

# DOES DEBRIDEMENT OF PLANTAR SKIN AFFECT THE RELIABILITY OF A REVISED CLASSIFICATION SYSTEM FOR CORNS AND CALLUS IN THE FOREFOOT? A CONTROLLED CLINICAL STUDY

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This paper considers observations of the effects of debridement upon keratin (corn/callus) lesions on the plantar surface of the foot, pre-debridement and post-debridement, using an existing classification system applied to the foot

## ABSTRACT

### Background

Classification of callus and corns has previously been cited but the reliability of clinical observer-rating has not been considered for plantar lesions. The earliest reported system dates back to 1985 where surface corn and callus are divided into four distinct features, and was updated in 2017.

### Objectives

Debridement serves to define the state of the underlying layers of epidermal strata influenced by changes within the dermo-epidermal junction at different locations under the forefoot. It has been contended that debridement enhances the accuracy of clinical assessment. The use of a known classification system complete with tested descriptors allows the grading system to be evaluated within a controlled clinical environment.

### Methods

Twenty students acting as observer-raters from a podiatry

school volunteered to participate in the clinical study using a four point graded classification method for three patients (five feet). A group of 'experts' assigned from qualified podiatrists validated the key lesions and contrasted student's outcomes by using pre- and post-debrided lesion photographs from each of the three patients.

### Results

There was no difference in the pre/post count;  $p > 0.10$ ,  $t = 1.561$ . Cohen quadratic weighted statistic Kappa suggested that students improved following debridement, but experts showed less accuracy for graded keratin lesions when observing the same debrided lesions using photographs. First year students appeared to perform better than third years.

### Conclusions

Debridement is important for diagnostic purposes. The use within a clinical environment is more likely to yield better results than photography with unskilled and skilled clinicians.

**Figure 1 (right).**  
Five sets of  
photographs taken  
before and after  
debridement

## INTRODUCTION

Not all corns and callus arise from pressure.<sup>1,2</sup> Changes in the dermo-epidermal junction (DEJ) are affected by infection, foreign bodies, human papilloma viruses (HPV), and underlying soft-tissue changes.<sup>3,4</sup> The DEJ is sensitive to change, and such pathology is usually clearer following debridement. Confusion between a virus-mediated corn and callus has been reported in a recent reflective survey of cases following excision with histological analysis.<sup>2</sup> Concerns for poor differentiation leading to poor treatment outcome were considered, and reliance on debridement as a mode of treatment thought unlikely to appeal to a national health agency such as the NHS.<sup>5,6</sup>

In the context of foot care, debridement is the action of removing dead tissue, and is equally applicable to ulcer management.<sup>7</sup> As a working protocol, it is embedded within podiatry degree training and formally assessed around 1000 hours before qualifying.<sup>8</sup> The precise period of training may vary because of 'national placements' with the NHS.

Debridement as applied to wound management is well documented for the lower limb,<sup>9</sup> and critiqued<sup>10</sup> in terms of its limitations. Debridement of callus and corns as far as foot management is concerned has mainly been studied in the context of pain relief using a visual analogue scale (VAS)<sup>11, 12</sup> The value of debulking tissue has not been studied in terms of aiding classification and therefore the diagnostic value associated with debridement emphasis remains unchallenged.

Location frequency of callus has also been studied under the forefoot with reference to the metatarsal heads (MTH). Epidermal changes under the second metatarsal may appear most frequent. A set of results from one centre used 1,223 lesions observed from 459 patients (age group 20-90).<sup>13</sup> Fifty-eight lesion patterns were described but their descriptive appearance was omitted. Nonetheless this study set the bar for lesion studies in the UK. A number of other authors studied callus location, all with respectable sample numbers.<sup>14, 15</sup>

