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Systematic review of the advantages of trichloroacetic acid and electrocautery therapy in verruca vulgaris

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Systematic Review

ABSTRACT

Verruca vulgaris (VV), a cutaneous disorder associated with human papillomavirus (HPV), presents as a benign proliferation of keratinocytes. Verruca vulgaris therapy with destructive methods such as trichloroacetic acid (TCA) and electrocautery is the most commonly used therapeutic modality. The study aims to assess the therapeutic efficacy and clinical benefit of trichloroacetic acid (TCA) and electrosurgery in managing VV by synthesising evidence from clinical studies or case series. Systematic review adhered to the guidelines outlined in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA). To ensure the collection of accurate and relevant information, literature searches were conducted across PubMed, Google Scholar and Cochrane Library covering publications from 2014 to 2023. Twelve studies were included, comprising eight articles on TCA and four articles on electrosurgery. Trichloroacetic acid achieved a maximum cure rate of 93.3% while electrosurgery reached 100%. During six-month follow-up period, TCA showed no recurrence (0%), whereas electrosurgery had a recurrence rate of 21,9%. Electrocautery has more advantages than TCA with a higher cure rate. Even though it has a higher cure rate, electrocautery has a higher recurrence rate with more severe side effects than TCA.

INTRODUCTION

Verruca vulgaris (VV) is a skin condition resulting from an infection of the human papillomavirus (HPV), which is characterised by benign proliferation of keratinocytes.[1,2] The most common skin disease is experienced throughout the world and mainly affects young adults and adolescents.[3] The global prevalence of VV is estimated to reach 10%.[4] In 2015, Plant et al. reported 52 cases of VV in Manado City, Indonesia, over the last 5 years, equating to a prevalence rate of 10.4 cases per year.[5]

Verruca vulgaris lesions are characterised by the presence of exophytic hyperkeratotic lesions, dome-shaped papules of various sizes with a rough surface.[6] Transmission of VV occurs relatively easily through direct contact with sufferers or through contact with an environment that has been contaminated with HPV.[7,8] Verruca vulgaris lesions are benign and usually appear in easily visible locations such as the hands and feet.[3] There are several therapeutic modalities that have been developed for VV, with trichloroacetic acid (TCA) being the commonest. However, there is no therapeutic modality that is 100% effective in treating VV.[9,10]

Verruca vulgaris therapy with destructive methods such as TCA and electrocautery is the most commonly used therapeutic modality. Trichloroacetic acid acts by chemical coagulation of the lesions. Meanwhile, electrocautery is a type of destructive therapy that targets VV by direct burning. Both of them destroy verruca vulgaris lesions without targeting HPV itself. The use of this therapy is often accompanied by the appearance of scars.[8,10] This systematic review evaluates

the comparative advantages of trichloroacetic acid (TCA) and electrocautery as therapeutic options for verruca vulgaris (VV).

METHODS

The systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which include a 27-item checklist and a flow diagram to ensure comprehensive and transparent reporting of systematic reviews. However, it was not registered with the International Prospective Register of Systematic Reviews (PROSPERO).

Eligibility criteria

Studies were selected based on strict inclusion criteria: (1) clinical trials, randomised controlled trials (RCTs), or case series investigating trichloroacetic acid (TCA) or electrosurgery for verruca vulgaris (VV); (2) full-text availability in English; (3) publication between 2014 and 2023 to prioritise recent evidence; (4) interventions involving TCA or electrosurgery; and (5) reported outcomes such as cure rates, recurrence rates, or adverse effects. Studies with irretrievable full texts or non-English publications were excluded. Data extraction focused on author names, publication year, study design, geographic location, follow-up duration, sample characteristics, intervention details (e.g., TCA concentration, electrosurgery parameters), and clinical outcomes (e.g., efficacy, side effects). While the English-only criterion ensured consistency in data interpretation, it may have introduced selection bias by excluding relevant non-English studies. This methodology balanced rigour and feasibility, emphasising clinically actionable outcomes while maintaining transparency through dual-reviewer verification during extraction.

