

Surgical Excision of Intractable Plantar Keratoses (Corns) of the Foot

A Scoping Review

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Background: Hyperkeratosis is a hypertrophic thickening of the skin. A callus (tyloma) is considered diffuse thickening, whereas a corn—also known as a clavus, heloma durum, or intractable plantar hyperkeratosis (IPK)—is a more focal, circumscribed hyperkeratotic lesion with a central conical core of keratin. Treatment (including surgical excision) of plantar keratoses is often sought because of pain and discomfort. The aim of this study was to collect and chart data regarding the surgical excision of plantar corns. The emerging themes were then mapped so that suggestions for areas of future research could be made.

Methods: A scoping review of the literature was performed using the six-stage methodologic framework (minus stage 6) proposed by Arksey and O'Malley incorporating the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews reporting guideline. A database search by means of the United Kingdom National Health Service Care Advanced Database Search yielded 1,056 articles, 12 of which appeared to be of potential relevance. After removing five duplicate articles, this total was reduced to seven, which were retrieved as full texts. Three were excluded. Thirteen further articles were found through Google Scholar and reference lists from the full texts retrieved to give 17 articles for review. One was discounted as not being in English/irrelevant; and one article did not relate to IPK excision, leaving 15 articles for data extraction.

Results: Iterative charting of the included articles yielded overlapping codes and two main themes. The first theme was closure: by primary intention (with or without a skin flap) or by secondary intention. The second theme was whether excision was performed in combination with IPK excision with other (bony) surgery.

Conclusions: There is modest evidence that excision of the lesion with either primary closure or healing by means of secondary intention can be useful for the management of IPKs. A further consideration is an emerging hypothesis that many of these IPKs are viral in origin, rather than mechanical, which implies that prospective studies are required with cross-reference to lesion excision by anatomical site and histopathologic confirmation of the diagnosis. (J Am Podiatr Med Assoc 113(6), 2023)

Hyperkeratosis is a hypertrophic thickening of the skin. It is the principal protective response of the plantar and palmar skin to adapt to and withstand external stress during physical activity and is

produced through spatially arranged keratins found in the stratum corneum.¹ However, continued pressure can become pathologic and lead to the formation of painful callus and corns.² Spink et al³ reported that plantar hyperkeratotic lesions affect 60% of older people and are associated with female sex, hallux valgus, toe deformity, increased ankle flexibility, and time spent on feet. The formation of hyperkeratotic lesions is explicated by Kim et al⁴ and Hashmi et al⁵ as the hyperproliferation and clumping of corneocytes brought about by incomplete cell differentiation. Hashmi et al⁵ further explained that dermal and epidermal cells react to

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pathologic stress by producing proinflammatory cytokines that accelerate skin cell transit through the epidermis, alter the degradation of corneodesmosomes, create abnormal lipid formation, and ultimately compromise corneocyte desquamation. Tobacco use has been found to contribute to several hyperkeratotic skin complaints, including human papillomavirus infections, palmoplantar pustulosis, psoriasis, and malignant and benign epithelial tumors of the skin.⁶

Al Aboud and Yarrarapu⁷ and Mukhopadhyay⁸ note that confusing terminology is often used for different types of hyperkeratotic skin lesions. A callosity, or tyloma, is considered diffuse thickening. In contrast, a corn (also known as a clavus, heloma durum, or intractable plantar hyperkeratosis [IPK]) is a more focal, circumscribed hyperkeratotic lesion with a central conical core of keratin.^{9,10} In 1845, Durlacher¹¹ described corn subtypes as soft corns (heloma molle), festered corns (ulcerative), and neurovascular corns. Swanson,¹² Montgomery,¹³ and Lemont¹⁴ discussed helomata (corns complicated by blood vessels, nerves, and scar tissue) using the terms heloma neurofibrosum and heloma vasculare. Histologically, Bonavilla¹⁵ found that the reticular layer of the dermis beneath the stratified epithelium was heavily collagenized, resulting in capsulation of the sweat glands. The nerve filaments within the dermis showed perineural scarring, which Bonavilla thought might account for the pain of an IPK.