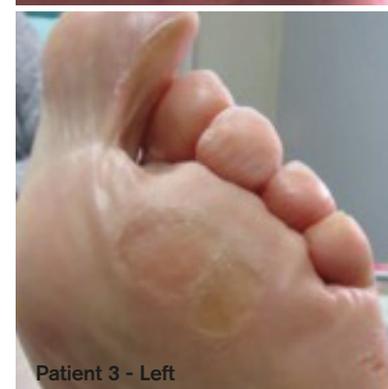
A group of athletes (n=115)<sup>16</sup> and elderly patients<sup>17</sup> (n=301) introduced groups other than those included in the at-risk category where deficient vascular status more traditionally has been included in funded research work. The frequency and patterns of callus showed better diversity of localisation between MTHs than previous authors.<sup>17</sup> The visual descriptor failed to clarify the fact that keratin-based lesions do not always arise over metatarsal heads. The use of diagrammatic representation of lesions in texts is helpful but accuracy cannot be relied upon and can only be considered an aide-memoire. Greater emphasis needs to be placed on locational variation. While researchers understand localisation differences, some MTH location distinctions are considered too small to be of concern. Where studies have been considered in high-risk groups with diabetes, rheumatoid arthritis and the elderly, lesions may vary outside these groups. Coloured plates taken for observation from photographs provided clearer defined callus formations in patients without disease and aged between 30 and 60 than often seen in the elderly. This is more likely because tissue quality changes with the ageing process.<sup>5, 6, 17</sup>

The value of observation in planning treatment, beyond an expression of simple terminology and location, is paramount to good notation. In relation to plantar corns and callus, the use of a classification system enables the lesion to be described precisely alongside location, size, colour and appearance. Progress of lesions can be monitored and management evaluated.<sup>18</sup> The ability and skill in observing lesions was reported using photographic samples, where first and third year podiatry students acted as observer-raters, with a small cohort of qualified podiatrists forming a control.<sup>5, 6</sup> The results are compared to clinical reliability in this paper using the same observer-raters. ▶

## UNDEBRIDED



## DEBRIDED



Grade	Simplified Descriptor	Detailed descriptor
<b>Reference only</b>	No callus lesion. Normal.	No lesion. Even colour, thickness and 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.
<b>1</b>	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 may be 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) 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.
<b>2</b>	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 haemorrhage, do not constitute a nucleus of tissue and should be disregarded.  If debrided, and the tissue is shown to have broken down, eroded or ulcerated, it no longer follows the callus classification but that of a wound.
<b>3</b>	Concentrations of discrete keratin plugs isolated, or in groups of lesions, generally with a diameter of less than 4mm 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.
<b>4</b>	Border definition present or partially present with variable keratin depth but demonstrating discrete distributions of concentrated keratin greater than 4mm 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 (DEJ) 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 DEJ. 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.** Simple and detailed descriptors. The simple descriptor was utilised in the pilot studies. The detailed descriptor was designed for inexperienced students.<sup>5</sup>

## MATERIALS AND METHOD

### Selection

The project involved a single podiatry training school. All students were consented as volunteers. Two student full cohorts were invited to participate. Fifty-five were recruited into the study but only 20 students (36%) volunteered to undertake a clinical observation study, which divided equally between first- and third-year students.

Ethical approval was granted from the university. The in-house podiatry training clinic at the University Department of Health and Sciences was selected to carry out a direct observer-rating study on three patients (five feet) selected by an independent observer and provide three qualified podiatrists to debride plantar lesions (Figure 1).

Consent was taken for students and patients for the purpose of the study. There were no exclusion criteria for the observers while patients were only required to present callus amenable to debridement. Students were asked to mark all lesion locations, number of lesions and grade each lesion before debridement using a system first advocated in 1982<sup>19</sup> and reviewed in 2015.<sup>5,6</sup>

