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A Study of Plantar Keratoma Using a Classification Model for Student Observational Skills Compared to an Expert Panel

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Abstract

Background: Refining observational skills in students should improve patient management when distinguishing intractable pain for plantar Keratoma. An adjunctive method of observation is proposed using an existing classification model when learning about epidermal changes in the foot. A previously untested model conducted in a School of Podiatry in the United Kingdom highlights the weakness of descriptors applied to observational methods.

Method: Students participated in a study covering 10 pedal diagrammatic impressions of plantar Keratoma without prior tuition. The model used four distinct groups; impressions of light Keratoma (callus), thicker callus, concentric keratin plugs and Keratoma with deeper density changes under the forefoot. A group of 'experts' assigned from qualified podiatrists and nurses validated the observer-rated responses by the students.

Results: First year students (unskilled), n=31, performed well using weighted Kappa (k)reliability statistic (k=0.58) but compared less well to third year students, n=24 (semi-skilled, k=0.73). The experts, nurse n=20, podiatrists n=6, performed better than students at all levels; k=0.84 and k=0.97 respectively and appeared more reliable than observing clinical photographs when conducted by the same cohort of students in a different study.

Conclusion: Descriptors are paramount to observation ability when grading diagrams. The transference of this skill to clinic is important when observing skin lesions during the foundation years of training. The value behind clinical annotation, supported by a classification model for Keratoma, combined with patient outcome tools (not discussed), could improve scientific rationale allowing prioritization of patient care. Further observational study using direct clinical examination following debridement is planned.

Keywords: Cohen-Kappa Coefficient; Descriptors; Keratoma; Observer-Rater; Reliability; Validation; Warts

Introduction

The use of the term Keratoma is favored more in North American literature when compared to other English-speaking parts of the world, where corns and callus are terms adopted for non-disease related epidermal thickening. Resolution of pain from a Keratoma, after careful diagnosis, can be considered the aim of the clinical skill. There is a distinction between reducing skin thickness for cosmesis compared to resolving pain associated with disability which chiefly separates the function of a podiatrist from pedicure. Keratoma under the sole of the foot is commonly expressed as Intractable (Plantar) Keratoma (IPK) and favored in this paper. Some may consider this a term for painful callus resistant to management [1]. IPK lesions have been reported after histology [2-4]. Evidence indicates deeper tissue pathology can influence Keratoma formation without frictional shear or pressure. These implications are important, not least because co-infection with the Human Papilloma Virus (HPV)is common. Diagnosis can prove difficult from observation alone.

Management of plantar Keratoma has been documented in terms of acids and debridement together with orthoses [5-8] but prioritization is emphasized in higher risk patients where concerns for pedal deterioration [9,10] are paramount. The elderly form the second group susceptible to age related foot disease and falls [11]. With healthcare providers looking to minimize costs, the podiatrist is finding delivery of care challenging with changing healthcare economies. While validation can be provided by biopsy [4] it is important to justify intervention outside the framework of cosmesis. Clinical training has to be effective and respond to changes brought about by external influences.

Podiatric training in the UK, NZ and Australia follow similar patterns with a suggested 1000 clinical hours to achieve adequate ability in debridement [12]. Diagnostic skills rely on acquisition of knowledge and clinical exposure over time and are driven by problem solving objectives in education. The rationale for training technique will vary between institutions, but as time to deliver education within courses becomes critical, with reduced investment in campus facilities (clinical), students rely on experience from placements. The quality of the instructor initiating skills is important for optimum development and best delivered in small groups [13]. Education in clinical podiatry has reflected upon changes brought in by Objective Structured Clinical Examination (OSCE) methods where testing skills are designed around objective tasks. The OSCE has been considered to reduce subjective ratings of student by staff and influence improved clinical competence. The OSCE is orientated toward a 'process' rather than achieving a specific 'product'. The more structured a learned skill the easier that skill can be assessed objectively [14].

Origin of the Model

Keratoma location and complexity was evaluated using a classification model in 1700 patients (2000 feet) after examining patients with hallux valgus before and after surgery. The original nominal model comprised a graded (1-4) scale for 'calluses. Light callus (Grade 1), heavy defined callus (Grade 2), concentric keratin plugs (Grade 3) and callus with deeper density changes under the forefoot (Grade 4) [15]. A modified scale (1-6)was published based on this original model [16,17]. No system existed at the time of the original study[15]except for a vague model which included Human Papilloma Virus (HPV)[1].While HPV compounds the effect of IPK [4],some are distinctive and can be excluded by observation, but this is not the case for all Keratoma. A further podiatric classification system considered 7 different grades of shear callus [18] but remained undeveloped due to lack of quality testing.