Search strategy

A search was performed to identify studies evaluating the use of trichloroacetic acid (TCA) as a chemical cautery and electrocautery treatment for verruca vulgaris (VV) between 2014 and 2023, utilizing the following keywords: ((*Verruca vulgaris*) OR (*Common Warts*) OR (HPV) OR (*Human papilloma virus*)) AND ((TCA) OR (*Trichloroacetic acid*)) AND ((*Management*) OR (*Therapy*) OR (*Treatment*)), ((*Verruca vulgaris*) OR (*Common Warts*) OR (HPV) OR (*Human papilloma virus*)) AND ((Electrocautery) OR (Electrocauter) OR (Electrosurgery) OR (Electrosurgical)) AND ((Management) OR (Therapy) OR (Treatment)).

The researchers conducted independent searches across multiple databases, including PubMed, Google Scholar, and the Cochrane Library, with their decisions systematically documented using Microsoft Excel.

Data collection process and data item

Two reviewers independently extracted data using a predefined form, including authors, intervention, duration of treatment, number of subjects, mean age of subjects, count of lesions, advantages, side effects, and recurrence rate. The selection was assisted by Rayyan.ai (https://www.rayyan.ai/) and manually re-evaluated by the authors. The data that passes the selection is then synthesised and presented descriptively through tables according to the data collection carried out by the author.

Study selection and characteristics

The initial search process yielded a total of 1,041 articles. After removing 44 duplicate entries, 705 articles were excluded based on abstract screening, leaving 292 full-text articles for eligibility assessment. Out of these, 12 studies met the inclusion criteria and were included in this systematic review, comprising 3 quasi-experimental studies and 9 randomised controlled trials (RCTs). The detailed flow of the article selection process is illustrated in Figure 1.

Study of bias assessment

The revised Cochrane Risk-of-Bias Tool (RoB 2) was used to evaluate study quality. Each domain was assessed as low, high, or unclear risk using Review Manager 5.4.1.[11] The evaluation of the risk of bias between studies was conducted by 2 authors, if there was any discrepancy between the two, it was resolved by a third party.