Plantar hyperkeratotic lesions are commonly found under the metatarsophalangeal joints (MPJs), with various studies reporting on the distribution and pattern of MPJ involvement,¹⁶ but they can appear elsewhere on the plantar surface of the foot. Such lesions are frequently painful and are associated with reduced walking speed, impaired balance, and difficulty ascending and descending stairs.¹⁷

Conservative Treatment

Conservative treatment aims to reduce the pain and discomfort from IPKs by debridement and enucleation of the central plug.^{10,18} Topical keratolytic medications, orthodigital padding, and orthoses to redistribute the pathologic load, pressure, and friction are core podiatric skills, as management of hyperkeratosis accounts for up to 75% of a podiatrist's workload.¹⁹ Although reducing mechanical stress by a change in footwear may resolve hyperkeratotic lesions on the digits, conservative management of

painful plantar lesions is often ongoing; thus, surgery may be considered after conservative measures have failed.¹⁰ This can be in the form of bony surgery, skin surgery, or a combination of both.

Surgical Techniques

Given the common presentation within a primary and podiatric setting, there is a disappointingly small section of the podiatric and medical literature concerned with surgical excision of IPKs. Surgical removal can be via full-thickness excision; curettage (Fig. 1), or excochleation (removal of the contents of a cavity by scraping). A full-thickness surgical removal can take the form of a punch/incisional biopsy²⁰ (Fig. 1), a 3:1 ellipse (Fig. 2), or a local skin flap. Curettage is used when the pathologic tissue being removed is softer than the surrounding skin, or when there is a natural plane to separate the diseased tissue from the normal tissue.²¹

Methods

This scoping review aims to determine the range of quantitative and qualitative evidence available for the surgical excision of plantar IPKs and examine the located data to identify and chart themes. Organization ethical approval was not required for this review. Consent for publication of this article was granted by mean of a Northamptonshire Healthcare NHS Foundation Trust Research and Innovation Department, and patient consent for publication of the images was obtained. This review will provide a basis for future prospective studies to

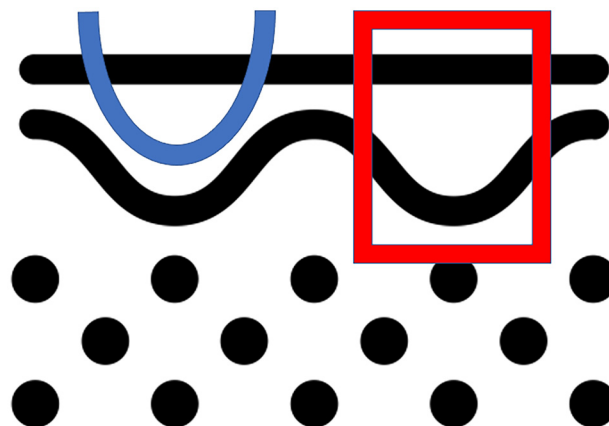


Figure 1. Skin techniques: curette (blue semi-oval); full thickness (red square). (Adapted from Dan Vo, <https://thenounproject.com/icon/dermatology-2451161/>.)



Figure 2. Circular and elliptical excision. (Photograph by Ian Reilly.)

be developed. A scoping review is used to map out and clarify the conceptual boundaries of a topic or field.²² Scoping reviews identify gaps in the existing literature and are useful when a body of literature has yet to be comprehensively reviewed, or exhibits a large, complex, or heterogeneous nature that is not amenable to a systematic review.²³ To support the greater breadth of scoping reviews, a variety of study designs (irrespective of quality) are usually included, but because of the heterogeneity of the data, data synthesis is not typically undertaken.²⁴

This scoping review will use the six-stage methodologic framework (minus stage 6) proposed by Arksey and O'Malley²³ and later amended by Levac et al.²⁵ The stages of the framework for conducting a scoping study are as follows:

Stage 1: identifying the research question.

