Skin problems in lower limb amputees: an overview by case reports

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Abstract
The stump in lower limb amputees is prone to skin problems because it is exposed to several unnatural conditions (shear and stress forces and increased humidity) when a prosthesis is used. This study reviews the literature on case reports of lower limb amputees with skin problems on the stump. In total, 56 reports comprising 76 cases were identified in the literature. The main disorders are acroangiodermatitis, allergic contact dermatitis, bullous diseases, epidermal hyperplasia, hyperhidrosis, infections, malignancies and ulcerations.

Introduction
The stump in lower limb amputees is prone to skin problems because it is exposed to several unnatural conditions when a prosthesis is used, such as shear and stress forces, increased humidity and prolonged and moist contact with the prosthesis, resulting in exposure to its constituent chemical compounds (fig. 1). The resultant skin problems have been reported and discussed in the literature. However, since the overview written by Levy in 1995, no comprehensive investigation has been published.

We recently investigated the literature on the prevalence of skin problems in lower limb amputees over the past 40 years in a systematic review. In that review, only one publication fulfilled the defined methodological selection criteria. The prevalence of skin problems in a series of 45 lower limb amputees aged 65 years and older was 16%. It was concluded that the prevalence and incidence of skin problems of the stump in lower limb amputees are basically unknown.

While performing the review we discovered that many case reports regarding skin problems of the stump in lower limb amputees can be found in the literature. Some skin problems are mentioned more than others. The aim of this study was to provide an overview of the skin problems in lower limb amputees found in the literature, published as case reports.

Methods
A literature search was performed in MEDLINE, EMBASE, CINAHL and RECAL (a database with particular interest in amputations and prostheses and orthoses, managed by the University of Strathclyde, Scotland, UK). The time period chosen was the first date possible for each database until June 2005. MESH headings used included: ‘Amputation’, ‘Amputation-Stumps’, ‘Lower-limb’ (MEDLINE), ‘Leg’, (EMBASE); ‘Extremities’ (CINAHL); ‘Skin-Diseases’ (MEDLINE and CINAHL), ‘Skin-disease’ (EMBASE), ‘Artificial-Limbs’ (MEDLINE and CINAHL), ‘Limb prosthesis’ (EMBASE). Free text words in the title and the abstracts used included: ‘amputation’, ‘stump’, ‘leg’, ‘tibia’, ‘femur’ and ‘skin’. Because we focused on major lower limb amputation, we excluded cases concerning ankle and foot amputations.

In RECAL, no MESH terms could be used, therefore the free text words ‘amputation’ and ‘skin’ were used. All reports giving detailed information about lower limb amputees and their skin problems were included in the review. Case reports not concerning lower limb amputees or not concerning skin problems were not included.
Results

In total, 56 references describing 76 cases concerning skin problems in lower limb amputees were identified. Some references also described several skin problems that were not restricted to lower limb amputees. The latter were not included. Two of the authors (H.M. and M.J.) sorted the cases into the following diagnostic categories alphabetically: acroangiodermatitis, allergic contact dermatitis, bullous diseases, epidermal hyperplasia, hyperhidrosis, infections, malignancies and ulcerations. The classification is based on physical presentation (skin efflorescence) and aetiology (cause of the skin problem).

Acroangiodermatitis

Acroangiodermatitis consists of red, livid papulae, plaques and indured infiltrates and is a skin condition frequently found on lower limb amputation stumps. The first description in the medical literature was in 1965 by Mali and Kuiper in 18 patients with chronic venous insufficiency. Acroangiodermatitis is a reactive disorder that resembles Kaposi’s sarcoma clinically and histologically. This benign and reactive disease appears most often between 1 and 15 years after amputation, and the diagnosis may be complicated by the resemblance with stasis dermatitis, haemangioma, lymphangioma, Kaposi’s sarcoma and lymphangiosarcoma (Stewart–Treves syndrome). Acroangiodermatitis has several different names in the literature: acroangiodermatitis Mali–Kuiper, Stewart Bluefarb syndrome and pseudo-Kaposi sarcoma.