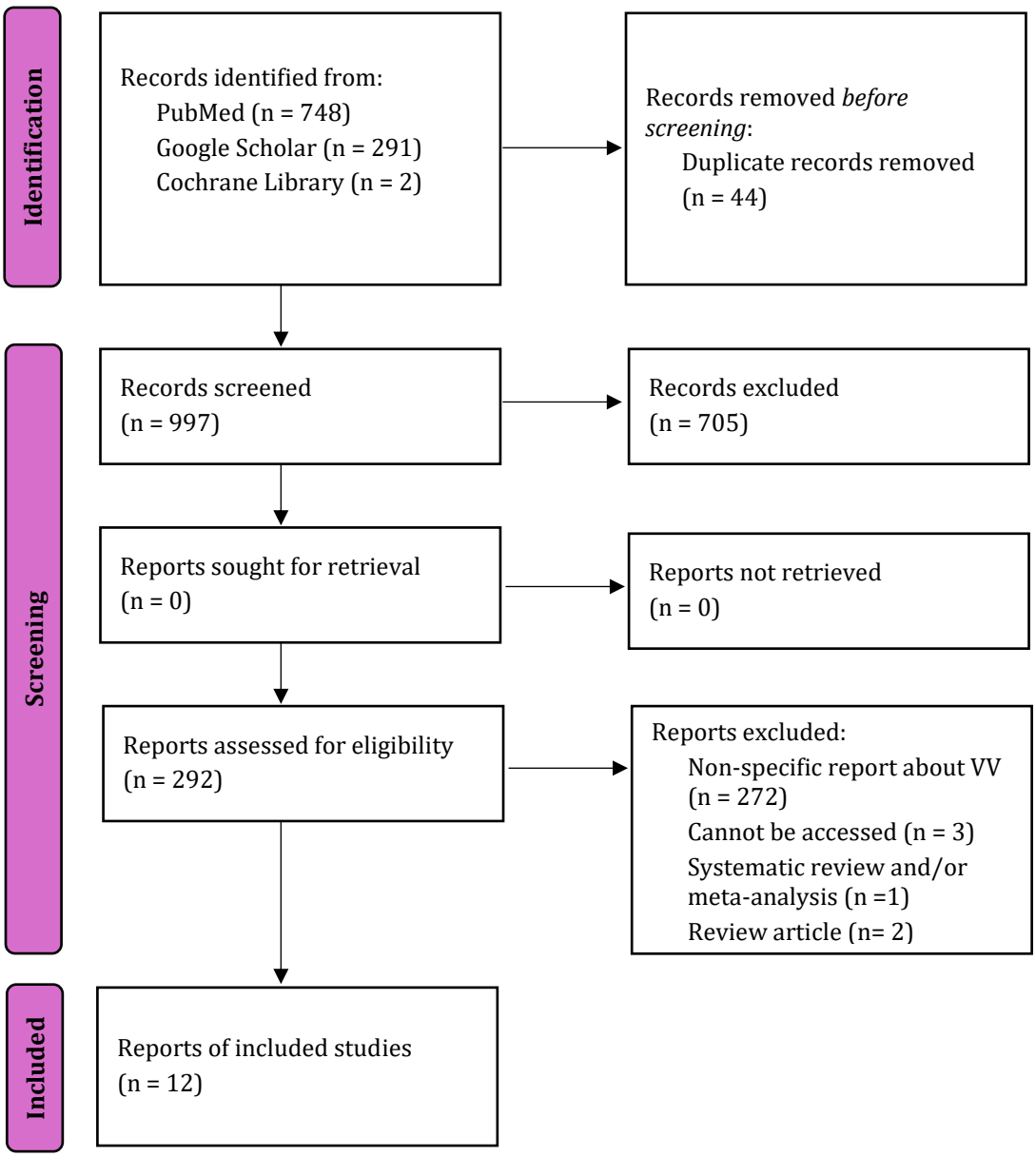

Figure 1. PRISMA chart. Adapted from Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *International Journal of surgery.* 2021; 88: 105906. Creative Commons

RESULTS

The outcomes of each study are summarised in Tables 1 and 2. The cure rates for chemical cautery using TCA varied widely, ranging from 3.7% to 66.65% for partial clearance and 11.11% to 93.3% for complete clearance. In comparison, the cure rates for electrosurgery ranged from 20% to 100%. Following a six-month follow-up, the recurrence rates were 27.6% for chemical cautery with TCA and 14.6% for electrosurgery. Electrosurgery was associated with several adverse effects, including bleeding and scar formation, with pain being the most frequently

reported side effect. On the other hand, the most commonly reported adverse effects of chemical cautery with TCA were pain and a burning sensation.

There were 787 subjects who received TCA therapy (mean age of 23.87 years) and 381 subjects who received electrocautery therapy (mean age of 24.8 years). The duration of TCA therapy ranges from 4 to 12 weeks. The cure rate for TCA ranges from 11.11% to 93.3% for complete cure and 3.7% to 66.65% for partial cure, while the cure rate for electrocautery ranges from 75% to 100%. One article even reported spontaneous resolution of lesions that did not receive electrocautery intervention. Reported side effects of intervention with TCAs are pain, hyperpigmentation, itching, ulcers, erythema, burning, and bullae. Electrocautery has reported side effects, including infection, pain, ulcers, scars, impaired wound healing, and post-inflammatory dyspigmentation. The TCA recurrence rate was reported to be 0% from three studies with a follow-up period of 12-24 weeks, and the electrocautery recurrence rate ranged from 14.5% to 23% with a follow-up period of 12-24 weeks. There is one study of TCA that reported a recurrence rate of 6.6% with a follow-up period of 3 months. A summary of outcomes can be seen in Tables 1 and 2.

