Dermatological problems following spinal cord injury in Korean patients

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Objective: To identify dermatological conditions following spinal cord injury (SCI) and analyze these conditions in relation to various characteristics of SCI.

Design: Retrospective chart review.

Setting: National Health Insurance Corporation Ilsan Hospital of Korea, Rehabilitation Center, Spinal Cord Unit.

Participants: Patients treated for SCI who were referred to dermatology for dermatological problems, 2000–2012.

Results: Of the 1408 SCI patients treated at the spinal cord unit, 253 patients with SCI were identified to have been referred to dermatology for skin problems and a total of 335 dermatological conditions were diagnosed. The most common dermatological finding was infectious ($n = 123$, 36.7%) followed by eczematous lesions ($n = 109$, 32.5%). Among the infectious lesions, fungal infection ($n = 76$, 61.8%) was the most common, followed by bacterial ($n = 27$, 21.9%) lesions. Seborrheic dermatitis ($n = 59$, 64.1%) was the most frequent eczematous lesion. Ingrown toenail occurred more frequently in tetraplegics whereas vascular skin lesions occurred more commonly in patients with paraplegia ($P < 0.05$). Xerotic dermatitis showed a higher occurrence within 12 months of injury rather than thereafter ($P < 0.05$). Of these, 72.4% of the infectious and 94.7% of the fungal skin lesions manifested below the neurological level of injury (NLI; $P < 0.001$) and 61.5% of the eczematous lesions and 94.9% of seborrheic dermatitis cases occurred above the NLI ($P < 0.001$). There was no significant difference in dermatological diagnoses between patients with neurologically complete and incomplete SCI.

Conclusion: The most common dermatological condition in patients with SCI among those referred to dermatology was fungal infection, followed by seborrheic dermatitis. Although dermatological problems after SCI are not critical in SCI outcome, they negatively affect the quality of life. Patients and caregivers should be educated about appropriate skin care and routine dermatological examinations.

Keywords: Dermatology, Paraplegia, Skin disease, Spinal cord injury, Tetraplegia

Introduction

Central denervation after spinal cord injury (SCI) affects multiple systems both above and below the neurologic injury level (NLI) and is also thought to cause various changes in the microenvironment of the skin. Physiological changes due to autonomic dysfunction cause excessive sweating especially in patients with SCI with a level T6 and above and subsequently lead to skin disease.¹ Immune function deviation, as well as behavioral alterations in skin hygiene secondary to paralysis of the upper and lower extremities, all contribute to changes in skin integrity after SCI.¹

A few previous studies investigating the skin have been performed in patients with SCI. Stover *et al.*¹ performed a prospective study that examined the skin and nails after SCI and found clinical skin thickening and nail hypertrophy as the most frequent finding. Rubin-Asher *et al.*² prospectively studied acute traumatic SCI patients for new dermatological findings during their inpatient rehabilitation and concluded that local fungal infection below the neurological level was the most common dermatological disorder following acute SCI. Although not merely focused on patients with SCI, one study tried to identify and define the incidence and types of skin disorders in patients with hemiplegia and paraplegia and reported that dermatological disorders were more common than controls in these patient

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groups and that local fungal infection was the most common condition.³ However, despite these reports, an overall lack of information still remains and extensive analyses, as well as a comprehensive review of dermatological conditions occurring in patients with different SCI etiologies have not been made.

The present study attempted to understand more about dermatological findings in patients with both acute and chronic SCI and in patients with SCI with various etiological origins including trauma. In addition, we aimed to define these dermatological conditions in regard to the various neurological characteristics specific to patients with SCI.

Methods

Patients

We retrospectively reviewed the medical records of 1408 patients with SCI who were treated at the Rehabilitation Center of the National Health Insurance Corporation Ilsan Hospital (NHIC Ilsan Hospital) between March 2000 and March 2012 and identified 253 SCI patients who were referred to the dermatology department for skin lesions. All patients with SCI treated at our hospital were classified according to the international standards for neurological classification of SCI (ISNCSCI).^{4,5} The study received approval by the Institutional Review Board (IRB) of the NHIC Ilsan Hospital.