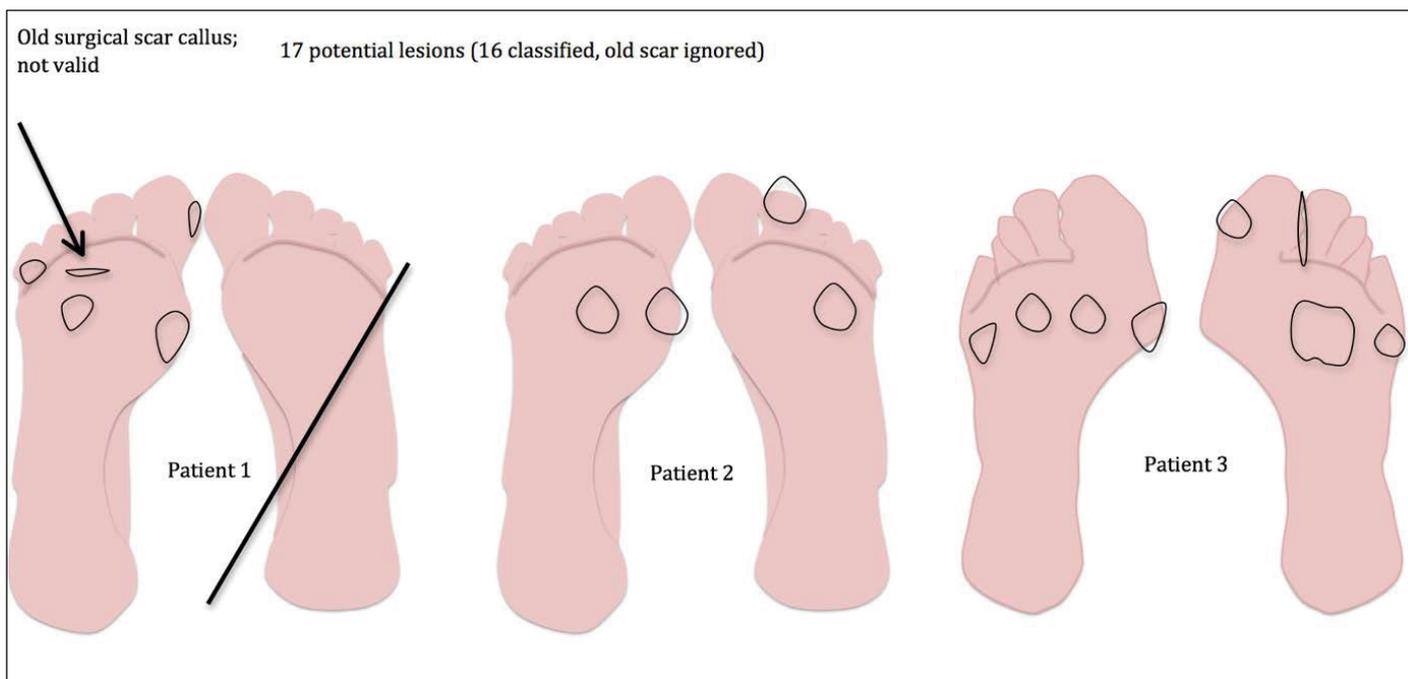
Following scalpel debridement, the students revisited each patient and repeated the exercise without reference to their original sheet. Photographs were taken of each foot before and after debridement using a Canon Powershot SX50HS by

(DT) using macro settings with standard lighting control without flash photography set at the highest definition for the experts to review off site. The same instructions were sent to each of the volunteer experts. They were only able to mark the second series of five feet (three patients) after they had sent their first results back.

Weighted quadratic and linear Kappa statistics were calculated to analyse reliability for observer-ratings on a nominal, or ordinal scale.<sup>20,21</sup> Kappa provided a measure of true agreement as a proportion between that achieved and what was possible. The frequency of agreement and disagreement were calculated and tabulated for each lesion, graded 1–4. Quadratic weighted Kappa was more sensitive and used for majority of analyses. The strength of agreement for a Kappa coefficient of 0.81–1.0 implied an almost perfect state, 0.41–0.60 moderate, 0.21–0.40 fair and 0.10–0.20 slight.<sup>20</sup> A two-tailed student's t test was used to consider if the null hypothesis would be accepted or rejected between pre- and post-operation location counts.

