

Clinical Burden of Primarily Misdiagnosed *Tinea capitis*: A Comparative Statistical Analysis

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= Abstract =

Background: Tinea capitis has been recognized as the most commonly misdiagnosed scalp disease. Inappropriate medication and delayed intervention leads to a broad array of complications from prolongation of treatment to scarring of the scalp. The financial deficits and problems imparted on patients continue to be a clinical and social burden.

Objective: The clinical and financial aspects between the initially misdiagnosed group and the properly diagnosed group were analyzed, to provide the epidemiologic basis and to address improvements for misdiagnoses of tinea capitis.

Methods: A retrospective review of electronic and written chart was performed on all patients diagnosed of tinea capitis at Daegu Catholic University Medical Center (DCUMC) from January 2006 to June 2016. A total of 100 patients were included in the study and an initially misdiagnosed group and initially diagnosed group were evaluated.

Results: Significant differences between the groups were not observed in variables including age, sex and occupation. The highest diagnostic precision was observed in dermatologists (78.4%) by using standard microscopic (31.0%) and culture studies (13.0%). Misdiagnosis rate was highest in pediatrics (34.9%) and erroneous examination such as laboratory test (48.4%) and Gram stain (19.4%) were countered in the misdiagnosed group. Additional clinic visits, prescriptions and extra trips to clinics resulted financial disadvantage in the misdiagnosed group.

Conclusion: The misdiagnosed tinea capitis was found to arise from unawareness of the disease that leads to inappropriate approach and medication prescription. The duration, complications and financial loss were reported to be higher in misdiagnosed group based on the study.

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Key Words: Comparative analysis, Misdiagnosis, Scalp disease, Tinea capitis

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INTRODUCTION

Tinea capitis (TC) is defined as superficial fungal infection of the scalp and still presents with a high incidence, which poses a public health concern around the world¹. Effective control was brought in industrialized countries after introduction of griseofulvin while other third world regions still remain endemic². Initial stages of the infection is usually asymptomatic, however it can easily spread and present in various clinical forms. Ranging from asymptomatic carrier state to inflammatory favus, the differential diagnoses encompass seborrheic dermatitis, atopic dermatitis, psoriasis vulgaris, alopecia areata, furunculosis, and trichotillomania³. Especially, an inflammatory type otherwise known as kerion usually establishes a pustular mass⁴. A combination of lymph node enlargement and fever may lead to the presumption of bacterial infections and treatment with antibiotics is likely administered⁵. Moreover TC has been recognized as the most commonly misdiagnosed scalp diseases referred to a tertiary hospital and concurrent diagnostic challenge result in irreversible complications and prolong unnecessary hospitalization⁶. In Korea, the majority of patients with TC are less than 15 years of age and patients seek medical treatment from clinicians often unwary of dermatophytosis⁷. Predictive symptoms and signs in diagnosing TC should be done by adequate modalities such as potassium hydroxide mount with culture for accurate diagnosis in order to limit financial and clinical burden of the disease. In the present study, the clinical aspects between the initially misdiagnosed group and the properly diagnosed group were analyzed, to provide the epidemiologic basis and to address improvements for further limiting diagnostic difficulties.

MATERIALS AND METHODS

1. Data collection

A retrospective review of electronic and written chart was performed on all patients diagnosed of TC at Daegu Catholic University Medical Center (DCUMC) from January 2006 to June 2016. The following data retrieved from the medical record include admission note, progress note, diagnostic measures and treatment options before and during visits at DCUMC, laboratory results along with basic vital signs. The result of following test methods evaluated in the studies include potassium hydroxide preparation, fungal culture, Grams swab stain, blood culture, trichogram, woods lamp examination, and skin biopsy. Subjects with indefinite history of their primary diagnoses were excluded in the study. A total of 100 patients were gathered under the stated inclusion criteria. The patients were divided into two groups upon whether TC was primarily misdiagnosed or primarily diagnosed and subsequent clinical manifestation, diagnostic measures, complications and treatment duration were analyzed between the two groups.

