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Meulenbelt, HEJ; Dijkstra, PU; Jonkman, MF; Geertzen, JHB

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REVIEW

Skin problems in lower limb amputees: A systematic review

HENK E. J. MEULENBELT[1,2], PIETER U. DIJKSTRA[1,2,3], MARCEL F. JONKMAN[4] & JAN H. B. GEERTZEN[1,2]

[1]*Center for Rehabilitation,* [2]*Northern Center for Health Care Research,* [3]*Department of Oral and Maxillofacial Surgery, and* [4]*Department of Dermatology, University Medical Center Groningen, Groningen, The Netherlands*

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Abstract
Purpose. Skin problems of the stump in lower limb amputees are relative common in daily rehabilitation practice, possibly impeding prosthetic use. This impediment may have great impact in daily life. Our objective was to review literature systematically concerning incidence and prevalence of skin disorders of the stump in lower limb amputees.
Method. A literature search was performed in several medical databases (MEDLINE, CINAHL, EMBASE, RECAL) using database specific search strategies. Reference lists in the identified publications were used as threads for retrieving more publications missed in the searches. Only clinical studies and patient surveys were eligible for further assessment.
Results. 545 publications were initially found. After selection, 28 publications were assessed for research methodology. Only one publication fulfilled the selection criteria. The prevalence of skin problems in a series of 45 lower leg amputees of 65 years and older was 16%.
Conclusions. Prevalence and incidence of skin problems of the stump in lower limb amputees are mainly unknown.

Keywords: *Skin problems, lower limb amputees, review*

Introduction

Skin of the residual limb in lower limb amputees is exposed to several unnatural conditions. It is exposed to shear and stress forces during weight bearing, possibly leading to stump oedema, blisters, lichenification, verruciform hyperkeratosis, epidermoid cysts, acro-angiodermatitis, and skin carcinoma. Due to the close fitting and warmth of the socket of the prosthesis, the skin tends to perspire more than usual, and moreover the sweat cannot evaporate freely over a substantial area. Because of the increased humidity intertrigous dermatitis may occur, evoking infections with dermatophytes and yeasts of the groin and stump. In addition, bacterial infections occur, especially with *Staphylococcus aureus* leading to folliculitis, furunculosis (or boils), cellulitis, pyoderma, and hidradenitis. The hygiene of the prosthetic wearer, moisture and hairiness of the skin, and temperature of the environment influence development of infections. Ulcerations may become persistent, enhanced by poor nutritional skin status, vascular insufficiency, or localized pressure from a poorly fitting prosthesis. Sensitisation from chemical compounds of the socket or liner (a prefabricated sleeve made of silicone material, which is put around the amputation stump) may lead to allergic contact dermatitis. Irritant dermatitis and atopic eczema may also develop. Finally, pre-existent skin disorders (e.g., psoriasis or acne) may be elicited (Köbner phenomenon) by wearing a prosthesis. Many of the above-mentioned types of skin disorders in amputees have been reported by Levy [1 – 7].

To prevent skin problems several adaptations of sockets and liners have been developed. It was expected that skin problems would reduce with the introduction of the Icelandic Roll On Silicon Socket (ICEROSS), a silicon socket [8], due to improved fit, and less shear and stress forces; however, skin problems may also occur in lower limb amputees wearing an ICEROSS socket.

Correspondence: Henk E.J. Meulenbelt, M.D., Center for Rehabilitation, University Medical Center Groningen, University of Groningen, Hanzeplein 1, P.O. Box 30.001, 9700 RB Groningen, The Netherlands. Tel: 31 50 3613638. Fax: 31 50 3611708. E-mail: H.E.J.Meulenbelt@rev.umcg.nl

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Skin problems impede daily prosthetic use, and reduce mobility of the amputee, and jeopardise vocation. In literature, skin problems are frequently discussed but are scarcely investigated systematically. The impact of skin disorders on activities of daily life, vocation and leisure in lower limb amputees is unknown.

The aim of this systematic review is to analyse the literature with respect to incidence and prevalence of skin problems of the stump in lower limb amputees.

Materials and methods

In MEDLINE, EMBASE and CINAHL[1] a search was performed. The time period chosen was the first date possible for each database until December 2002. 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); and 'Limb prosthesis' (EMBASE). Free text words in the title and the abstracts used included 'amputation', 'stump', 'leg', 'tibia', 'femur', and 'skin'. To exclude publications concerning ankle amputations and foot amputations, the free text words 'foot' and 'ankle' were excluded. The search strategy is illustrated in Appendix 1. No language restrictions and no publication type restrictions were applied. Publications in a language not comprehended by one of the authors were analysed by rehabilitation experts with extensive knowledge of the language. An additional search was performed in RECAL[2], a database with specific interest in amputation and prosthetics. This database was searched using free text words 'Skin' and 'Amputation'. Excluded from this systematic review were publications not dealing with skin problems or not dealing with lower limb amputees. Publications were excluded on the basis of analysis of title and abstract. All included publications were retrieved from the library. Reference lists of the retrieved publications were screened for additional relevant publications not identified by the searches and a second selection was performed. Included were clinical studies and patient surveys reporting incidence and prevalence of skin problems. Excluded were case studies, (expert) reviews, and letters to the editor, as well as publications dealing with shear and stress forces, and other topics not relevant for this review.