Stage 2: identifying relevant studies.

Stage 3: study selection.

Stage 4: charting the data.

Stage 5: collating, summarizing, and reporting the results.

Stage 6: consultation (this stage is considered optional: not required for this study).

Stage 1: Identifying the Research Question

The Joanna Briggs Institute for scoping reviews recommends the Population, Concept and Context framework to identify the main concepts in review questions²⁶:

- Population: patients with IPKs.
- Concept: surgical excision by means of sharp excision, curettage, or punch biopsy.
- Context: all study designs and book chapters with no date restrictions.

Stage 2: Identifying Relevant Studies

To achieve the objective, the authors adopted a strategy that involved searching for all levels of research evidence by means of different sources:

- Electronic databases.
- Google Scholar.
- Reference lists.

Search Strategy

- Step 1: Databases were searched by means of the UK NHS Healthcare Advanced Database search

engines AMED, CINAHL, EMBASE, and MEDLINE using MeSh terms and free text the keywords:

- “((corn).ti,ab OR (heloma*).ti,ab OR (keratos*).ti,ab) AND ((excision).ti,ab OR (surgery).ti,ab OR (curettage).ti,ab OR (punch).ti,ab).”
- Step 2: Google Scholar was searched using keywords identified from an analysis of the text words contained in the title and abstract of retrieved articles, and these key words were used to search for articles.
- Step 3: examining the reference lists of all identified sources from steps 1 and 2.

Stage 3: Study Selection

Following the execution of the search strategy, the identified records were retrieved in full, which were then evaluated regarding the quality of the information found and included or excluded according to the following criteria: articles where a plantar IPK was excised by sharp excision, skin flap, punch biopsy, curettage, or excochleation were included. Articles where a different lesion (eg, a plantar wart) was excised by sharp excision, skin flap, punch biopsy, curettage, or excochleation; the excision was not from the plantar foot; and in cases where the original manuscript could not be retrieved, were not in English, or were in the gray literature were excluded.

Stage 4: Charting the Data

The data were charted according to theme.

Stage 5: Collating, Summarizing, and Reporting the Results

The data were charted according to the criteria outlined by Peters et al²⁶ and adapted for use in this review.

Stage 6: Consultation

This stage is considered optional (not required for this study). In 2018, the Preferred Reporting Items for Systematic Reviews (PRISMA) statement was extended to include Scoping Reviews.²⁷ This study followed that process.

Results

A database search by means of the NHS Healthcare Databases Advanced Search yielded 1,056 articles, 12 of which appeared to be of potential relevance. After removing five duplicate articles, this total was reduced to seven, which were retrieved as full texts. Three were excluded at this point, as they were not related to IPK excision. Thirteen further articles were found through Google Scholar, and extraction from the reference lists from the full texts retrieved to provide 17 articles for review. One was discounted because it was not written in English (it also did not appear relevant), and one article did not relate to IPK excision, leaving 15 articles for data extraction (Fig. 3²⁷).

The data were charted according to the following criteria outlined by Peters et al²⁶ and adapted for use in this review (Table 1)¹⁻⁵⁹:

1. Author(s).
2. Year of publication.
3. Origin, or country of origin (where the source was published or conducted).
4. Aims and purpose.
5. Population and sample size within the source of evidence (if applicable).
6. Methodology.
7. Intervention type, comparator, and details of these (eg, duration of the intervention), if applicable.
8. Outcomes and details of these (eg, how they were measured), where applicable.
9. Key findings that relate to the scoping review question(s).

Iterative charting of the included articles yielded overlapping codes and two main themes:

1. Closure: by primary intention (sutures) with or without a skin flap; or by secondary intention (open).
2. Combination of IPK excision with other (eg, bony) surgery.