Clinical profiles

The demographic characteristics (age, sex, etiology of SCI, time since trauma, onset of skin lesion, completeness of injury, NLI) and various clinical parameters at the time of dermatology referral were recorded. The neurological level of injury (NLI) and the neurologic completeness were all determined using the guidelines of the ISNCSCI.

Dermatological diagnoses made by board-certified dermatologists were recorded. All lesions were categorized into the following subgroups: infection, eczema, immune mediated, acne vulgaris, urticaria, alopecia, ingrown toenail, vascular related, and miscellaneous. Location of the skin lesion in relation to the NLI was also recorded.

Dermatological diagnoses were analyzed according to neurologic completeness, extent of paralysis (paraplegia vs. tetraplegia), NLI, and time since SCI. Statistical analysis for qualitative differences between the above and below NLI groups was performed twice in the following manner. (1) Simultaneously occurring lesions were excluded in the analysis and qualitative differences were analyzed between the above and below NLI groups. (2) Lesions that occurred simultaneously were individually counted and included in both the above NLI and

below NLI groups and statistical analysis was made thereafter. Statistical significance was accepted when both the analysis resulted in a P-value <0.05.

Statistical analysis

Qualitative differences between groups were analyzed by the chi-square test and Fisher's exact test. $P < 0.05$ was considered to be statistically significant. The SPSS for Windows, version 19.0 (SPSS, IBM Corp., Armonk, NY, USA), software package was used for statistical analysis.

Results

A total of 1408 patients with SCI received treatment at our rehabilitation center between 3 March 2000 and 3 March 2012. In all, 1041 (73.9%) were male, 367 (26.1%) were female, 857 (60.9%) has tetraplegia and 551 (39.1%) had paraplegia. Among the patients, 253 (17.9%) were referred to the dermatology department and of these patients, 199 (78.7%) were male, 54 (21.3%) were female, 160 (63.2%) had tetraplegia, and 93 (36.8%) had paraplegia. Of these patients, 121 (47.8%) were neurologically complete and 132 (52.2%) incomplete. Mean age was 43.7 ± 15.9 years and trauma ($n = 220$, 87.0%) was the most common etiology of SCI.

Of the patients referred to dermatology, a total of 335 dermatological conditions were diagnosed. The dermatological findings appeared on an average of 406.1 ± 561.3 days with 31.0% ($n = 104$) occurring within 6 months, 34.6% ($n = 116$) occurring between 6 and 12 months, and 34.3% ($n = 115$) occurring after 6 months of injury.

Among the dermatological findings, 123 (36.7%) were infectious and 109 (32.5%) eczematous lesions. A total of 32 (9.6%) conditions were acne vulgaris, 25 (7.5%) ingrown toenail, 11 (3.3%) immune-mediated lesions, and 10 (3.0%) were urticaria. Among the infectious lesions, fungal infection ($n = 76$, 61.8%) was the most common, followed by bacterial ($n = 27$, 21.9%) and viral ($n = 20$, 16.3%) lesions (Table 1).

Vascular skin lesions ($n = 6$, 1.8%) included a single case of facial flushing and five cases of petechia.

Miscellaneous skin lesions included three cases of milia, two cases of rosacea and hyperpigmentation, and single cases of lichen simplex chronicus, keratolysis exfoliation, toenail dystrophy, cystic mass, granuloma pyogenica, telogen effluvium, abrasion, and keloid scar.