Tabel 1. Articles Addressing of Trichloroacetic Acid (TCA)

Authors (study design)	Intervention	Duration	Amount	Age	Number of lesions	Advantages	Side effect	Recurrence rate
Helmy,[12] 2023 (*quasi-experimental*)	TCA 80%; TCA 100%	6 weeks	30 (18 male; 12 female)	Average 29,47 years old	NR	Complete response 50%; Partial response 40%	12% pain minimal; 10% hyperpigmentation	NR
Basavarajappa,[13] 2021 (RCT)	TCA 30%	12 weeks	60 (30 male; 30 female)	Average 22,87 years old	Mostly 1-3; 3-6 lesions	Complete response 93,3%; Partial response 6,7%	60% pain; 6,7% burning sensation	0% after 6 months
Karrabi,[14] 2020 (RCT)	TCA 40%	4 weeks	60 (41male; 19 female)	Average 20,16 years old	NR	Complete response 86,67%; Partial response 13,33%	Bulae, pain, ulcer, and erythema	0% after 6 months
Meguid,[15] 2019 (*quasi-experimental*)	TCA 90%	6 weeks	414 (95 male; 319 female)	Average 26,34 years old	NR	Complete response 21,3%; Partial response 6,4%	34,7% hyperpigmentation	NR
Recanati,[16] 2018 (RCT)	TCA	8 weeks	29 (not mentioned)	not mentioned	2,33	Complete response 66%	Pain	NR

Authors (study design)	Intervention	Duration	Amount	Age	Number of lesions	Advantages	Side effect	Recurrence rate
Jayaprasad,[17] 2016 (*quasi-experimental*)	TCA 30%	12 weeks	54 (23 male; 31 female)	Average 28,96 years old	17,62	Complete response 11,11%; Partial response 66,65%	66,67% burn sensation; 37,03% dyspigmentation	0% after 3 months
Cengiz,[18] 2016 (RCT)	TCA 40%	4 weeks	60 (28 male; 32 female)	Average 22,6 years old	NR	Complete response 33,33%; Partial response 46,6%	76,7% pain; 72% erythema; 10% itch; 26,6% ulcer; 26,6% bullae	6,6% after 3 months
Cengiz,[19] 2015 (RCT)	TCA 10%; TCA 25%	8 weeks	80 (not mentioned)	Average 16,68 years old	10,8	TCA 10%: Complete response 85,7% TCA 25%: Complete response 92,6%; Parsial response 3,7%	TCA 10%: 3,6% pain; 7,1% erythema; 50% itch; 10,7% hyperpigmentation TCA 25%: 25,9% pain; 37% erythema, ;77,8% itch; 48,1% hyperpigmentation	NR

TCA: Trichloroacetic acid; HIV: Human immunodeficiency virus; RCT: Randomised control trial; NR: Not reported

Tabel 2. Articles Addressing of Electrosurgery

Authors (study design)	Evaluation	Amount	Age	Number of lesions	Advantages	Side effect	Recurrence rate
Anwar,[20] 2021 (RCT)	8 weeks	50 (27 male; 23 female)	Average 23,22 years old	≤6	Complete response 80%; Partial response 20%	Erythema, scar	NR
Singh,[21] 2020 (RCT)	6 weeks	108 male	Average 25,45 years old	4	75%	Pain, infection, impaired wound healing, post-inflammatory dyspigmentation, scar	21,9% after 24 weeks
Haroon,[22] 2020 (RCT)	12 weeks	192 (119 male; 73 female)	Average 23,08 years old	NR	87,3%	Hyperpigmentation, hypopigmentation, depygmentation	14,5% after 12 weeks

Authors (study design)	Evaluation	Amount	Age	Number of lesions	Advantages	Side effect	Recurrence rate
Awad,[23] 2019 (RCT)	12 weeks	31 (20 male; 11 female)	Average 27,43 years old	10,26	100% resolution complete	Infection; ulcer	23% after 12 weeks

RCT: Randomised controlled trial; NR: Not reported

Risk of bias analysis was presented in Figures 2 and 3. Most included studies demonstrated low risk of bias in core methodological domains, strengthening the reliability of the review findings. There remain specific risk areas—particularly blinding and reporting bias—where further methodological rigour or clearer reporting is needed to enhance study quality and interpretability.