Both published models were untested for reliability and validity and any reference disappeared from future texts [19,20]. A similar model considered in appropriate discharge in elderly patients with cessation of local foot health services [21]; the information was theoretical and failed to contribute toward objective evidence. The original work [15] was reviewed after a gap of 32 years by photographic analysis of 6 examples by first and third year students using an expert panel. The reliability was measured using Kappa statistic. First year students demonstrated k=0.33, third year students k=0.62 and experts 0.79 [22].

Classification should be precise and reproducible [23]. Progress can be monitored and management evaluated by improving notation [17]. In the latter case, the authors used an extended scale following a lesion localization study [16], but this model, although based on the 1985 study [15] included two additional stages relating to epithelial breakdown. This localization study provided an early example of positioning trends of Keratoma with a modest population sample(n=243).

Observation

Kappa Cohen has been applied to categorical data in a number of observation projects with musculoskeletal research [24]. Errors in measuring and comparing observation reliability with percentages were emphasized [25]and Interclass Correlation Coefficient (ICC)or Kappa Cohen coefficient (k) for reliability was favored over percentage comparisons.

The classification model reflected photographic evidence of a plantar Keratoma comprising a well-defined edge of raised skin (callus) with a dense centre (corn).The research considered physiological properties in normal and hyper keratosis skin and extended to measuring hydration, elasticity, collagen and fibrin organisation, together with surface cell activity[26].The interpretation of the lesion as a grade 1 or grade 2 lesion led to critical comments about further clarification in respect to thickness and yet grade 4 was implied more by definition. Brevity of the narrative in the original papers [15,16] was most likely responsible for this misunderstanding. When cataloguing keratin lesions grade 1-4, any pathogenic changes should be mentioned within the narrative to improve the descriptor. Reliability has more to do with an assessment method free from measurement error [23]. While narrative is important; the use of diagrams can assist the clinician with future reference to lesions. The use of a circle around metatarsal head (MTH) is popular for Keratoma location, [27,28].

Only one author stands out as representing Keratoma outside the location of the MTH despite majority of IPK 'appearing to' reside under the MTH (Figure 1) [28]. True validation of location relies on methods such as radiographic markers. Studies have reflected on the commonest patterns, but the methodology varies as do population numbers and patient selection, which makes statistical inference difficult. Further discussion lies outside this study despite the importance to annotation.

Figure 1: Notation (from author's clinical notes) showing a grade 4 Keratoma lesion with eccentric density (corn) within a disc of callus. The location is outside the MTH domain and may reside between MTHs.

Method

Source of the study

Two unpublished pilot studies were carried out between November 2013 and June 2014 by the author to test the classification model using photographic examples of lesions, but with refined descriptors over the 1985 classification work. A recent study re-introduced photographic observations providing a baseline for observer selection, and used the same observer-raters as in the observation of diagrammatic representation of hypothetical lesions in this study [22].

Objectives of the study

The method explores improvement in the pre-clinical awareness of podiatry students in observation skills between the medium of the classroom and clinic. The diagrammatic element in this study forms one observation method (Figure 2). Descriptors remain central to the theme under investigation to elaborate weaknesses within a simplified nominal scale. From an educational objective the highest quality of annotation should be achieved. The theoretical outcome could lead to improved annotation of skin changes within clinical records complimenting descriptive features; color, border variation, symmetry within lesions, to localization of IPK. Enhancing student skills by reliable methodology is focused using experts as controls against two student groups. The primary study was designed with a view to considering observation methods attractive to OSCE involvement. Implementation of an OSCE rests outside the study.

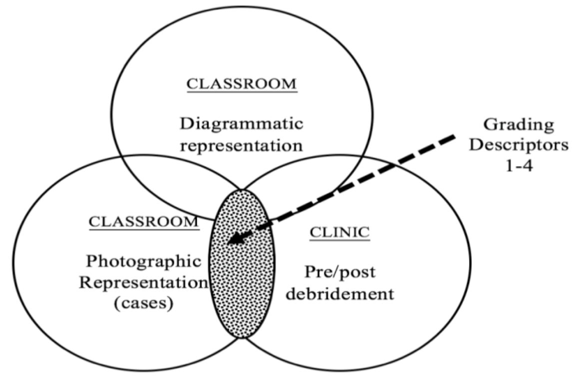

Figure 2: Diagrammatic representation and basis of study to refine skills development in observation method represents three elements of observational learning using a classification model for students. The diagrammatic representation formed the basis of this study with the aim to refine skills development in observation method.