The articles ranged in academic rigor and strength from technical articles, single-case studies, and case series to retrospective audits. American podiatric references dominate by number.

Discussion

This scoping review has identified the nature and extent of the evidence base available on the

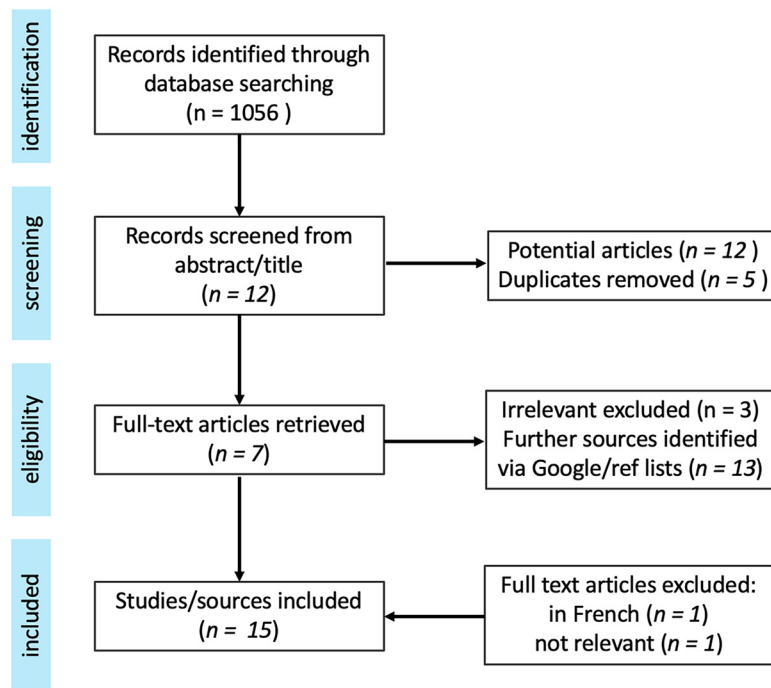


Figure 3. Preferred Reporting Items for Systematic Reviews flow chart. (From Tricco AC, Lillie E, Zarin W, et al: PRISMA extension for scoping reviews [PRISMA-ScR]: checklist and explanation. *Ann Intern Med* 169: 467, 2018).

surgical excision of IPKs of the foot. A search strategy was developed and executed; 15 articles were available for data extraction. Iterative charting of the included articles yielded two main themes: closure and combination with other surgery.

Mann and Mann²⁸ suggest that when an anatomical or structural abnormality disrupts the weight-bearing pattern, abnormal weight transfer occurs, which results in abnormal weight distribution and an IPK. Clinicians and practitioners must remember that not all hyperkeratotic lesions are the same, as there is significant morphologic variability from one lesion to another and from one patient to another. One corn will manifest different characteristics than others in terms of location, thickness, pattern, and symptomatology. Spink et al³ highlighted the proposed association between elevated pressures and plantar hyperkeratotic lesions, and that some authors have suggested that there are characteristic patterns of lesion formation related to different “foot types.” They also noted that associations have not been confirmed with objective data and considered that lesion distribution patterns are influenced by other variables, such as body weight, footwear, foot dominance, and concurrent deformities. Thus, clinicians and practitioners should

consider whether lesions, which develop on first and fifth MPJs in a rigid, plantarflexed first ray–type foot, will similarly respond to treatment to a solitary lesion under the second MPJ in the hypermobile first ray–type foot.

A corn biopsy will reveal hyperplasia, a proliferation of all epidermal layers (acanthosis), including the stratum corneum and loss of the underlying stratum granulosum. Cells at the stratum corneum layers will retain their nuclei (parakeratosis), indicating premature or incomplete differentiation. The dermis may often show dense fibrous tissue with hypertrophied nerves, and scar tissue may extend to or replace the subcutaneous fat.^{7,14} Al About and Yarrarapu⁷ suggest that histopathologic examination of a corn is unnecessary but may be helpful to differentiate corns from other hyperkeratotic conditions such as verruca pedis. In contrast, Schofield²⁹ states that any tissue removed from a patient must be sent for histologic examination to confirm the diagnosis, which may be different from the provisional diagnosis.