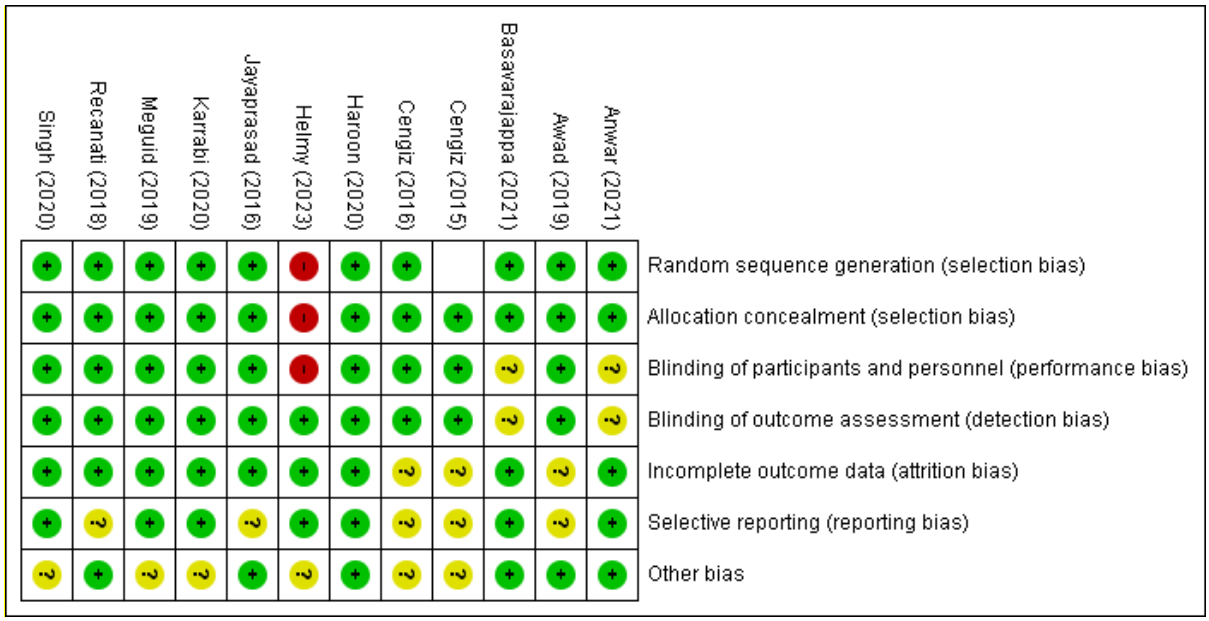

Figure 2. Risk of bias summary

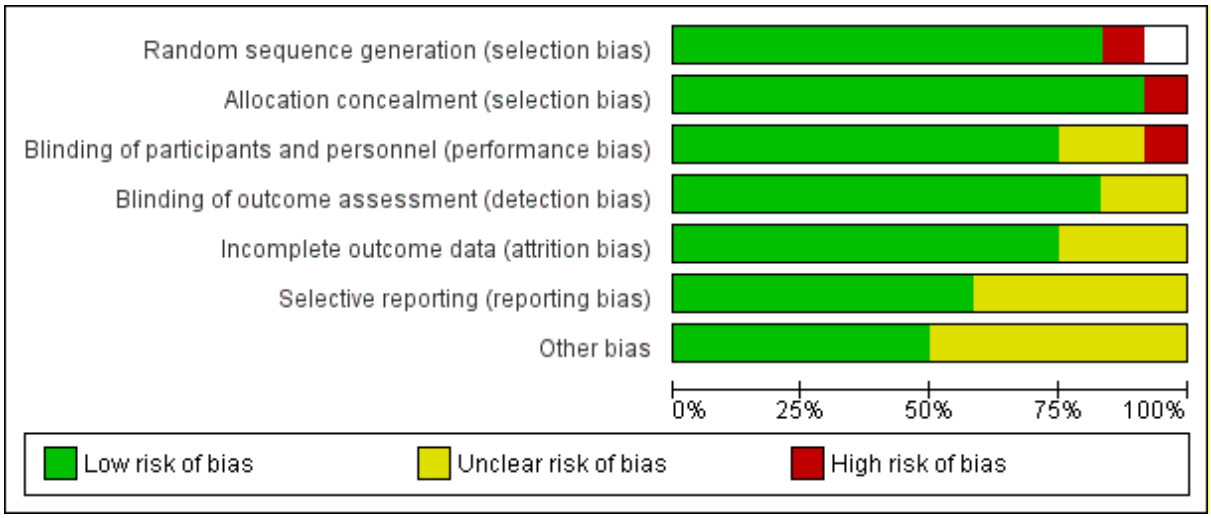

Figure 3. Risk of bias graph

DISCUSSION

Verruca vulgaris is a disease characterised by keratinocyte proliferation caused by HPV infection. This viral skin disease is quite common, with a prevalence rate of up to 10%.[24,25] Human papillomavirus is a double-stranded DNA virus with over 200 identified types. Human papillomavirus can be categorised into high-risk and low-risk types based on its potential to cause malignancies. Its life cycle is intricately linked to the processes of epithelial cell proliferation and differentiation. HPV infection of the skin generally manifests in various parts of the body. HPV infection in VV itself manifests on the hands and feet.[26] Most HPV infections of the skin cause benign proliferative lesions and rarely develop into malignancies such as squamous cell carcinoma (SCC).[27,28]

Verruca vulgaris is transmitted through direct contact and infects keratinocytes or the mucosal lining of the body. Verruca vulgaris is rarely a serious health problem, but VV can cause physical and psychosocial disorders.[29,30] The incubation period for HPV infection varies based on the inoculation titer and can range from 3 weeks to 8 months before lesions become visible. These lesions are commonly found on the hands, arms, and legs but can also develop on any part of the skin or, less frequently, on mucosal surfaces.[31] The clinical picture of VV is hyperkeratotic and exophytic lesions with rough surfaces and varying sizes. Lesions can also be accompanied by papules with a dome-like shape.[32] Diagnosis of VV is mostly done clinically, with visual analysis of lesions as the most common method, especially because the cost of genotyping using polymerase chain reaction (PCR) is quite expensive.[33,34]The use of dermoscopy as a diagnostic modality for VV has increased over recent years. VV dermoscopy can show dots and lumps that can be red, brown, or black, which occur as a result of widening of the capillaries. The capillaries are located in a white halo, which gives a frog-like appearance.[35,36]