Six skilled podiatric observer-raters had >20 years each and were accepted as experts against 55 student-observer-raters. Twenty qualified nurses experienced in working with surgical foot cases were recruited by an independent senior nurse. All students invited from the new first and third years at a Podiatry School within a University Department of Health Sciences agreed to participate in the methodology. First years had no prior clinical contact and were considered unskilled. Third year students had two years with some clinical experience and were semi-skilled. Each recruit was consented and allowed to withdraw from participation at any point. The two student cohorts comprised first year (unskilled = 31), third year (semi-skilled = 24).

Written information was provided explaining the study process, descriptors (Table 1), and diagrams covering the grading (Figures 3,4).

Grade	Simplified Descriptor	Detailed Descriptor
Reference only	No callus lesion. Normal	No lesion. Even colour, thickness & consistency remain within normal limits for each part of the foot. Heel, sole and pulp of toes may be thicker. There would be insufficient epidermal tissue to debride without affording damage. There are no ridges, fissures or deep tissue changes or lesions within the skin. Keratin lesions associated with other forms of hyperkeratosis do not form part of plantar callus classification.
1	No border definition but retained uniform keratin depth. Ridged or pinch callosity can be considered within the Grade 1 definition	The epidermis is thickened and may have some irregular deeper density changes so as to alter the colour. Callosity shows no border symmetry and maybe diffusely spread without any concentrated area of keratinisation. Petechiae (blood vessels) may be seen or extravasated content. Pinch callosity, also known as ridging, is callus on the edge of the forefoot, occasionally sulcus, heel or apex of a toe. The border may appear isolated as streaky (striated) of callus. While this Grade of callus may have a defined border it is considered Grade 1 because it conforms to physiological build up or deformity, and the deeper tissue changes are not involved as in Grade 2 or Grade 4.
2	Border definition was present or partially present with variable keratin depth. No discrete distribution of concentrated keratin is evident in the Grade lesion but asymmetric density changes might be observed	A thickness of epidermis forms usually over one or more metatarsals or phalangeal surface of a toe. The border is discrete and may be raised forming a button or disc of thickening. If a partial border is observed, then this is classified as a Grade 2 callus. Debridement may be necessary to determine any true nucleation. The underlying callus may be spongy and can only be determined by examination. Areas of flaky skin, complicated with sub epidermal hemorrhage do not constitute a nucleus of tissue and should be disregarded. If debrided the tissue is shown to have broken down, eroded or ulcerated it no longer follows the callus classification but that of a wound.
3	Concentrations of discrete keratin plugs isolated, or in groups of lesions, generally with a diameter of less than 4 mm without background callus.	Usually a discrete circumscribed area, but may be elongated. This lesion has no surrounding callus except at the extreme border where a thickened ring or rim may exist. The lesion is mostly associated with the metatarsal plantar skin where weight bearing is reduced and fat tissue is less pronounced, often with a less tightly bound epidermis. However, the lesion may not be associated with mechanical origins and can occur due to other causes including foreign body infiltration or HPV infection. If this is a suspected HPV then it no longer follows callus classification.
4	Border definition present or partially present with variable keratin depth but demonstrating discrete distributions of concentrated keratin greater than 4 mm diameter within the callus	The callus will have a circumscribed symmetrical or asymmetrical area of greater depth, ridge or greater concentration anywhere within the callus. The size can vary from lesion to lesion-occupying crater like areas after debridement. The nucleus does not have to be limited to the centre and can in some cases manifest within a larger percentage of the lesion. On debridement the base may be damaged as well as uneven in depth. As Grade 4 calluses are considered typical of intractable lesions, these are often complicated within the dermo-epidermo junction. Extravasated material, without debridement confirmation cannot be assumed consistent with Grade 4 lesions, but there may be density changes within the callus complicated by blood vessel disturbance. The same rule applies if the dermis is breached leading to a wound.

Table 1: The simple descriptor was utilised in the pilot studies, the detailed descriptor was designed for inexperienced students [22].