A study by Lopez and Kilmartin³⁰ noted the presence of viral elements in classically presenting corns. This is supported by the senior author’s unpublished data from the Northamptonshire Department of Podiatric Surgery, demonstrating

Table 1. Extracted Data

Reference	Country	Aim	Population	Methodology	Intervention	Outcome/Findings
Bouché et al, 1995 ⁴⁹	United States	To describe unilobed and bilobed flaps for excision of plantar skin lesions	Not stated	Technical article on flap design	Unilobed and bilobed flaps with primary closure	N/A; technical article
Carmona et al, 2009 ⁵⁰	Spain	To describe an epidermoid cyst as a possible cause of IPK	Single patient	Case report	Semielliptical incision with primary closure	No recurrence at 1 year
Dockery, 1995 ⁵¹	United States	To describe the Schruddle flap	Not stated	Technical article on flap design	Schruddle flap with primary closure	N/A; technical article
Dorkar et al, 2015 ⁵²	India	To study three corn excision methods	90 patients in three groups	Prospective trial	Excision with primary closure; excision and secondary intention healing; salicylic acid	9.68%, 3.33%, and 16.67% recurrence across the three groups at 6 mo
Gibbard and Kilmartin, 2003 ³²	United Kingdom	To assess the Weil osteotomy (with corn excision)	33 feet in 29 patients	Case series	Weil osteotomy with IPK excision/secondary healing	27% recurrence at 42.4 mo (average) but reduced symptomatology in those that remained
Güngör et al, 2014 ⁵³	Turkey	To describe punch excision for corns	17 corns in 15 patients	Case series	Punch excision; healing by secondary intention	Complete resolution in 12 of 17 corns
Kuwada et al, 1983 ³³	United States	To describe osteotomy with corn excision	70 osteotomies in 50 patients	Case series	Elliptical incisions with primary closure in combination with osteotomy	4% recurrence
Kuwada, 1995 ⁵⁴	United States	To describe plantar incisional approaches	Not stated	Review article	Elliptical incisions with primary closure in combination with osteotomy	N/A; review article
Lopez and Kilmartin, 2016 ³⁰	United Kingdom	To describe a full-thickness skin excision	43 patients	Case series	Primary excision with limited concomitant bony procedure	No recurrence in 46.5%; 51.2% diagnosis of verrucae on histopathology
Pontious et al, 1998 ⁵⁵	United States	To describe occasional corn excision with V osteotomy	40 osteotomies	Case series	Excision of lesion in combination with osteotomy (12.5% of cases)	Cannot be extrapolated for lesion excision alone
Richardson et al, 1993 ⁵⁶	United States	To describe plantar incisional approaches	172 plantar incisions in 1,137 patients (all pathology)	Case series	Not stated	Cannot be extrapolated for lesion excision alone
Sacchidanand et al, 2012 ⁵⁷	India	To describe punch excision for corns	6 patients	Case series	Punch excision; healing by secondary intention	No recurrence
Saipoor et al, 2018 ³⁴	United Kingdom	To audit outcomes after skin flap corn excisions	54 patients; 36 included	Case series	Schruddle flap; primary closure	88.9% patient satisfaction
Satterfield and Jolly, 1994 ³⁸	United States	To describe a plantar incisional approach	13 feet in 12 patients (5 IPKs)	Case series	Advancement flap and primary closure	52.9% patient satisfaction

Table 1. continued

Reference	Country	Aim	Population	Methodology	Intervention	Outcome/Findings
Wang et al, 2017 ⁵⁹	Taiwan	To describe a split-thickness skin graft for corn excision	Not stated	Case series	Plantar split-thickness skin graft	Not clear from paper