The cause of acroangiodermatitis was presumed to be primarily chronic venous insufficiency. Reports of acroangiodermatitis have appeared in the literature more frequently since the increased use of the suction socket prosthesis. This prosthesis uses suction as a mechanism for securing the socket to the stump by using a valve system to create negative pressure in the stump socket environment (fig. 2). It is currently thought that acroangiodermatitis is
caused by the negative pressure in the stump socket environment, leading to altered local circulation and the proliferation of small vessels.\textsuperscript{7–15} Additionally, if the fit of socket and stump is not perfect, repeated microtraumata to the skin of the stump may occur, leading to proliferation of fibroblasts and small vessels and, in particularly sensitive tissue such as the skin on an amputation stump, to acroangiodermatitis.\textsuperscript{13}

**Allergic contact dermatitis**

When skin lesions occur on a stump after the use of a new prosthesis or persist after therapy, allergic contact dermatitis should be considered. Contact allergic reactions can be acute (swelling, erythema) or chronic (scaling).

Following the change in the main component of lower limb prostheses from wood to plastics, starting approximately after World War II, the types of allergens also changed. When wearing a wooden prosthesis, there could be allergic reactions to several components of the prosthesis (e.g. varnish, paint or the metal parts used for assembly).\textsuperscript{18} When using a prosthesis consisting of plastics, allergy can occur to one of the components of the plastic. It was expected that the introduction of the ICElandic Roll-On Silicone Socket (ICEROSS) would diminish allergic contact dermatitis in prosthesis wearers because the non-allergic quality of the silicone used would prevent sensitization.\textsuperscript{19} However, contact allergy has been described in a patient wearing ICEROSS, in whom a component of the silicone liner (tetraethylthiuram disulfide/zinc diethyldithiocarbamate) turned out to be the allergen.\textsuperscript{18}

Cross-sensitization to a component may also occur. Thus an allergic reaction to a component can occur, where that component has a chemical resemblance to another component that is known to cause an allergic reaction.\textsuperscript{18}

Friction, sustained pressure and humidity of the amputation stump may not only act as cofactors to increase the chance of allergic contact dermatitis but may also be primary factors in causing irritant contact dermatitis.\textsuperscript{20} When an allergic reaction occurs, it is important to rule out other causes of dermatitis and to determine if the reaction is limited to the stump, or to the part of the stump that is in contact with the prosthesis (as in, for example, the valve of a suction socket prosthesis) (fig. 3).

In the literature several cases have been reported concerning allergies to components of the prosthesis socket, such as resins, glue, rubber components and leather preservatives. Table 1 presents a summary of the case reports on allergic contact dermatitis.

**Bullous diseases**

Bullous pemphigoid is a subepidermal bullous autoimmune disease against autoantigens in the epidermal basement membrane zone, which leads to tense blisters on the skin. Immunofluorescence of the skin reveals linear immunoglobulin G (IgG) and/or C3c deposits along the basement membrane zone. The localized variant of bullous pemphigoid may be restricted to the stump. Localization to the stump may be induced by the Köbner phenomenon, that is the development of lesions in previously normal skin that has been subjected to trauma. The mechanical forces of the prosthesis might elicit the Köbner phenomenon or the isomorphic prickle phenomenon of a pre-existing skin disease.\textsuperscript{29} A localized variant can eventually generalize.

Early diagnosis of this entity guides treatment towards specific immunosuppressive therapy. At the start of symptoms, subepidermal pemphigoid blisters can be confused with friction blisters; the latter, however, have a

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**Table 1** Case reports of allergic contact dermatitis in lower limb amputees sorted by year of publication