The selected publications were assessed according to 13 criteria (Appendix 2): score '1' if the criterion was met and '0' if the criterion was not met. The sum score of each publication was calculated as the number of times a criterion was met, leading to a score ranging from 0 to 13. Two reviewers (HM, JG) independently assessed all publications selected. In a consensus meeting the scores of the two reviewers were compared. As a measure of interobserver agreement Cohen's Kappa was calculated. When there was disagreement in the assessment score, consensus was reached by means of discussion. In case of persistent disagreement a third reviewer (PD) gave the final judgement.

Publications were selected for detailed review if they fulfilled six major criteria: (1) report of inclusion criteria, (2) report of exclusion criteria, (3) report of assessment method, (4) actual investigation of skin problems by the observers or authors, (5) report of number or percentage patients with skin problems, (6) description of the population from which the study population was drawn.

Results

The literature searches yielded 545 publications. In the first selection, 469 publications were excluded, because they did not concern skin problems or lower limb amputees, leaving 76 publications. The screening of the reference lists of these 76 publications resulted in 42 additional publications (see Table I). From these 118 publications, 90 were excluded, because they were not clinical studies or surveys (see Table II). In total 28 publications were included for methodological assessment.

The interobserver agreement of the assessment expressed as Cohen's κ was 0.83.

The methodological sum scores of the 28 publications selected are presented in Figure 1. Mean sum score was 7.1 points (SD 1.8).

Results of the detailed review

One publication of 28 fulfilled the six major criteria (Appendix 2). Chan et al. performed a prospective study in an amputee clinic in Singapore. The study group were lower limb amputees of 65 years and older, who were referred for follow-up to the amputation clinic. The study was divided into a questionnaire, and a clinical examination. Total number of included persons was 47, whereas 45 were completely assessed. Amputation level was divided into below-knee ($n = 44$), and above knee ($n = 1$). Main outcome measure was the usage of the prosthesis, and independence measured in a frequency of usage, level of independence in self care, ability to return to work, and degree of dependence on their care giver. The occurrence of complications was assessed using the questionnaire, skin problems being one of them. In total, 16% of the assessed patients reported skin problems (three painful pressure ulcers, one painless pressure ulcer, and three painless skin abscesses) [9].

Table I. Source of identification of the publications and the number of publications, identified, excluded and included.

Source	Publications identified	Excluded after first selection	Included after first selection	Identified in reference lists	Excluded after second selection	Included after second selection
Medline	175	115	60	–	42	18
Embase	20	17	3	–	2	1
Cinahl	45	39	6	–	5	1
Recal	305	298	7	–	3	4
Reference lists	–	–	–	42	38	4
Total	545	469	76	42	90	28

First selection: Publications excluded per database because they did not concern skin problems or lower limb amputees. Reasons for exclusion are presented in Table II.

Table II. Reason for exclusion after second selection and number of publications excluded.

Reason for exclusion	*N*
Publication type	
Case reports	31
Reviews* dealing about skin problems	21
Letter to editor	1
Topic	
Shear/stress forces investigation	17
No skin problems	12
Upper extremity	4
Anatomy	2
Transplanted skin	2
Total	90

*Including expert opinions, clinical recommendations, narrative reviews.

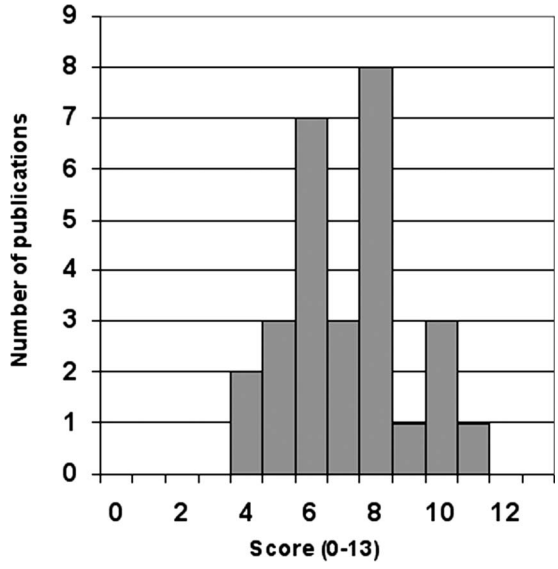

Figure 1. Sum scores of the methodological assessment ($n = 28$; Mean = 7.1; SD = 1.8).

In some publications, skin problems [10–13] or specific skin problems [14–16] were the subject. All these publications, except one [16] scored a mere four points (out of the six) in the final comparison using the six major criteria, demonstrating that the methodological quality of these publications is below our standards (see Figure 2).

