on the distal stump, the more immediate and lasting was the improvement.

It was as a result of this investigation that the engineers and prosthetists of the Biomechanics laboratory modified the prosthetic design to provide back pressure for the tissues at the end of the stump. After several weeks' use of the modified prosthesis, the verrucose condition of these patients disappeared and did not recur. The hyperplastic condition appeared to have been secondary to an underlying vascular disorder, poor prosthetic fit and alignment, and, possibly, bacterial infection.

The successful treatment of this disorder serves as yet another example of the need for interdisciplinary cooperation to provide the maximum benefit to the individual amputee.

#### Other disorders

Over a period of time numerous cases have been observed of chronic dermatoses which were localized on the stump. We have seen patients with acne vulgaris of the face and back develop acne lesions of the stump. We have seen similar localizations in patients with seborrheic dermatitis, folliculitis, and eczema. We have seen and there are recorded instances of psoriasis (Fig. 6) and lichen planus developing on the stump skin with few lesions present elsewhere on the body. Here it is important to treat the generalized cutaneous disorder in order to improve the stump condition.



Fig. 6. Psoriasis of distal stump skin.

#### Summary

The importance of early recognition and treatment of skin lesions on the stumps of amputees cannot be overemphasized. Heavy demands are placed on the stump skin by the artificial limb. Even a minor skin eruption may, through neglect or mistreatment, become an extensive disorder that will seriously threaten the amputee's mental, social, and economic rehabilitation. Contact dermatitis, eczemas, epidermoid cysts, bacterial and fungus infections, chronic ulcers, and verrucose hyperplasia are among the disorders to which the stump skin is subject. Proper stump hygiene is often effective in alleviating or averting some of these conditions.

Since skin disorders in amputees are essentially "environmental" dermatoses, their treatment often involves change of the environment through adjustment or redesign of the artificial limb. For example, verrucose hyperplasia was treated successfully by a change in prosthetic design. Thus, the skills of engineers and prosthetists must be combined with the contributions of dermatologists and other medical specialists in the solution of skin problems of the amputee.

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