<table>
<thead>
<tr>
<th>Author (date)</th>
<th>Allergen/topic</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suurmond et al. (1967)\textsuperscript{21}</td>
<td>Azo dyes</td>
<td>1</td>
</tr>
<tr>
<td>Correcher and Perez (1981)\textsuperscript{22}</td>
<td>Mercaptobenzthiazole/paratertiary butyl formaldehyde resin</td>
<td>1</td>
</tr>
<tr>
<td>Romaguera et al. (1985)\textsuperscript{23}</td>
<td>Paratertiary butylphenol formaldehyde</td>
<td>2</td>
</tr>
<tr>
<td>Freeman (1986)\textsuperscript{18}</td>
<td>p-tertiary butyl catechol</td>
<td>1</td>
</tr>
<tr>
<td>Requena et al. (1986)\textsuperscript{24}</td>
<td>Epoxy dermatitis due to resins</td>
<td>1</td>
</tr>
<tr>
<td>Condé-Salazar et al. (1988)\textsuperscript{25}</td>
<td>2-Mercaptobenzthiazote</td>
<td>1</td>
</tr>
<tr>
<td>Foussereau et al. (1989)\textsuperscript{26}</td>
<td>Methyl methacrylate</td>
<td>1</td>
</tr>
<tr>
<td>Baptista et al. (1992)\textsuperscript{18}</td>
<td>Tetraethylthiuram disulfide/zinc diethyldithiocarbamate</td>
<td>1</td>
</tr>
<tr>
<td>Bala et al. (1995)\textsuperscript{27}</td>
<td>Paratertiary butylphenol formaldehyde/mercaptobenzthiazole/mercaptomix/para-phenylenediamine</td>
<td>6</td>
</tr>
<tr>
<td>Corazza et al. (1995)\textsuperscript{28}</td>
<td>Methyl methacrylate</td>
<td>1</td>
</tr>
<tr>
<td>Komamura et al. (1997)\textsuperscript{29}</td>
<td>Impurities of cetyl alcohol</td>
<td>1</td>
</tr>
</tbody>
</table>

\*The article describes an investigation in a group of 19 persons, concerning allergic reactions caused by shoe components. One person used a lower limb prosthesis.

\†The article describes several problems with orthopaedic devices including six patients with a transtibial amputation.
split beneath the stratum granulosum higher in the epidermis. Biopsies of the blister edge for histology and of perilesional skin for immunofluorescence have to be taken to confirm the diagnosis.\textsuperscript{30–32}

\textbf{Epidermal hyperplasia}

Changes in the epidermis of the skin of amputation stumps have been reported over the years. Conditions that may occur in people with a lower limb amputation are verrucous hyperplasia, epidermoid cysts, hyperkeratotic papules and acne mechanica. All these conditions have the proliferation of epidermal cells in common.

Verrucous hyperplasia on the amputation stump is a condition that shows multiple, irregular warty papules and plaques, hence the name verrucous. Other names are papillomatosis cutis lymphostatica, lymphostatic congestion papillomatose (e.g. elephantiasis) or papillomatosis cutis verrucosa (e.g. mossy foot). It has been suggested that verrucous hyperplasia results from persistent stump oedema, usually when the distal stump is unsupported in the prosthesis socket (fig. 4).\textsuperscript{33}

Oedema can be induced by venous or lymphatic stasis by prosthesis use (or through infection, tumours, surgery or radiotherapy) or by insufficiency of the venous or lymphatic system. The (most) distal part of the stump is often the most affected. When wearing a prosthesis there is a continuous influence on the skin due to the interaction between the socket or liner and the stump. Verrucous hyperplasia is associated with the use of suction socket prosthesis. Because of the combination of congestion by the entrance of the socket and possible failure of the endbearing, stasis of fluids can occur, causing oedema and venous congestion. In already vascular compromised persons, this condition will occur earlier.

Epidermoid cysts are a well-known problem in wearers of prostheses. These cysts consist of follicular props of keratin that turn into pigmented, painful, confluenting cysts. Favourable locations in wearers of prostheses are the groin (in transfemoral amputees) and the popliteal region (in transtibial and through knee amputees). Initially the cysts were thought to be a reaction to foreign material that was pressed into the skin (e.g. extrafollicular dislocation of hairs, at protrusions, leather parts of the prosthesis).\textsuperscript{34} Later on, the origin of epidermoid cysts was found to be invaginated keratin into the dermis. Shear and stress forces may play a part in the origin of these cysts. When a cyst occurs, dermatological causes have to be ruled out. The cysts are not by definition infected, but may become infected as a secondary factor.\textsuperscript{34}

Hyperkeratotic papules are caused by poor fitting of the prosthesis, pressure, and sensitization of certain areas of the stump. It is not certain how much each factor contributes to the development of these papules.\textsuperscript{35,36}

\textbf{fig. 3} A transfemoral amputation stump with verrucous hyperplasia on the medial part.