Discussion

After systematic review of the literature for the incidence and prevalence of skin problems in lower limb amputees, only one publication was found to fulfil our quality criteria. The primary search listed 545 publications. It is clear that available study books and other types of publications have been missed. However, we believe that these sources usually transmit expert knowledge, mostly consisting of lists of possible skin disorders without stating frequencies. To make sure no publications were missed by using foot and ankle as free text words, the searches were performed again without excluding foot and ankle. No eligible publications were additionally found. In total, 28 publications were eligible for assessment on methodological criteria.

In the literature there are, as far as we know, no assessment criteria available for methodologically assessing publications concerning skin problems in lower limb amputees. We therefore selected assessment criteria ourselves. A division was made between major and minor criteria (Appendix 2). The first three major criteria are based on good research methodology. The criterion whether skin problems were actually investigated by the observers was added to identify possible information bias. The criterion whether the number or percentage of patients with skin problems was reported was added, because it was the topic of interest in this review. Finally, the criterion whether the population from which the study population was drawn was described was added to assess external validity. The minor criteria for methodological quality of the publications were applied, but we found these criteria less important. By using criteria, an adequate comparison of the selected publications was possible.

The mean quality of the selected publications was 7.1 on a 13-point scale. Finally one publication

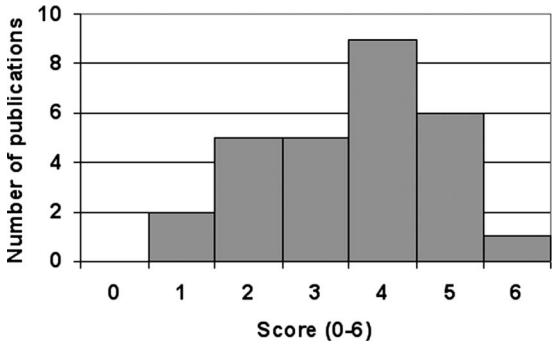

Figure 2. Score of the publications on the six criteria ($n = 28$; Mean = 3.5; SD = 1.3).

fulfilled the six major criteria. The publication concerns a population of amputees of 65 years and older of which 16% had skin problems [9]. Regarding the other publications, we found that the majority were not primarily studying skin problems. Fields of primary interest in these publications were: children [17], elderly [9,18], people using an ICEROSS [19–21], other types of component of a prosthesis [22,23], traumatic amputees [24–28], satisfaction or use of the prosthesis in a group of patients [29,30], and a clinic-orthopaedic evaluation of a group of male unilateral above-knee amputees [31].

Some intervention studies reported factors that may influence the chance of obtaining skin problems, i.e. bacterial flora [32,33], hygiene [34], perspiration [35], and the changing of the socket form to reduce perspiration [36]. But changes in prevalence of skin problems were not reported.

In this study, we were not interested in investigations describing the effect of shear/stress forces on skin disorders, since the studies did not use skin problems as main outcome parameter, and no causal relationship has been made between occurrence of shear/stress forces and the prevalence of skin problems. We also excluded these publications because there is no consensus that interaction between residual stump and prosthesis has an influence on clinical outcome [37].

We conclude that the best estimate of prevalence of skin problems was 16% in a population of elderly lower limb amputees in a single study.

The incidence and prevalence of skin problems in lower limb extremity amputees in general are poorly investigated, and are mainly unknown.

Notes

1. Winspirs version 5.0, Silverplatter International National Library of Medicine, Washington, DC, U.S.A.
2. University of Strathclyde, Glasgow, Scotland.

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Appendix 1

MesH headings, free text words, and combinations used in the literature search in MEDLINE, CINAHL, and EMBASE.

NR/#	MEDLINE	CINAHL	EMBASE
1	Amputation/all subheadings		
2	Amputation – stumps/all subheadings		
3	#1 or #2		
4	Amputation		
5	Stump		
6	#3 or #4 or #5		
7	Lower-extremity/all subheadings	Extremities/all subh	Leg/all subheadings
8	Leg		
9	Tibia		
10	Femur		
11	Foot		
12	Ankle		
13	#11 or #12		
14	#7 or #8 or #9 or #10		
15	#14 not #13		
16	#6 and #15		
17	Skin-diseases/all subheadings		Skin-disease
18	Skin		
19	#17 or #18		
20	#16 and #19		
21	Artificial-limbs/all subheadings	Limb-prosthesis	
22	#20 and #21		
23	#6 and #19 and #21		

Appendix 2

Methodological criteria used for assessment of the selected publications.

Major criteria:
01) Are inclusion criteria reported?
02) Are exclusion criteria reported?
03) Is the assessment method reported?
04) Are skin problems actually investigated by the observers?
05) Is number or percentage of patients with skin problems reported?
06) Is the population from which the study population was drawn described?

Minor criteria:
07) Is the design of the study prospective?
08) What's the number of included patients? (less or more than 50)
09) Are skin problems present specified?
10) Are number or percentage of patients with a lower limb amputation reported?
11) Are adequate descriptive statistics concerning gender reported?
12) Are adequate descriptive statistics concerning age reported?
13) Are adequate descriptive statistics concerning type and height of amputation reported?