2. Statistical analysis

All data was gathered and was encoded in numerical values. Frequency and inclination were evaluated with descriptive and multiple response analyses. The variables in continual forms were evaluated with two-sample *t*-test. The descriptive data are expressed in percentage and mean \pm standard deviation. All analysis was performed using SPSS 19.0 version (SPSS, INC®, Chicago, USA) with a *p*-value of less than 0.05 as statistically significant value.

RESULTS

1. Demographic study

The selected subject groups compliant with the inclusion criteria were a total of 100 patients and 37 were diagnosed of TC on their first visits while remaining 63 were misdiagnosed as other disease entity. The correctly diagnosed group was referred as group 1 and the misdiagnosed group was referred as group 2. For the demographic study, sex, age, route of medical visit, region, occupation and past medical history were evaluated. Regarding the sex, both groups 1 and group 2 displayed similar compositions where female was more dominant. The age ranged from 0 to 89 years with the mean age of 35.84 in group 1, and similarly the age ranged from 0 to 83 years with the mean age of 29.89 in group 2. Outpatient visits were more dominant in both groups and regional variance also showed similar results with slight dominance in urban areas. As for the occupation, unemployed patients were dominant in both groups followed by housewife, farmer, student, office staff, sales clerk, athlete in group 1 and student, housewife, farmer, office staff, sales clerk in group 2 (Table 1).

2. Comparative frequency analysis

Comparative frequencies of the following variables were measured: initial visited consultant type, symptoms, diagnostic methods, complications, treatment choices. Additionally, duration of treatment was also evaluated between two groups by using two sample *t*-test. Primarily correct diagnoses were mostly achieved by dermatologist, followed by pediatrician, internists, general practitioners, and lastly emergency medical doctor. Misdiagnosis was most prevalent in pediatricians, followed by dermatologists, urologists, internists, general practitioners

and lastly by emergency medical doctors (Fig. 1). Presented symptoms between two groups showed similar results as pruritus was the most common symptom presented by patients in both groups followed by scales, pustules, papules, nodules, hair loss and excoriations. Varying degree of cutaneous lesions including alopecia dominant presentation, pustular inflammatory ulcerative presentation and seborrheic scaly presentation ranged among different patients (Fig. 2A-I). However, in group 1, seborrhea and other symptoms including gastrointestinal trouble were also noticed while ulcer was more presented in group 2. Complication was also more noticeable in group 2. Among 67 patients 61 cases of complication was reported and scar was the most common form. Treatment choices were significantly different between group 1 and group 2. In group 1, initial treatment modalities were based on targeting antifungal effects. The highest prescribed medication was griseofulvin, followed by topical isoconazole, oral terbinafine and oral itraconazole. Antibiotics was more prevalently prescribed in group 2 as the major prescribed drug was third generation cephalosporin with counting up to 25% of all prescription followed by first generation cephalosporin, topical mupirocin, and topical isoconazole. First generation H1 antihistamine was both counting up to 12.6% and 27.5% prescribed respectively in groups 1 and 2. In consideration of various factors, the duration of the illness was measured between the two groups. The mean days of contraction for group 1 was, on average, 34 days compared to 65 days in group (Table 2).

3. Compensatory analysis of misdiagnosed group

The frequency regarding misdiagnosed group was separately measured to calculate the days, visited specialties, diagnostic methods and estimated