There are various treatment modalities available for VV depending on the size, severity, location, and type of lesion caused. The choice of therapeutic modality also depends on the patient's immune status.[1,37] The currently available therapeutic modalities for VV are generally divided into destructive therapy and immunotherapy. Destructive therapy focuses on destroying the lesion, while immunotherapy focuses on eliminating HPV as the virus that causes VP lesions.[38] Several types of immunotherapy currently available include mumps antigen injection, hepatitis B virus vaccine, and Candida antigen.[39,40,41] Destructive therapy options are generally divided into chemical destructive therapy and mechanical destructive therapy. Several types of chemical destructive therapy include TCA, salicylic acid, 5-fluorouracil, cryotherapy, silver nitrate, phenol, cantharidin, formic acid, pyruvic acid, glycolic acid, zinc oxide, monochloroacetic acid, and imiquimod, while several types of therapy, including mechanical destructive therapy, are electrocautery, laser, and surgical excision.[42,43] Management of VV has largely focused on destructive therapy rather than immunotherapy.[1]

In this systematic review, we compare the effectiveness of two types of destructive therapy, namely chemical destructive therapy with TCA and mechanical destructive therapy with electrocautery, as a treatment modality commonly used in VV. To the best of the authors' knowledge, this is the first systematic review to compare the effectiveness of VV treatment using TCA and electrocautery. The results of this systematic review found that electrocautery has a higher cure rate than TCA in studies published over the last 10 years. Even though it has a higher cure rate, VV therapy with electrocautery has a higher recurrence rate with more severe side effects. TCA therapy modalities have a treatment duration ranging from 4 to 12 weeks.