Dermatological conditions in relation to neurologic completeness were analyzed. Among the 335 dermatological findings, 49.9% ($n = 167$) of the conditions were diagnosed in the neurologically complete group and 168 (50.1%) in the patients with neurologically incomplete SCI. However, there was no significant difference in occurrence of infectious skin lesions, eczematous lesions, acne

Table 1 Dermatological findings

Dermatological conditions	n	%
Total number	335	
Infectious skin lesions	123	36.7
Fungal infection	76	61.8
Bacterial infection	27	21.9
Viral infection	20	16.3
Eczema	109	32.5
Seborrheic dermatitis	59	54.1
Contact dermatitis	21	19.3
Xerotic dermatitis	9	8.3
Non-specific dermatitis	20	18.3
Immune-mediated skin lesions	11	3.3
Erythema multiforme	5	45.4
Psoriasis	3	27.3
Vasculitis	2	18.2
Scleroderma	1	9.1
Acne vulgaris	32	9.6
Urticaria	10	3.0
Allopecia	4	1.2
Ingrown toenail	25	7.5
Vascular skin lesion	6	1.8
Miscellaneous	15	4.5

vulgaris, immune-mediated skin lesions, urticaria, vascular skin lesions, alopecia, or ingrown toenails between the two groups. All five cases of erythema multiforme occurred in the neurologically complete SCI group ($P < 0.05$).

Dermatological conditions were analyzed between the tetraplegic and paraplegic groups. A total of 216 (64.5%) of the skin lesions occurred in the tetraplegic and 119 (35.5%) in the patients with paraplegia. Statistical differences between the tetraplegic and paraplegic groups were only seen between vascular and ingrown toenails lesions. Among the six vascular skin lesions, the single case of simple facial flushing (16.7%) not associated with autonomic dysreflexia was diagnosed in the tetraplegic group and all five (83.3%) cases of petechia in the paraplegic group. Vascular skin lesions occurred more frequently in the paraplegic group with a significant difference ($P < 0.05$). Of the 25 cases of ingrown toenail, 21 (84.0%) occurred in the tetraplegic and 4 (16.0%) occurred in the paraplegic group and such differences were significant ($P < 0.05$).

Dermatological conditions were analyzed according to time appearance of skin lesions 12 months before and after SCI. Of the 20 viral skin lesions, 8 (40%) occurred before 12 months post-injury and 12 (60%) after 12 months post-injury ($P < 0.05$). All nine (100.0%) cases of xerotic dermatitis occurred within 12 months of injury and these findings were significant ($P < 0.05$). All other skin lesions showed no statistical difference in frequency between 12 months pre- and post-injury.

Dermatological conditions were analyzed in relation to their occurrence above or below the NLI. A total of 144 (43.0%) lesions occurred above the NLI, 176

(52.5%) below the NLI, and 13 (3.9%) simultaneously. In all, 72.4% ($n = 89$) of the infectious skin lesions occurred below the NLI and 27.6% ($n = 34$) above the NLI ($P < 0.001$). Of the 76 fungal skin lesions, 94.7% ($n = 72$) were observed below the NLI and only 5.3% ($n = 4$) were detected above the NLI ($P < 0.001$). A higher percentage of the bacterial infections occurred above ($n = 19$, 70.4%) vs. below the NLI ($n = 8$, 29.6%) ($P < 0.001$). A total of 67 (61.5%) of the 109 eczematous lesions occurred above the NLI whereas 37 (33.9%) occurred below the NLI ($P < 0.001$). Seborrheic dermatitis developed more frequently above the NLI ($n = 56$, 94.9%) rather than below the NLI ($n = 2$, 3.4%) ($P < 0.001$).

All nine (100.0%) cases of xerotic dermatitis manifested below the NLI ($P < 0.001$). Thirty (93.8%) of the 32 acne vulgaris cases developed above the NLI vs. 1 (3.1%) occurring below the NLI ($P < 0.001$). Although not statistically significant, all cases of petechia ($n = 5$) and hyperkeratotic lesions ($n = 3$), including lichen simplex chronicus, keratolysis exfoliation, and toenail dystrophy, appeared below the NLI.