Table 1. Demographic evaluation between group 1 and group 2

Variable	Group 1 *	Group 2 †
Sex: frequency (%)	Male: 16 (43.2) Female: 21 (56.8)	Male: 29 (46.0) Female: 34 (54.0)
0~10	13 (3.69)	28 (4.25)
11~20	2 (16.50)	6 (15.33)
21~30	5 (28.20)	0 (-)
31~40	1 (39.00)	7 (36.00)
Age: frequency (mean)	41~50 51~60 61~70 71~80 81~90	3 (45.67) 2 (57.50) 5 (67.40) 4 (76.25) 2 (85.50)
Overall	37 (35.84)	63 (29.89)
Route of visit: frequency (%)	Outpatient: 36 (97.3) Inpatient: 1 (2.7)	Outpatient: 60 (95.2) Inpatient: 3 (4.8)
Occupation (%)	Unemployed (45.9) Housewife (16.2) Student (10.8) Farmer (10.8) Office worker (8.1) Salesclerk (5.4) Athlete (2.7)	Unemployed (52.4) Student (14.3) Farmer (12.7) Housewife (9.5) Office worker (9.5) Salesclerk (1.6)
Region: frequency (%)	Rural: 22 (59.5) Urban: 15 (40.5)	Rural: 34 (54.0) Urban: 29 (46.0)
Past Medical History (%)	Allergic rhinitis (25.6) Liver disease (12.8) Hypertension (10.3) Tuberculosis (7.7) Cerebrovascular disease (5.1) Abnormal thyroid function (5.1) Diabetes mellitus (2.6) None (30.8)	Allergic rhinitis (20.0) Hypertension (14.5) Diabetes mellitus (10.9) Abnormal thyroid function (9.1) Tuberculosis (3.6) Liver disease (3.6) Cerebrovascular disease (1.8) None (36.4)

*Group 1: Initially correctly diagnosed group, †Group 2: Initially misdiagnosed group

financial deficits required to a correct diagnosis. The average time for misdiagnosed group to achieve a correct diagnosis was 64 days. Dermatologist was the most commonly visited specialist to sign out proper diagnosis followed by general practitioners, pediatricians, and urologists. For the diagnosis, hair

plucking tests was most commonly performed followed by potassium hydroxide preparation, skin biopsy, and Gram swab culture. The estimated financial loss included the extra visits to local medical clinics, tertiary based hospitals, additional fee for medication, and management for complication. In

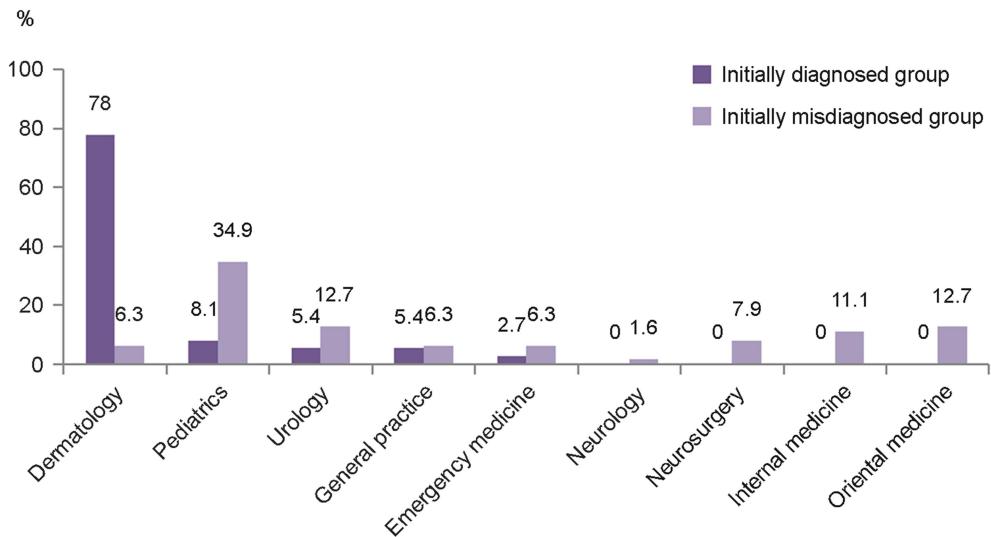


Fig. 1. Percentage distribution of diagnosed group and misdiagnosed group by initially visited departments

In the present study, the misdiagnosed group was visited on average of 3.4 local clinics and 1.7 tertiary based hospitals before coming to DCUMC for the correct diagnosis. On average of 2.5 prescriptions were given to these patients and each patient had made 7.2 trips on average before achieving the right diagnoses.