In this study, TCA demonstrated the highest effectiveness in subjects with an average age of 22.87 years, achieving a complete cure rate of 93.3% and a partial cure rate of 6.7%. The effectiveness of TCA was reported to be lowest in subjects with a mean age of 28.96 years, with a total cure rate of 11.11% and a partial cure rate of 66.65%. Low cure rates tend to be observed in interventions with high TCA concentrations (80-100%), whereas with low-medium TCA concentrations (10-40%), the total cure rate can exceed 90%. However, there are two studies using moderately low concentrations of TCA with relatively low cure rates. These two studies are quasi-experimental studies, so it is suspected that there is a lack of randomisation, which causes the cure rate to be low in both studies.

TCA is a type of destructive therapy for VV that works by triggering protein hydrolysis in target cells, which then causes apoptosis. TCA is available in low concentrations (10-30%), medium concentrations (30-50%), and high concentrations (50-90%). Low-concentration TCA can be used for superficial exfoliation or peeling, while high-concentration TCA is generally used for deep peeling.[44,45] Superficial peeling can reduce the thickness of the stratum corneum layer by triggering protein deposition and cell necrosis in the epidermis layer of the skin. TCA concentrations >15% can reach the papillary layer of the dermis to the upper reticular layer of the dermis and trigger necrosis of skin collagen compounds. Meanwhile, the acid content in TCA causes protein coagulation and has an impact on keratinocyte death and skin peeling.[46,47] The lack of effectiveness in healing high concentrations of TCA in VV, as found in this study, is thought to be because TCA concentrations that are too high not only damage VV lesions but are thought to also damage healthy skin structures due to their high penetration ability, causing the elimination of lesions to be less than optimal.

The cure rate using electrocautery in this study reached 75-100%, higher than TCA. Electrocautery works by passing high-frequency electricity through the cautery, which then produces intense heat, causing tissue damage. This electrical flow can occur due to the transfer of electrons from one atom to another. The pressure difference is the force that allows this phenomenon to occur. The ultimate goal of electrocautery is coagulation, separation, and desiccation.[48,49] Even though it has a higher cure rate, the side effects caused by electrocautery are more severe than TCA. Some of the side effects reported in several articles that have been identified include pain, scars, infections, ulcers, and disturbances in the wound healing process. Scarring is the main side effect that has been reported in several previous studies. Bleeding is also a side effect that is frequently reported but was not observed in this study.[50,51,52]

There are several factors that cause scarring during the electrocautery procedure, such as speed of incision, genetic factors, comorbidities, age, amount of electrical power, and the type of active tip used as an electrode. The small size of the electrode can transmit more concentrated electricity and result in faster tissue cutting.[53] Meanwhile, the side effects caused by TCAs tend to be mild and minimal, such as pain, hyperpigmentation, burning, bullae, and ulcers. Even though it has a higher cure rate, the recurrence rate for electrocautery is higher than for TCA. The electrocautery recurrence rate ranged from 14.5% to 23%, while the TCA recurrence rate from one study was reported as 6.6%, although four studies did not report the recurrence rate. Several factors influence the incidence of resistance to VV, such as immune status, age, smoking history, and HPV reinfection.[54] Patients aged >25 years are reported to be twice as likely to experience recurrence. Meanwhile, smokers have a five times higher risk of recurrence. This is due to the suppressive effects of the immune system and chronic inflammation caused by smoking.[8] In addition, the higher recurrence rate in electrocautery may be due to the presence of lesions, especially small and micro lesions that cannot be removed with electrocautery, thus resulting in the recurrence of VV lesions.[1]

Thus, in general, electrocautery has a higher cure rate but causes more severe side effects and a higher recurrence rate than TCA. There are also several other advantages of using TCA compared to electrocautery, such as being easier to use because it does not require local anaesthesia. TCA can be easily performed even by untrained operators, whereas electrocautery should be performed by trained operators to avoid complications.[55] The application of TCA does not result in tissue evaporation, which helps reduce the risk of HPV transmission from the patient to the healthcare provider. Another advantage of using TCA is that the side effects are milder than electrocautery, and the healing process is faster.[56,57]