### Classification

The four-grade classification method was reviewed and described against the historical use of previous attempts to classify such lesions.<sup>5,6</sup> The model used in this study was



**Figure 2.** Lesion location validated by expert panel. Expert panel derived lesions produced seven dominant plantar locations indicated by the fine arrow. Each site is approximated to the nearest drawing by the experts. MTH = metatarsal heads as closest representation for replication purposes but are only schematic representations.

modified from the method employed to evaluate callus within the forefoot of patients presenting with hallux valgus.<sup>18</sup> The descriptors were expanded (see Table 1).

**RESULTS**

The results shown in Figure 2 depict five feet in three patients. The data were validated by the expert observer-raters not the researcher. The first MTH appeared as the most frequent lesion from this cohort and the fourth MTH the least. In patient 1, the grade 4 lesion was more likely between the 4<sup>th</sup> and 5<sup>th</sup> metatarsals. The use of a 'bifid' shape<sup>22</sup> for patient 3 accounts for a single lesion from two metatarsal head locations (Figure 3).

**Lesions - numbers and counts under controlled method**

The number of lesions counted varied widely from 7 to 17. By using the expert panel, the most frequently observed

lesions annotated by the two student groups were considered comparable. Twenty-six observer-raters were represented in Figure 2.

**DISCUSSION**

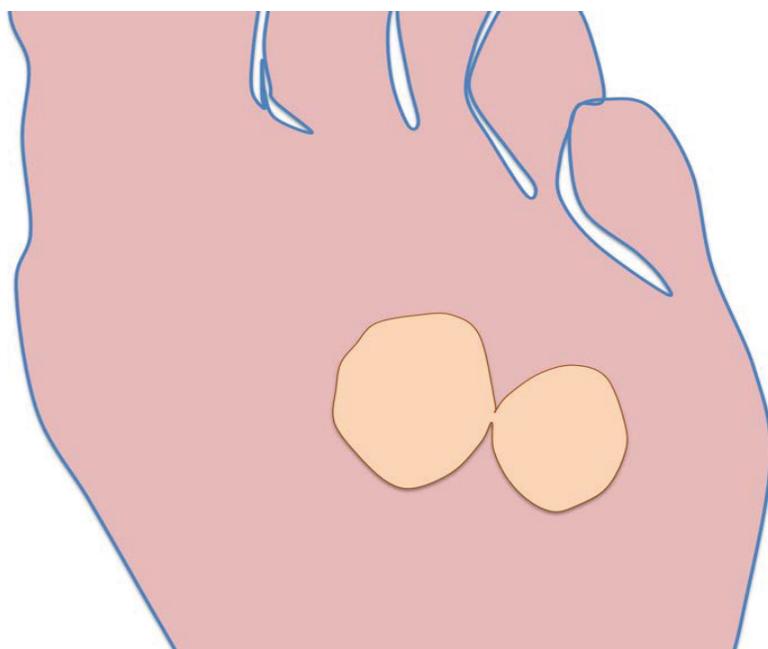
Data are considered for both pre-debridement and post-debridement modes. Given that inadequate deep definition can arise within callus until the surface has been reduced, the research question was directed at the likelihood that grading would be affected because underlying elements of pathology cannot always be visualised accurately.

**Validating data problems with poor lesion definition**

One of the problems with dealing with the diversity of lesions related to minor skin thickening is that, once debrided, the area became slightly cavitated, appearing more significant and difficult to classify within a grading method (Figure 1a&b). As part of validation, 17 potential sites of callus were reduced by expert panel consensus (Figure 2) to seven dominant lesions. Lesion sites were validated before student data were analysed. Students recorded the existence of more lesions than the expert panel. All results were compared to those expected by the author. Ideally the panel should have been able to observe each lesion directly but this was impractical due to wide geographic distances.