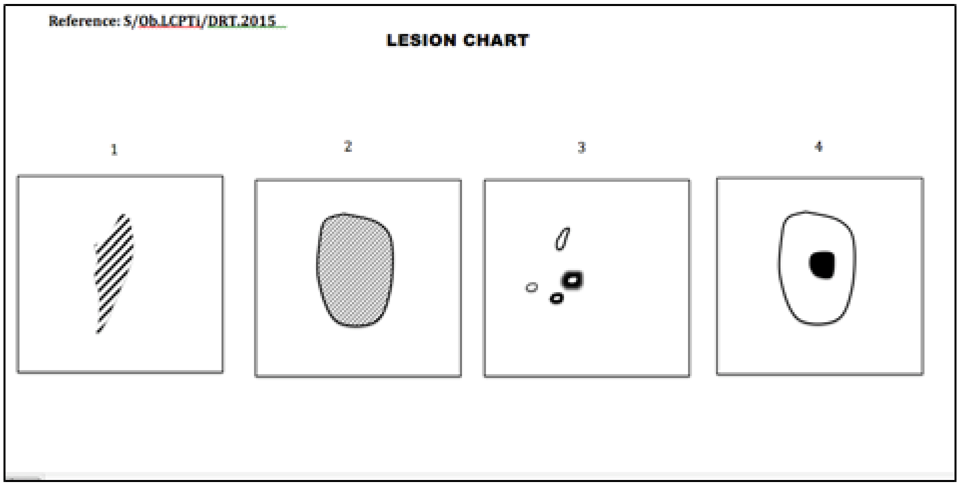

Figure 3: Key to diagrammatic representation the lesion chart key was used in the student study alongside the exercise to select the most appropriate grade in diagrams A-J.

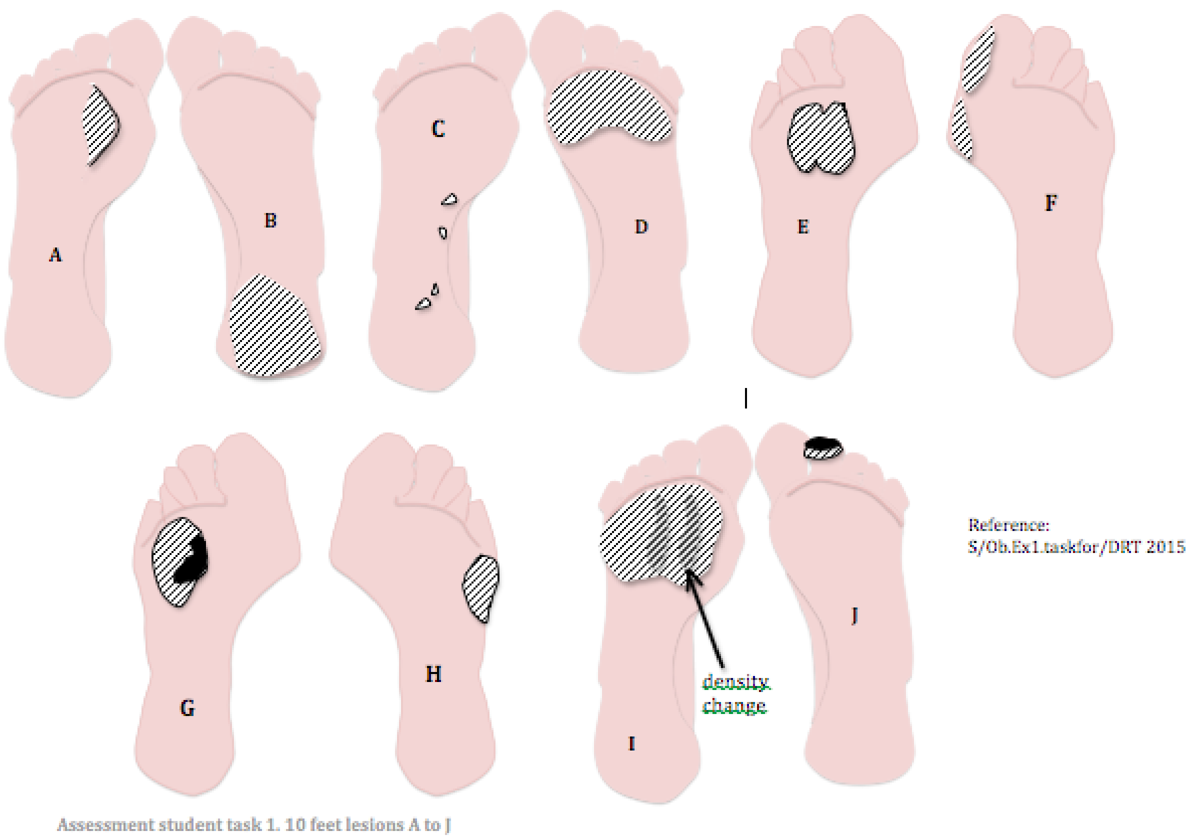

Figure 4: Student assessment task. Diagrammatic illustrations A-J.