\textbf{fig. 4} Detail of a suction socket prosthesis. The arrow points to the metal part of the valve, which may cause an allergic reaction.
Acne mechanica is an exacerbation of pre-existing acne due to physical trauma (Köbner phenomenon). It does not always have to be preceded by a history of acne or acneiform lesions. A mechanical triggering has to occur for the diagnosis.

Table 2 presents a summary of the case reports of epidermal hyperplasia in lower limb amputees sorted by year of publication.

### Table 2: Case reports of epidermal hyperplasia in lower limb amputees sorted by year of publication

<table>
<thead>
<tr>
<th>Author (date)</th>
<th>Topic</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young (1951)</td>
<td>Epidermoid cysts</td>
<td>5</td>
</tr>
<tr>
<td>Levy and Barnes (1956)</td>
<td>Verrucous hyperplasia</td>
<td>1</td>
</tr>
<tr>
<td>Mosto et al. (1968)</td>
<td>Verrucous hyperplasia</td>
<td>1</td>
</tr>
<tr>
<td>Larrière et al. (1975)</td>
<td>Hyperkeratosis</td>
<td>1</td>
</tr>
<tr>
<td>Bendl (1976)</td>
<td>Pigmented hyperkeratotic pressure papules</td>
<td>2</td>
</tr>
<tr>
<td>Grosshans and Laplanche (1981)</td>
<td>Verruciform xanthoma or xanthomatous transformation of inflammatory epidermal naevus</td>
<td>1</td>
</tr>
<tr>
<td>Bues et al. (1983)</td>
<td>Pseudokanzerose der Haut (Papillomatosis cutis carcinoides Gottron)</td>
<td>1</td>
</tr>
<tr>
<td>Görzgen (1988)</td>
<td>Verrucous hyperplasia</td>
<td>1</td>
</tr>
<tr>
<td>Brunner et al. (1994)</td>
<td>Verrucous hyperplasia</td>
<td>2</td>
</tr>
<tr>
<td>Wlotzke et al. (1997)</td>
<td>Epidermoid cysts and verrucous hyperplasia</td>
<td>3</td>
</tr>
<tr>
<td>Stewart and Wilson (1999)</td>
<td>Mechanical irritation</td>
<td>2</td>
</tr>
<tr>
<td>Strauss and Harrington (2001)</td>
<td>Stump acne mechanica</td>
<td>1</td>
</tr>
<tr>
<td>Heim et al. (2003)*</td>
<td>Psoriasis and the effect of prosthesis fitting</td>
<td>2</td>
</tr>
<tr>
<td>Bardazzi et al. (2003)</td>
<td>Verrucous hyperplasia</td>
<td>1</td>
</tr>
<tr>
<td>Lee et al. (2004)</td>
<td>Verrucous hyperplasia with lymphoedema</td>
<td>1</td>
</tr>
</tbody>
</table>

*The article describes two patients with amputation and psoriasis: one had psoriasis prior to amputation, the other developed psoriatic lesions after amputation.

Hyperhidrosis

The introduction and increased use of the ICEROSS and other kinds of silicone sockets and liners in the preparation of prostheses have changed the design of prostheses (fig. 5). Nowadays, a larger part of the amputation stump is in close contact with the prosthesis, thereby isolating the skin of the stump from the outer environment. Because of the inability of sweat to evaporate (decrease of transport of sweat) and the increased production of sweat because of the cooling reflex of the skin, this isolation will lead to stasis of sweat in the isolated area. As a consequence, hyperhidrosis (an unbalance between production and evacuation of sweat) will occur. Hyperhidrosis can worsen skin problems of the stump, or can be an initiating or supporting factor in the development of skin problems on amputation stumps as mentioned earlier.