Discussion

Dermatological findings after SCI have been rarely investigated in the literature. In 1994 Stover *et al.*¹ prospectively examined the skin and nails after SCI and reported high incidences of skin thickening and nail hypertrophy. According to Rubin-Asher *et al.*² local fungal infections below the neurological level was the most common dermatological disorder following acute traumatic SCI and concluded that dermatological findings are common during the rehabilitation period of acute SCI. Fungal skin infections were also common findings in a study examining skin disorders in hemiplegic and paraplegic patients.³

Immunological changes begin soon after SCI and are maintained thereafter.^{6,7} The sympathetic nervous system is a known modulator of immune function and thus dysregulation of sympathetic outflow, which is common in patients with SCI, may be associated with high incidences of infection in this patient group. Decentralization of the autonomic nervous system has been reported to be associated with decreased natural-killer cell function, retardation of T cell activation and function, and alteration in macrophage phagocytosis.^{7,8} Reductions in cellular adhesion molecules and surface markers on both lymphocytes and granulocytes, as well as declines in IL-2 and IL-1 levels have also been implicated as a consequence of immune dysfunction after denervation.^{8,9} Taken together, it is not surprising that infection was the most common dermatological

condition in our study and that a statistically higher frequency of infectious skin lesions were detected below the NLI. Although not statistically significant, a higher percentage of infectious lesions were found in the tetraplegic rather than paraplegic group and these findings may be explained by the increased incidence of autonomic dysfunction in patients with tetraplegia.

Fungal infection was the most common infectious skin lesion in the present study and a significantly large number of fungal infections occurred below the NLI. Immune dysfunction as well as a reduced ability to properly dry the skin may have predisposed patients with SCI to local fungal infections.¹⁰ A higher occurrence below the NLI may be due to inadequate airing and increased humidity of skin below the NLI in comparison with the skin above the NLI. Furthermore, among the 76 cases of fungal infection, 69 (90.7%) occurred in either the perineal/groin or foot/toenail region. These findings may be secondary to uncontrolled urination and bowel movements in patients with SCI and may also reflect behavioral changes regarding skin hygiene and the inadequacy of maintaining adequate skin hygiene in the feet and perineal regions.

Eczematous lesions and acne vulgaris were more frequent above the NLI and these findings may be secondary to general skin hygiene or due to alterations in eccrine and sebaceous gland function after SCI.^{11–15} James *et al.* reported that sweat glands below the NLI were less sensitive to cholinergic activation and thus showed a decreased ability to produce sweat.¹² In contrast, sweat glands above the lesion showed a compensatory increase in activity and consequently produced more sweat when exposed to physical training and physiologic stress.¹² These findings of increased sweating above the NLI as well as the inadequacy of hair and facial cleansing may be related to the increased episodes of acne vulgaris and seborrheic dermatitis above the NLI. Although not statistically significant, seborrheic dermatitis and acne vulgaris showed a higher incidence in patients with tetraplegia. This may be caused by a tendency of reduced hygiene in patients with tetraplegia due to their relatively extensive motor weakness when compared to those with paraplegia. The significantly higher occurrence of bacterial skin infection above the NLI may be due to the differences in sweat production according to the NLI.

Xerotic dermatitis showed meaningfully higher frequencies below the NLI and also within 1 year post-SCI. One previous study reported on an increased incidence of xerosis in hemiplegic and paraplegic patients and attributed these findings to a possible reduction in cutaneous blood flow and nutritional deficiencies.^{1,3,16} Decreased eccrine function below the NLI may contribute to skin dryness and increased xerotic dermatitis below the

NLI. Furthermore, moisturization of the skin may not be a priority during the acute and subacute period post-SCI, further contributing to skin dryness and heightened risk for xerotic dermatitis in the early periods post-SCI.

Ingrown toenails were more common in patients with tetraplegia in the present study. Jaffray *et al.* suggested that the combination of brittle nails, gravitational edema on atrophic skin and subsequent obliteration of nail angle, and strong toe flexor spasticity may be predisposing factors of ingrown toenails.^{17,18} However the reason for the increased frequency of ingrown toenails in patients with tetraplegia still needs more investigation.