Limitations of this review are, first, the number of high-quality, recent studies directly comparing TCA to electrocautery remains limited, with only twelve eligible articles. Many studies involved small sample sizes, and the follow-up durations were relatively short, typically limited to three to six months, which may underestimate the true recurrence rates of VV, known to recur up to 26 months post-treatment. Additionally, the heterogeneity in TCA concentration, electrosurgery techniques, and outcome assessment across studies introduced variability that may have affected pooled results and their interpretability. Most of the included studies excluded

non-English publications, resulting in potential language and selection bias, which could limit the global generalisability of findings. Publication bias may also be present, as negative or inconclusive results are less likely to be published. Although the search strategy employed major databases and used recognised MeSH terms, some potentially relevant studies indexed with other terms (e.g., "electrofulguration") or published after the search cutoff may have been missed. Furthermore, this review was not prospectively registered (e.g., with PROSPERO), and a meta-analysis could not be conducted due to the heterogeneity and descriptive nature of available data.

Despite these limitations, this review highlights practical implications for daily dermatological practice. Electrocautery offers a higher cure rate and faster lesion resolution for VV but comes with a greater risk of recurrence and more severe adverse effects, such as scarring and delayed wound healing. The TCA remains a favourable option in many settings, particularly where local anaesthesia or specialised operator training for electrocautery is not available, or where minimising adverse effects is prioritised. Personalising therapy based on patient age, comorbidities, lesion site and size, recurrence risk factors (such as immune status and smoking), and health system resources is crucial for optimal outcomes.

From a policy perspective, the data suggest that making both TCA and electrocautery accessible—alongside clear clinical guidance on their use—would benefit population-level VV management, especially in resource-limited settings. The need for operator training for electrocautery and attention to infection control procedures to limit HPV transmission during ablative procedures also has policy relevance. Future research should address several gaps, such as longer follow-up, extended observation beyond twelve months is needed to accurately determine recurrence, safety, and long-term satisfaction for both TCA and electrocautery. Otherwise, larger and multicenter studies, well-designed randomised controlled trials with larger, more diverse patient populations can increase generalisability and allow subgroup analyses for specific risk factors. Then, broader modalities with comparative effectiveness studies, including other evolving modalities, such as immunomodulators, high-concentration salicylic acid, laser, cryotherapy, and combination or sequential therapies, deserve emphasis. Future studies recommended to assess quality of life, cosmetic results, cost-effectiveness, and patient preferences will further inform shared decision-making.

CONCLUSION

Electrocautery demonstrates more advantages than TCA in the treatment of VV, with a higher cure rate observed. However, despite its greater efficacy, electrocautery is also associated with a higher recurrence rate and more severe adverse effects compared to TCA. Future studies should aim to include longer follow-up periods to better capture late recurrences, investigate additional treatment modalities such as immunomodulator agents or novel topical therapies, and evaluate larger, more diverse patient populations. Furthermore, expanding outcome reporting to include patient quality of life and cost-effectiveness will enhance the clinical relevance of future research in this field.

CONFLICT OF INTEREST

The authors report no conflicts of interest in this work.

ACKNOWLEDFMENTS

None.

REGISTRATION AND PROTOCOL

We did not register this review in the International Prospective Register of Systematic Review (PROSPERO).

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

SUPPLEMENTARY MATERIALS

There are no supplementary materials for this study. All relevant data are fully presented within the main article.

DECLARATION OF USING AI IN THE WRITING PROCESS

The authors have not used any AI tools or technologies to prepare this assessment.

AUTHOR CONTRIBUTIONS

Conceptualisation, N.D.; writing—original draft preparation, L.K., S.P.A and N.D.; writing—review and editing, L.K., S.P.A and N.D.; supervision, N.D. All authors have read and agreed to the published version of the manuscript.

LIST OF ABBREVIATIONS

VV: Verruca Vulgaris; HPV: Human Papilloma Virus; TCA: Trichloroacetic Acid, SCC: Squamous Cell Carcinoma, PCR: Polymerase Chain Reaction.

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