DISCUSSION

TC is the most common form of scalp disease misdiagnosed by clinicians and a highly inflammatory type may confound medical practitioners unfamiliar with the disease¹⁻⁶. Treatment with antibiotics frequently occurs and may account for unnecessary costs and morbidity⁸. TC presents in a number of specific patterns including diffuse scale type, black dotted type, discrete areas of pustules with excoriation and lastly kerion, which is an isolated inflammatory lesion⁹. Each pattern must list a differential diagnosis encompassing sebor-

rheic dermatitis, psoriasis vulgaris, alopecia, furunculosis, and trichotillomania³. The level of host immunity and the type of fungal organism involved with the disease can lead to inflammatory type of tinea capitis which is highly confounding with symptoms that of bacterial infection¹⁰⁻¹². Although numerous case studies and reports regarding the misdiagnosis have been reported no clinical survey of multi-centered study regarding the rate or burden of misdiagnosis has been evaluated. In the present study, a retrospective analysis between the correctly diagnosed group (group 1) and initially misdiagnosed group (group 2) were compared to evaluate various clinical aspects with the following burden created from the difference.

1. Demographic analysis

The demographic study revealed that TC was most commonly misdiagnosed in children. As the most common age group of TC occurs in children, definitive number also outnumbers rest of the popu-



Fig. 2. Various clinical presentations of tinea capitis. **(A)** Alopecia concomitant with erythematous pustules and surrounding scale in a 8 year old female. **(B)** Alopecia associated with flakes and scales in a 47 year old male. **(C)** Alopecia associated with follicular accentuated hypertrophic scars and erythematous base in a 52 year old male. Peripheral scaling and pustules are pronounced. **(D)** 2×2 cm sized roundish ulcerative lesion was consistent with fungal infection presented in a 36 year old male. **(E)** Oozing natured ulcerative nodular plaques combined with pustules, pus, and scales were noticeable in a 61 year old male. **(F)** 7×5 cm sized oval-shaped oozing natured ulcer was presented with peripheral crusts, pus and scales in a 12 year old male. **(G)** Hyperkeratotic linearly arranged crusted plaques on frontal scalp in a 6 year old male. **(H)** Friable hair and scales presumptuous of seborrheic dermatitis presented in a 44 year old female. **(I)** Erythematous hyperkeratotic plaques with whitish scales on scalp in a 57 year old female.

lation. The mean age and the percentage of the misdiagnosed group under 18 years of age was 5.82 and 63.29%, respectively. It was found that most of pediatric patients seek management initially from

pediatricians and the highest misdiagnosed group of specialty was pediatrics with over 34.9% of all misdiagnosed cases. This was similar with group 1, where only 8% of the cases were correctly diag-