Previous studies have demonstrated dermal fibrosis of the skin and a high incidence of skin thickening and nail hypertrophy after SCI.^{18,19} Nevertheless, in our study one case of toenail dystrophy, and two cases of hyperkeratotic lesions including lichen simplex chronicus and keratolysis exfoliation were reported. This discrepancy may most likely be due to bias created by data analysis of only patients referred to the dermatology department and subsequent under-reporting of these common abnormalities. However, these findings are also meaningful in that skin thickening and dermal fibrosis, although histopathologically important, may not have been troublesome or distressing enough to the patients to necessitate dermatology referral.

There was no statistically significant difference in dermatological findings in the present study in relation to neurologic completeness. This may imply that denervation itself may be the bigger problem rather than the extent of neurologic injury. However, further studies must be made for confirmation.

The results of this study highlight the importance of appropriate skin care and routine dermatological examinations. Although daily bathing and hair washing may not be a priority for both the care giver and the patient, these routines may be crucial in preventing dermatological complications in the patient with paralyzing SCI. Keeping the groin area clean and drying off thoroughly after bathing, as well as wearing loose cotton underwear are additional factors to consider during skin management after SCI.²⁰ Infectious skin lesions destroy natural skin resilience and thus may increase incidences of pressure ulcers in the perineal, coccygeal, and sacral areas. Not only pressure relief but personal hygiene must be stressed considering the detrimental effects of pressure sores in the active acute rehabilitation stages.

The retrospective nature of this study, lack of a control group, and data analysis of only those referred to the dermatology department are limitations of this study. However, our study analyzed a large number of subjects. Furthermore, the fact that referrals were made to

dermatology may suggest that the dermatological conditions investigated in our study may have been distressing, extensive, and thus more clinically important to the patients with SCI than other dermatological problems.

Conclusion

In conclusion, the most common dermatological conditions in patients with SCI among those referred to the dermatology department was infection, with fungal infection being the most frequent. In relation to extent of injury, a more frequent occurrence of ingrown toenail was found in tetraplegics whereas vascular skin lesions occurred more commonly in paraplegics. Analysis according to NLI resulted in a higher frequency of bacterial skin lesions, seborrheic dermatitis, and acne vulgaris above the NLI whereas fungal skin lesions and xerotic dermatitis were more common below the NLI. When comparing between dermatological diagnoses according to time since injury, xerotic dermatitis showed a higher frequency within 12 months of injury. There was no significant difference in dermatological diagnoses between patients with neurologically complete and incomplete SCI.

Although dermatological problems after SCI are not critical in SCI outcome, they negatively affect the quality of life in these patients. Patients and caregivers should be educated about appropriate skin care and routine dermatological examinations should be performed to prevent these complications. Medical and nursing staff specializing in patients with SCI should also be aware of common skin diseases that manifest in patients with SCI and make efforts to prevent their occurrence. Physicians treating patients with SCI should familiarize themselves in the diagnosis and treatment of simple and commonly occurring skin diseases, as well as make prompt referrals to dermatologists during difficult cases to improve outcome and prevent related complications. Further enlarged and prospective studies of dermatological conditions in SCI patients are needed to better assess the nature of skin disorders in these patients.

Disclaimer statements

Contributors All authors cited have made substantial contribution to the concept, design, acquisition and analysis of the data and have revised it critically for important intellectual content. All the authors have seen the final manuscript and approved to submit this manuscript and to give necessary attention to ensure the integrity of the work.

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Conflicts of interest None.