In order to derive more information post debridement, clinical observations by photographs were compared (Table 2). Experts showed that they were better able to assign a 'grade' to the lesion before debridement: Kappa = 0.7 for pre-debridement, versus Kappa = 0.6 for post debridement. Photographic post-debridement observation was 4.6% less reliable for experts. It is doubtful that this is truly statistically significant as the expert population was small, making statistical testing less meaningful. The project did not have the benefit of direct observation by experts, but it is hypothesised that in such circumstances experts would improve their score as skilled observers. In a study connected with nurses and burn wounds, 11 observer-raters with different skills experience including three inexperienced students. It was found that reliability increased exponentially with experience.<sup>23</sup>

**Figure 3.** The bifid callus lesion implies divided by a cleft or notch



MODE	EXPERTS	STUDENTS YR 1	STUDENTS YR 3
Photographic	0.795	0.325	0.615
Clinical before debridement	0.680	0.438	0.454
Clinical after debridement	0.568	0.555	0.540

**Table 2.** Kappa statistic. Comparison of results between the reliability of photographic and clinical observation before and after debridement. The experts utilised photographs rather than direct clinical observation in each case.

\*Taken from a photographic study<sup>5</sup> using the same student cohort and experts

Reliability associated with observation arising between the two student groups was broken down into seven categories relating to pre-podiatry experience but led to no conclusions. Because detailed analysis is limited to small numbers, data concerning age, gender and previous experience was difficult to interpret.

Dry skin patches, border distinction and variable density proved the biggest observational anomaly. Quality of colour variation within a lesion or a wound is important, so that identification of border definition and deeper tissue discrimination can be achieved. Before debridement, the skin may look negligibly affected, but after debridement, a false border can be created. Such a feature was related to the operator debriding the lesion. Traditionally, callus is debrided to blend with the surrounding skin, but many 'operators' leave edges. This is usually irrelevant as far as the outcome is concerned for the patient but is preferred aesthetically. Within this project, variable post-debridement border appearance could cause observational obfuscation, i.e. enhance a border or rim.

Further study, using the classification model, would require filtering of dry skin areas by extending the classification and implementation, i.e. grade 1 for dry skin. This would ensure podiatrists recognised such a feature without accrediting it to pathology that could lead to concern.

#### Lesion Identity and Counts

Comparative group observation associated with lesion numbers or counts distributed on the plantar foot was evaluated. The

range of isolated lesions identified pre-debridement was 8-16, and post-debridement 7-17; 23.1% showed no change (six observers). Thirty-four percent (nine observers) demonstrated reduced lesions observed after debridement, and 38.5% (10 observers) observed an increase in lesions (Figure 4). In one case the lesion suggested that callus under the metatarsal heads had coalesced, making counting difficult. In this case, the bifid (Figure 2) lesion could be counted as a single lesion.

The null hypothesis was not rejected as the difference between both groups was not significant;  $p > 0.10$ ,  $t = 1.561$ , using a two-tailed paired t test. The seven dominant lesion sites selected from a wide range of observed lesions (7-17) provided 140 observations, which appeared uniformly recognised by student observers and experts.

This additional finding could be useful within the field of training to test observational skills. Unless guided, as in the second part of the method, where lesions were specified, the interpretation of what constitutes a lesion varied widely between all observers, including experts. Filtering lesions became necessary and selected by consensus. Dry skin and an old scar featured on one patient, and all digital lesions were excluded.

#### CONCLUSION

This paper represents the second part of a larger study, and the conclusions drawn from the method and discussion represent a clinical observation method with validation by expert podiatrists rather than using photographic observation alone.<sup>5,6</sup> It is contended that clinical observation provides better reliability than photography, but post-debridement observation with photographs may not be any more helpful than photographs without debridement when using a classification system. ■