Table 2. Frequency table of clinical variables

Initially visited department (%)		Clinical presentation (%)	
Group 1*	Group 2†	Group 1*	Group 2†
Dermatology (78.4)	Pediatrics (34.9)	Pruritus (22.7)	Pruritus (19.6)
Pediatrics (8.1)	Urology (12.7)	Scale (21.6)	Hair loss (15.8)
Urology (5.4)	Oriental clinic (12.7)	Papule (15.5)	Pustule (13.3)
General practice (5.4)	Internal Medicine (11.1)	Pustule (13.4)	Nodule (13.3)
Emergency Medicine (2.7)	Neurosurgery (7.9)	Hair loss (8.2)	Papule (12.7)
Obstetrics/Gynecology (0.0)	Emergency Medicine (6.3)	Nodule (7.2)	Scale (12.0)
Neurology (0.0)	Dermatology (6.3)	Excoriation (5.2)	Pus (6.3)
Neurosurgery (0.0)	Obstetrics/Gynecology (3.2)	Pus (3.2)	Ulcer (5.1)
Internal Medicine (0.0)	General practice (3.2)	Seborrhea (1.0)	Seborrhea (1.3)
Oriental clinic (0.0)	Neurology (1.6)		Excoriation (0.6)
Diagnostic methods (%)		Prescribed medication (%)	
Group 1*	Group 2†	Group 1*	Group 2†
KOH‡ (32.0)	Laboratory (48.4)	Griseofulvin (17.9)	1G§H1 Antihistamine (27.5)
Gram stain (16.0)	Gram stain (19.8)	Topical isoconazole (15.8)	3G§ cephalosporin (25.0)
Fungal culture (13.0)	Swab culture (12.1)	1G§H1 Antihistamine (12.6)	Topical isoconazole (10.0)
Skin biopsy (14.7)	KOH‡ (8.8)	Oral Terbinafine (11.6)	Ampicilin (7.5)
Pull test (9.3)	Pull test (5.5)	2G§H1 Antihistamine (9.5)	2G§H1 Antihistamine (6.3)
Wood's lamp (6.7)	Skin biopsy (2.2)	Oral itraconazole (8.4)	Topical mupirocin (5.0)
Blood culture (4.0)	Blood culture (2.2)	Fluconazole (7.4)	Griseofulvin (3.8)
Laboratory (4.0)	Wood lamp (1.1)	Ampicilin (5.3)	Ciprofloxacin (3.8)
Folliscope (1.3)	Folliscope (1.2)	Topical mupirocin (4.2)	Fluconazole (3.8)
		3G§ cephalosporin (4.2)	Oral Terbinafine (3.8)
		1G§ cephalosporin (3.2)	Oral itraconazole (2.5)
			Monobactam (1.3)
Complication (%)		Treatment duration in days, mean ± (SE ††)	
Group 1*	Group 2†	Group 1*	Group 2†
Scar (33.3)	Scar (41.0)	34.24 (39.824)	65.21 (93.054)
Indentation (33.3)	Bacterial coinfection (31.1)	p-value ($p < 0.05$)	
Permanent hair loss (33.3)	Permanent hair loss (21.3)	(0.023)	

*Group 1: Initially correctly diagnosed group, †Group 2: Initially misdiagnosed group, ‡KOH: Potassium hydroxide preparation, §G: Generation, ††SE: standard deviation)

nosed by pediatricians (Table 2). On the other hand dermatologists were the group with the highest diagnostic precision, summing up to 78.4% in group 1. Additionally revisits in group 2 for making the correct diagnosis was most prevalent in derma-

tology clinics (55.6%) (Table 2). Dermatophytosis commonly presents in cutaneous manifestation and dermatologists are highly aware of the disease¹³. In addition, the methods used to diagnose TC such as potassium hydroxide smear and fungal culture pre-

valently prescribed by dermatologist additionally factor accurate diagnosis. Moreover, a retrospective study regarding the epidemiology of TC in the United States reported that 0.1% of the study population was hospitalized from their primary physicians and 71% of the patients were newly diagnosed of TC¹⁴. Therefore pediatricians or any medical provider regardless of specialty should be aware of the symptoms of TC and make appropriate referrals upon suspicious cases. In fact, guidelines stated by the American Family Physicians insist a thorough history of risk factors including recent contact with livestock, moist boggy appearance in addition to stressing the importance of fungal specific examinations¹⁵. Lower incidences of TC were reported expected in various clinical studies based on misdiagnosis or under-diagnosis of the disease. Spreading of infection among indigent African Americans along with the group lacking health insurance may factor the cause as well¹⁴.

2. Clinical manifestation and complications

The symptoms and lesions presented between two groups were comparable in terms of progression and complication of the disease. In group 1, pruritus was the highest complaint with 22.7% followed by scales, pustule and papules. The symptoms and lesions reported in group 1 are consistent with the primary lesions that are usually present in TC. On the contrary, although pruritus and primary lesions were also noticed in group 2, scarring alopecia was the most commonly presented lesion with higher rates of ulcers and seborrhea (Table 2). The result indicates that the misdiagnosed group was more susceptible to lesions that were consistent with complication. Concurrently, the misdiagnosed group showed a higher rate of complication. In group 1 only 41% (9 cases) were left with complications

which included scars, hair loss, and dents on scalps. In group 2, 96% (61 cases) suffered complication and scar (41%) was the major complication followed by bacterial co-infection, and hair loss (Table 2). Bacterial co-infection may occur under large superficial crusts and present in forms of folliculitis¹⁶.