Abbreviations: IPK; intractable plantar hyperkeratosis; N/A, not applicable.

that approximately 90% of IPKs sent for histopathology are diagnosed as viral. This information may lead practitioners to examine the usefulness of the term neurovascular corn and pose further questions. Are most lesions clinically diagnosed as IPKs in fact verruca pedis lesions that have transformed into IPKs? Or is the hyperkeratotic tissue a result of dried-out, virally infected corneocytes and not a corn in the truest sense? Human papillomavirus requires a breach in the epidermis to gain entry to the basal layer; therefore, it may be that the points of highest mechanical pressure create optimal conditions for viral infection. **Or else it could be hypothesized that the viral lesion that forms is compounded by weightbearing pressure, leading to a hyperkeratotic lesion that would appear even to the most trained eye as a corn but as a verruca under the microscope.** The authors think that the latter is likely, and this concurs with an observation made by Lemont,³¹ who presented a case study of a similar lesion that was frequently referred to as heloma neurofibrosum. Historically, these were thought to contain “entrapped nerve filaments”¹¹ because of the exquisite pain brought about by these lesions. However, Lemont noted that on histology, the cutaneous projections were keratin, not nerve tissue, and that the granular layer contained viral material.

Lopez and Kilmartin³⁰ discuss metatarsal surgery, which is performed to alter the relative metatarsal height or length, and is used to treat IPKs, but they also note the reported high recurrence rate. They suggest that the high failure rate of metatarsal surgery (changing the architecture of the foot) may be attributable to the number of viral lesions rather than mechanical lesions. Conversely, this would support the argument for sharp excision of IPKs as the initial surgical option before bony surgery. Where IPK excision is carried out in combination with bony surgery,³² the authors cannot ascertain whether the procedure’s bony or skin surgery component was the most effective. Lopez and Kilmartin conclude that lesser metatarsal osteotomy for plantar keratosis should not be undertaken until histopathologic examination has determined whether the lesion is of viral origin. They now excise all lesions and refer for histopathologic examination before considering lesser metatarsal osteotomy.

Lopez and Kilmartin³⁰ remove the lesion by full-thickness excision, as others in the retrieved sample of literature likewise do. Some authors³³ primarily close an elliptical incision, whereas others³⁴ promote flap closure. What cannot be concluded from this small sample of published evidence is whether one surgical technique conveys an advantage or

disadvantage over another. It could be argued that healing by secondary intention may create a smaller, flat scar. In contrast, the use of an advancement flap or a rotation flap may create more tissue trauma, with a greater risk of perilesional fibrosis.

This review is limited by the small sample of data from which to conclude. However, key themes highlight the importance of histopathologic examination of excised lesions to establish any viral involvement, in addition to considering the high complication rates associated with bony surgery. Thus, the research question becomes: Can we develop skin-based strategies for IPK that avoid the greater complication rates seen with invasive bony surgery?

An allied area of study exists examining the surgical dissection of plantar warts. Much of the research uses curettage rather than a full-thickness excision.³³⁻⁴² Similarly, the use of electro-surgery for IPKs⁴³⁻⁴⁸ was beyond the scope of this article, but its application for helomata should also be considered for future research.

Conclusions

This scoping review has produced a relatively small sample of literature. Fifteen articles have been identified that, considering the time frame and range of surgical specialities that treat the condition, represent a disappointingly small breadth of literature. The academic currency should also be considered, as many of these are older articles, and the methodologic quality of the sample is varied. That being said, there is modest evidence that excision of the lesion (either with primary closure or healing by means of secondary intention) can be helpful in managing IPKs, considering the hypothesis that many of these IPKs are viral in origin rather than mechanical. The authors conclude that prospective studies need to be performed with cross-reference of the lesion excision by anatomical site and other patient-related factors, as indicated from the available literature.

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