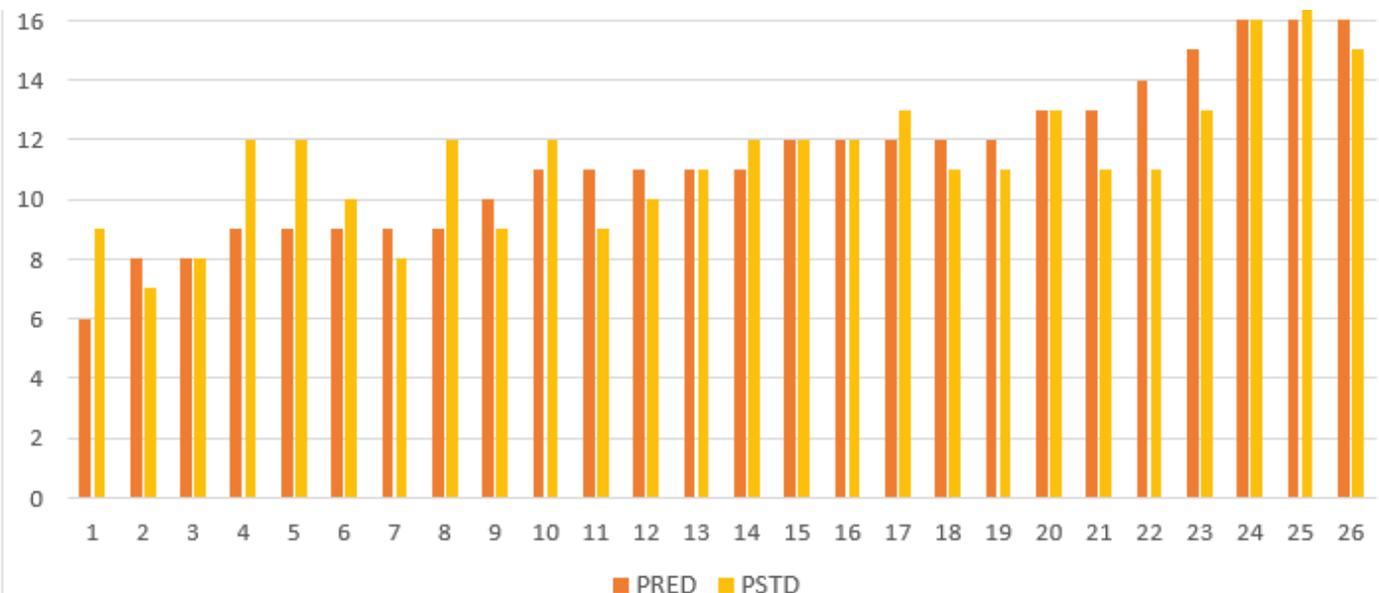
#### ACKNOWLEDGEMENTS

Dr A Bridgen and Dr J Stephenson.

#### ETHICS APPROVAL AND CONSENT TO PARTICIPATION

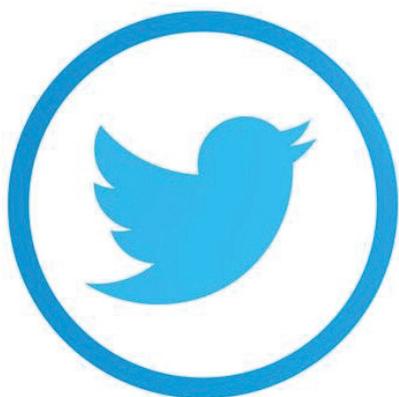
This study was approved by the Human and Health Sciences Post-Graduate Course Ethics Panel at the University of Huddersfield, Yorkshire, 2015.

**Figure 4.** Pre-operative debridement (shaded) and post-operative debridement (solid) for 26 observers (Student observers = 20, Experts = 6).



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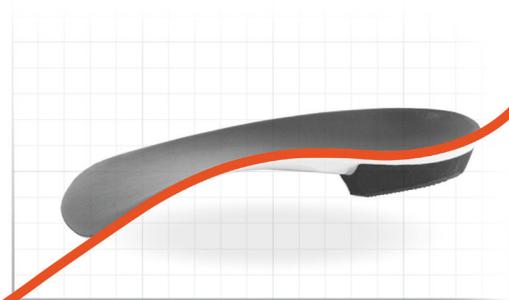


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