Descriptors

Two descriptors were implemented, (Table1) based on the original paper [5]. Simplified Descriptor (left Colum) provided brief for the experts [5]. The Detailed Descriptor [22] (right column) was additionally included for the students without any prior tuition. A diagrammatic key (Figure 3) replicated grades 1-4.

The diagrammatic representation considered whether the value of descriptors could be advanced by using simple diagrams? Each student had to select best fit to 10 scenarios (Figure 4). The nurses were used as secondary observers and had no podiatric knowledge but were provided with identical information to the students. All contributors were treated anonymously except the expert podiatrists known to the author. Qualified podiatrists were provided with the same material as students and nurses, but were only provided with simple descriptors (by e-mail).

Results

Kappa k- statistic was selected to analyses reliability for observer ratings on nominal or ordinal scales [24]. A contingency table was formed so that frequency of agreement and disagreement could be calculated for each graded lesion. The strength of agreement for a Kappa coefficient was illustrated [29], k= 0.81-1.0 almost perfect state, k=0.41-0.60 moderate, k=0.21-0.40 fair and=0.10-0.20 slight. Kappa (quadratic weighted) statistic was used alongside percentage responses (Figure 5).

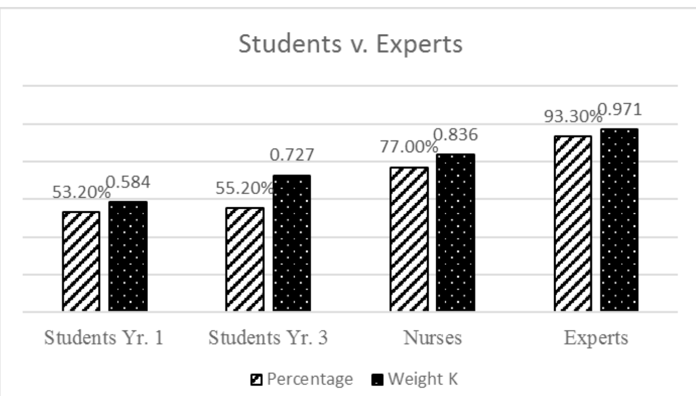

Figure 5: The bar graph illustrates the observer raters for percentage and weighted Kappa score for reliability. Yr.1 students performed well showing moderate reliability without clinical experience and prior tuition.

Additional Results

Variation occurred with diagrammatic lesion 'I' so that observers reported two different grades in equal proportions. 'I' showed some density variation making the lesion more challenging (Table 2). 'E' shows a bifid callus covering two metatarsal heads where callus typically can coalesce. The schematic drawings were intended to assist with photographic observation as part of a separate study [22]. 'Does discrepancy affect the results if the result from observing lesion 'I' value?' was removed as in (Table 3).

Method 1	A	B	C	D	E	F	DOMINANT
a	2	1	2	2	2	2	2
b	1	2	1	1	1	1	1
c	3	3	3	2	3	3	3
d	1	2	1	1	1	1	1
e	2	2	2	2	2	2	2
f	1	1	1	1	1	1	1
g	4	4	4	4	4	4	4
h	2	2	2	2	2	2	2
i	2	4	2	4	2	2	2/4
j	4	4	4	4	4	4	4
Note i. has two options grade 2 or grade 4.							

Table 2: Illustrates the results selected by podiatrists. Validation of the response was based on the dominant grading.

Group	Podiatrists	Nurses	Students Y.3	Students Y.1
Original test +i	0.971	0.836	0.727	0.584
Revised test-i	0.971	0.735	0.735	0.584

Table 3: Values of K statistic when one question diagram 9 - i was removed.

Discussion

Students were recruited along the same lines as research into observation of wounds where descriptors were used [23,30,31]. Knowledge and performance of the observer reliability of the students seems to hold true with more experience for the exponential k values; students 1Yr (0.58), students 3Yr (0.73) expert podiatrists (0.97), which suggests improved performance arises with greater clinical exposure(R=0.98). The nurse cohort appeared comfortable with diagrammatic observations even though they were unfamiliar with Keratoma (k=0.84). Given grounding in clinical observation of wounds, this group seemed to be comfortable differentiating theoretical grades for Keratoma. Inter-observer ratings suggest better reliability across a group of observers than intra-observer ratings [32].