Infections

Infections of the skin that occur on other parts of the body can also occur on the stump, such as folliculitis and furuncles. Most types of prostheses involve prolonged contact with the stump, or at least the distal part of the stump, thereby increasing the humidity of the stump socket environment and making it an excellent culture medium for microorganisms such as bacteria, yeasts and mycoses (fig. 6). Infections of the skin of the stump caused by microorganisms are therefore common, but are seldom described in detail in the literature as case reports.
Malignancies

Malignancies that are found on amputation stumps can be a recurrence of a malignancy that occurred earlier, or may develop from a (operation) scar of the stump. The development of malignancy out of already existing scars could be associated with the regenerating process of the scar. With the use of a prosthesis, irritation at the area of the scar may develop, possibly leading to chronic inflammation and consequently malignancy. Development of chronic inflammation into malignancy (Marjolin’s ulcer) may be increased when the prosthesis is not fitting well. Angiosarcoma is a malignancy that can develop in chronic oedematous stumps. When the oedema is the result of capillary proliferation, malignant development of this proliferation may occur. Table 3 presents a summary of the case reports of malignancies in lower limb amputees sorted by year of publication.

Ulcerations

Ulcerations of the amputation stump occur mainly because of friction between the stump and liner or socket. The development of an ulcer can start as an abrasion. The occurrence of ulcers on an amputation stump can be an indication of poor prosthesis fit. Some conditions such as an inadequate vascular system or diabetes mellitus may increase the chance of an ulcer. Chronic ulcerations can develop into malignancies. When ulcers are resistant to any therapy, the cause may be pyoderma gangrenosum or a mutation of factor V Leiden (one of the coagulation factors in human blood) and cryofibrinogenemia (cryofibrinogen is a precipitate formed in plasma of fibrin, fibrinogen and fibronectin by in vivo occlusion of small blood vessels).

Discussion

Case reports found in several medical databases were used to describe the rare skin problems that may occur on the stump in lower limb amputees. The choice was made to classify skin disorders by means of skin efflorescence and the cause of the skin problem. A
Changes in the field of prosthesiology have had an influence on the types and presentation of skin diseases in lower limb amputees as reflected by the case reports. The introduction of new materials and components in the construction of the prosthesis has given rise to new types of allergens (see Table 1). The interaction between the stump and the socket of the prosthesis has also changed. This change occurred by the introduction of new mechanics for suspension such as the suction socket prosthesis and the introduction of new materials such as silicones. As a result, there has been a change in the hypothesis or aetiology of certain problems of the skin of the amputation stump, for example in acroangiodermatitis (suction instead of chronic venous insufficiency as the cause) and verrucous hyperplasia (use of suction socket prosthesis and the occurrence of oedema and fluid stasis in the stump).

The use of case reports as a source to describe the skin problems in lower limb amputees has certain limitations. First, there is writing bias, in that when a disease is so common in daily clinical practice or extensively mentioned in text-books or taught through expert opinion, it may not be considered useful to write about it in a case report. Examples are the occurrence of furunculosis and folliculitis on the amputation stump. Second, there is publication bias by journals; the reviewers and the editor decide if a case report is suitable for publication or not in a certain journal. Third, there is selection bias while conducting a case studies. With the search strategy used we cannot be certain that every case report useful for this review was obtained. Nor is it certain if every case report ever published is searchable by using the available databases in the medical literature.

There are several reasons to write a case report. First, the condition (or rare disease) may not have been published before, and may be helpful in generating a hypothesis concerning the new disease. Second, the presentation of a rare disease may differ from previous reports, leading to a modulation of the existing hypothesis. Third, a new treatment may have been found for a certain disease, or an existing treatment modulated. Fourth, a case report may be written because of an unusual complication of a disease or therapy. All the case reports found and described in this review can be allotted to one of the above-mentioned categories.

Because of the existence of the various types of bias it is not possible to present a total overview of skin problems in lower limb amputees in this way. By using a search strategy that puts an emphasis on case reports, an overview is obtained of the mentioned skin problems (as in a rare problem published for the first time, or changes in hypothesis or aetiology) that have been published over the years, with regard to skin problems that are probably not reported by means of clinical narratives or expert opinions and that succeeded in evading the types of bias mentioned earlier.

**Conclusion**

The skin of the amputation stump in lower limb amputees is influenced by the use of a prosthesis. Several groups of skin problems may occur in these lower limb amputees. Changes in the field of prosthesiology have had an influence on the presentation and occurrence of skin problems in lower limb amputees.

**References**

Skin problems in lower limb amputees