3. Diagnosis, treatment and financial deficit

Statistically, potassium hydroxide preparation was the highest form of diagnostic measure performed in group 1 followed by fungal culture, Gram swab culture, skin biopsy and hair pluck tests (Table 2). The least valuable test used for differentiating TC was blood culture, and folliscope examination. A Bayesian analysis of conventional methods used for TC, including microscopic evaluation and fungal culture revealed 87.5% of efficiency in true positive values and 76.4% of efficiency in true negative values in which states the high sensitivity arriving at a diagnosis¹⁷. In other words, differential with microscopic evaluation and fungal culture must be encountered for making fewer misdiagnoses. Due to the confounding symptoms and lack of proper diagnostic measures, the majority of patients in group 2 was initially diagnosed of bacterial infection and was treated with oral antibiotics. In fact, there are numerous reports concerning TC and its clinical mimicry to bacterial infection. Dissecting cellulitis, bullous impetigo, and folliculitis were some of the commonly reported misdiagnosis in relation to bacterial colonization of TC¹⁸⁻²⁰. Additionally psoriasis, seborrheic dermatitis, and allergic urticaria were inflammatory disorders that were frequently misdiagnosed^{21,22}.

Treatments in regards to the misdiagnoses result in inappropriate medical prescriptions and prolongation of the disease course. The difference between group 1 and group 2 was noticed as oral or topical

anitfungals were more prevalently prescribed in group 1, while third generation cephalosporin followed by first generation cephalosporin was more commonly prescribed in the misdiagnosed group. Efficacy regarding the treatment upon prescribed medication revealed a statistically significant level time difference for group 2 with a *p*-value of 0.023 (Table 2). Pomeranz et al. reported that majority of admitted patients presumed bacterial infection resulted in major management changes consisting either addition of griseofulvin, or discontinuation of antibiotics⁶. From our experience, it takes about 34.24 days in group 1 and 65.21 days in group 2 until clinical manifestation resolve and mycological identification to be negative. Two cases of the misdiagnosed group suffered extensive surgical debri-dement, however clinical improvement was not achieved and unnecessary hospitalization with prolongation of treatment was required before providing appropriate treatment^{6,7}.

Misdiagnosis of TC leads to further complication and results in significant finical deficits within the groups. In the present study, the misdiagnosed group was visited on average of 3.4 local clinics and 1.7 tertiary based hospitals before coming to DCUMC for the correct diagnosis. On average of 2.5 prescriptions were given to these patients and each patient had made 7.2 trips on average before achieving the right diagnoses. Higher number of clinic visits, medication prescriptions, and trips were the main factors to consider the financial loss of the misdiagnosed subjects. An exact number of costs, however, was not achieved due to the limitations of a retrospective study. However the financial burden, complication and prolonged treatment course all factor negative outcomes in the disease progression. A comparative study states an average loss of 37,955 United States Dollars (USD) for ten unnecessary admission caused by misdiagnosis

tinea capitis as bacterial infection⁶. In United States, annual cost of treating TC patients was estimated to be on average \$253 per patient, composed of \$158 for prescription drugs and \$95 for medical services. Misdiagnosis adds additional financial burden up to double the amount^{6,23,24}.

CONCLUSION

Currently, there are no carefully controlled studies regarding the epidemiologic analysis of misdiagnosed TC and its evaluation of its clinical and social impact. The misdiagnosed TC usually arises from unawareness of the disease that leads to inappropriate diagnostic approach resulting in misleading medication prescription. The clinical duration and complications were reported to be higher and the financial loss was evident in the misdiagnosed group. Limited cases and retrospective study nature in a single center remain limitations to the study. However, based on the findings, the present study should provide a basis for further epidemiologic analysis and it is recommended to explore solutions for early diagnosis and solving patients' quality of lives with economic burden of TC.

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Conflict of interest

In relation to this article, I declare that there is no conflict of interest.

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