In a study where 11 observer raters with different skills experience were recruited, including three inexperienced students, reliability was also shown to increase with experience [31]. Diagrammatic observation ability appears unrelated to clinical skill but would rely on the quality of the descriptor. Student cohorts worked independently, although there may have been some vicarious sharing of knowledge. Sharing decision making however has been shown to improve reliability in nurses and when acting alone with photographic interpretation, the performance dropped off; k=0.33 [31].

While podiatry students may have benefitted from group work this was not included as part of the study. The students in the photographic Keratoma study showed similar values as nurses k=0.33 for year 1, while year 3 demonstrated 0.62 [22]. Experts showed slightly less reliability which may imply diagrammatic lesions are easier to analyze because they are represented by flat image verses photography where interpretation is affected by color, density changes and shape variation. The use of direct observation with debridement remains unreported in the literature. Wound classification observer studies have included expert panels to assist observation of other raters [23,30,32]. Expert panels provide a reasonable approach to validating results of less experienced observers, although not all qualified podiatrists were able to select 83% of correctly assigned photographs as part of the criteria to become a panel expert (pilot study [2014] n=36). Allowance for error may be realistic for subjective decisions; the effect of such error is likely to have a low impact on care delivery but maybe more critical if used for photographic triage using digitally transported information. The descriptors appear to form the most important element of any classification.

When the European Pressure Ulcer Advisory Panel (EPUAP) recruited 1452 nurses without prior training from different European countries, many nurses believed they had understood how to apply the classification. Poor reliability arose due to misunderstanding how to apply the descriptor to wounds [33]. The design in this Keratoma study minimized error by including more detail. The narrower range (1-4) of descriptors for corns and callus might contrast favorably with the errors found in the nurse study considering the subject of wound assessment. Absent prior training seems an open opportunity for error.

During the design of the form (Figure 3-i) the author used density change (marked) within the diagram but did not place a border around the general lesion area. The expert panel considered grade 2 and grade 4 equally (Table 2). From a clinical perspective, no single Keratoma lesion is the same and pathology varies widely as the dimensions of depth change according to sub-dermal damage [32]. Inevitable this makes assigning lesion grades more difficult. The absence of a border, but presence of density changes within the Keratoma, suggests that the lesion i is in fact a grade 4. However, in reality Keratoma may not have a clear border until debrided and yet possess variations in depth. This could reasonably be assigned grade 2 as the definition would not fit grade 1. The impression that the descriptor was important in establishing an accurate observer response might be challenged where too much information is offered.

The border of a keratin lesion on the plantar surface created the most common division for observer-raters. The diagrammatic exercise included one option for Grade 2 with a partial border to raise the potential for border variation (a). This learning feature from the model was important as with the potential error seen in an earlier reference [26]. The balance between too little or too much information must be balanced. When the error over grade 2/4 was analyzed, Kappa was re-applied after diagram i was removed.(Table 3) represents these new results.

Three places of decimal reflected the sensitivity of the change made. With exception of the nurse group, which suggested a slightly reduced score (0.836 down to 0.735), the remaining observers showed little change and not considered significant enough to alter the overall results. The diversity of Keratoma makes the task of minimizing descriptors difficult. Diagram 9-e introduced the complexity of the 'bifid Keratoma' where the lesion was essentially single but was conjoined over several metatarsal heads.

Conclusion

Graded classifications within orthopedic literature are often assigned without testing. Minimizing subjectivity is important and in order for any grading method to be effective, the descriptors require testing. The project excluded tuition, but with improved understanding and application fostering valued judgments, quality descriptors and visual aids, the training toward the skills involved in the treatment process could be strengthened. OSCE methods for podiatry use direct clinical observation for skin assessment favoring photographs [14]. Further study comparing photographic representation and clinical debridement skills as part of the OSCE process should provide wider perspective. Where photographic observation was implemented, the skills requirement seemed more important and dependent on prior tuition.

The K values for observation reliability shown between first and third year data confirms the importance of experience and learning when applying knowledge to a clinical process. The skill of annotating the four-point classification for Keratoma also depends on minimizing ambiguity, especially around border definition and recognizing density changes. The influence of debridement in a controlled environment on classification is currently being studied.

Author's Note

This paper was part of a larger study. The remaining study considered photographic methods of observation and direct clinical observation for pre- and post-debridement and awaits publication.

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Competing Interests

The author declares that they have no competing interests.

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