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References

- 1 Stover SL, Hale AM, Buell AB. Skin complications other than pressure ulcers following spinal cord injury. *Arch Phys Med Rehabil* 1994;75(9):987-93.
- 2 Rubin-Asher D, Zeilig G, Klieger M, Adunsky A, Weingarden H. Dermatological findings following acute traumatic spinal cord injury. *Spinal Cord* 2005;43(3):175-8.
- 3 Gül U, Cakmak SK, Ozel S, Bingöl P, Kaya K. Skin disorders in patients with hemiplegia and paraplegia. *J Rehabil Med* 2009; 41(8):681-3.
- 4 Kirshblum SC, Burns SP, Biering-Sorensen F, Donovan W, Graves DE, Jha A, *et al.* International standards for neurological classification of spinal cord injury (Revised 2011). *J Spinal Cord Med* 2011;34(6):535-46.
- 5 Marino R. Neurological assessment of spinal cord dysfunction. In: Lin V, *et al.* (eds.) *Spinal cord medicine: principles and practice*. 2nd ed. New York: Demos Medical; 2010. p. 85-91.
- 6 Nash MS. Known and plausible modulators of depressed immune functions following spinal cord injuries. *J Spinal Cord Med* 2000; 23(2):111-20.
- 7 Frost F, Pien L. The immune system and inflammatory response in persons with spinal cord injury. In: Lin V, *et al.* (eds.) *Spinal cord medicine: principles and practice*. 2nd ed. New York: Demos Medical; 2010. p. 270-6.
- 8 Campagnolo DI, Bartlett JA, Keller SE. Influence of neurological level on immune function following spinal cord injury: a review. *J Spinal Cord Med* 2000;23(2):121-8.
- 9 Stover SL, Brunnemann SR. Circulating levels of soluble interleukin-2 receptors are elevated in the sera of humans with spinal cord injury. *J Am Paraplegia Soc* 1992;16(1):30-3.
- 10 Sobera JO, Elewski BE. Fungal diseases. In: Bologna JL, *et al.* (eds.) *Dermatology*. 2nd ed. Vol. 1. New York: Mosby; 2008. p. 1135-64.
- 11 Thomas SE, Conway J, Ebling FJ, Harrington CI. Measurement of sebum secretion rate and skin temperature above and below the neurological lesion in paraplegic patients. *Br J Dermatol* 1985;112(5):569-73.
- 12 Yaggie JA, Niemi TJ, Buono MJ. Adaptive sweat gland response after spinal cord injury. *Arch Phys Med Rehabil* 2002; 83(6):802-5.
- 13 Mallory B. Autonomic dysfunction in spinal cord disease. In: Lin V, *et al.* (eds.) *Spinal cord medicine: principles and practice*. 2nd ed. New York: Demos Medical; 2010. p. 561-3.
- 14 Thomas SE, Conway J, Ebling FJ, Harrington CI. Measurement of sebum excretion rate and skin temperature above and below the neurological lesion in paraplegic patients. *Br J Dermatol* 1985;112(5):569-73.
- 15 Schaller M, Plewig G. Structure and function of eccrine, apocrine, apoeccrine and sebaceous glands. In: Bologna JL, *et al.* (eds.) *Dermatology*. 2nd ed. Vol. 1. New York: Mosby; 2008. p. 489-94.
- 16 Adams WC, Imms FJ. Resting blood flow in the paretic and non-paretic lower legs of hemiplegic persons: relation to local skin temperature. *Arch Phys Med Rehabil* 1983;64(9):423-8.
- 17 Jaffray D, El Masri W. Ingrowing toenails and tetraplegia. *Paraplegia* 1985;23(3):176-81.
- 18 Tosti A, Piraccini BM. Nail disorders. In: Bologna JL, *et al.* (eds.) *Dermatology*. 2nd ed. Vol. 1. New York: Mosby; 2008. p. 1032.
- 19 Stover SL, Omura EF, Buell AB. Clinical skin thickening following spinal cord injury studied by histopathology. *J Am Paraplegia Soc* 1994;17(2):44-9.
- 20 Gupta AK, Chaudhry M, Elewski B. Tinea corporis, tinea cruris, tinea nigra, and piedra. *Dermatol Clin* 2003;21(3):395-400.