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Clinical Reviews

Evaluation of Depilatory Agents in the Treatment of Hair-Thread Tourniquet Syndrome

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□ **Abstract— *Background* Hair-thread tourniquet syndrome (HTTS) is the constriction of an appendage or tissue by a hair thread, which can cause ischemia and necrosis of distal tissues. Depilatory agents have the potential to release the hair tourniquet without exposing the patient to the risks of surgery. *Objectives*: This review aims to evaluate the effectiveness, benefits, complications, and contraindications of depilatory agents in HTTS. *Methods*: Relevant terms to HTTS and depilatory agents were used to search for articles on MEDLINE and EMBASE databases using the NHS Healthcare Databases Advanced Search engine. *Results*: In total, 19 of the 295 articles identified in the primary search were included in the final review. Articles described the benefits of depilatory agents as painless, well tolerated, and non-invasive. Contraindications described include use on mucosal membranes, non-hair tourniquet, and allergy. Sixty-four percent (n = 55) of patients had resolution of their HTTS after one or two cycles of depilatory agent treatment. *Conclusions*: The use of depilatory agents has multiple potential benefits. The authors propose a treatment algorithm for the use of depilatory agents in HTTS and recommend that all acute centers should store and train staff in their use.**

□ **Keywords—Plastic surgery; Trauma; Wound management; Hair-thread tourniquet syndrome; Pediatrics**

Introduction

Hair-thread tourniquet syndrome (HTTS) is the constriction of an appendage or tissue by a hair thread. It has the potential to cause ischemia and eventual necrosis of distal tissues due to venous and arterial obstruction. Common sites are the toes, fingers, and genitals (1). Treatment typically involves the urgent removal of the tourniquet by either non-operative or operative methods.

Mechanical unwinding of the thread is a quick and effective route to tourniquet resolution; however, in cases where the hair thread cannot be unwound, surgical treatment involving an incision across the area of constriction may be required. Although usually definitive in terms of resolution, surgical treatment is not without risk, including problematic scarring, bleeding, and damage to underlying structures. In children, a general anesthetic may be required.

Depilatory agents may be an alternative to surgical treatment in such cases. They contain the active ingredient thioglycolate, calcium hydroxide, or sodium hydroxide, which work by breaking down the disulfide bonds found in hair keratin, weakening its tensile strength (2). This results in the hair dissolving and the tourniquet constriction

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being released. This extensive literature review aims to evaluate the use of depilatory agents in HTTS, and offer a treatment algorithm based on the available evidence.

Objectives

This literature review aims to evaluate the effectiveness, benefits, complications, and contraindications of depilatory agents in HTTS. A treatment algorithm for HTTS is proposed to help guide physicians.

Methods

Relevant terms to HTTS and depilatory agents were used to search for articles on MEDLINE and EMBASE databases using the NHS Healthcare Databases Advanced Search engine in October 2020. The search strategy was developed by a research librarian. After de-duplication, articles were screened for inclusion. There were no restrictions on the date or type of articles. All articles written in English and reporting on the use of depilatory agents for the treatment of HTTS were included for review. Reference screening was performed for all included studies. Data were extracted, including patient demographics, number of patients, number and type of appendage affected, examination findings, treatment regime, outcome, complications, and author recommendations. Articles discussing the use of depilatory agents, but without outcome data, were also reviewed. Meta-analysis was not performed due to a lack of high-quality comparative studies.

Main Results

The primary search identified 295 articles. After de-duplication, 215 article titles and abstracts were screened according to the exclusion criteria. After this, 54 full texts were reviewed, identifying 19 articles relevant for inclusion (Figure 1). Articles were from eight different countries and were published from 1977 to 2020. Nine were case reports, eight were case series, one was a review article, and one was a conference abstract.

Articles described the benefits of depilatory agents as being painless, well tolerated, and non-invasive (Table 1) (1–19). Contraindications described include use on mucosal membranes, thread/fabric (non-hair) tourniquet, and allergy. All articles that made an evaluation of effectiveness (n = 14) recommend depilatory agent use in either all HTTS, non-ischemic HTTS, superficial HTTS, non-mucosal HTTS, or cases with intact skin.

Of the 19 articles included in this review, five articles reported the use of depilatory agents on 84 patients, 78 of which were from one large case series (Table 2)

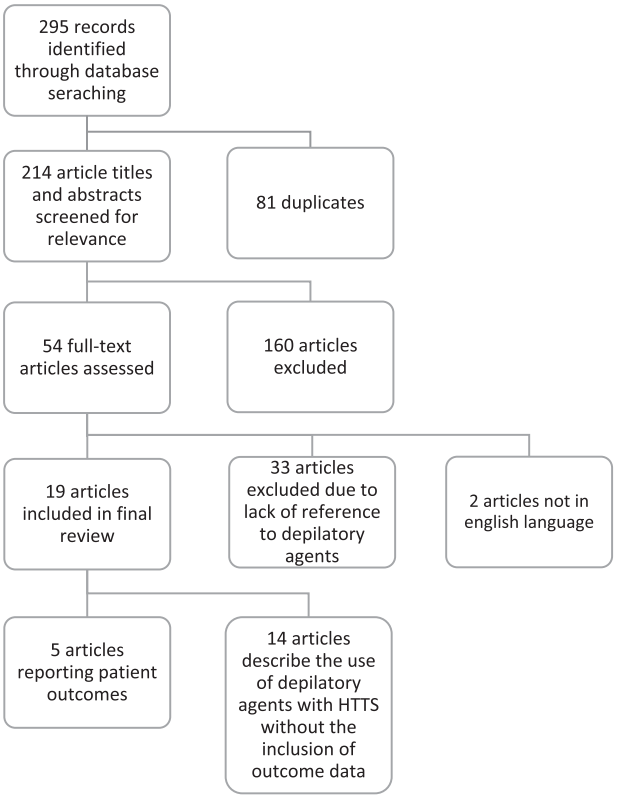

Figure 1. Flow chart showing review selection process. HTTS = hair-thread tourniquet syndrome.

(1,6,8,10,11). All patients were children; however, ages were inconsistently reported. Where age was reported, the mean age was 7 months (range 0.5 to 60, n = 6). Patients had either toe (n = 73), finger (n = 6), or genital (n = 5) HTTS. Examination findings were described in 6 patients; 2 had a capillary refill time more than 2 seconds, 6 had edema, 3 had erythema, 1 had evidence of laceration, and 3 had visualized hair tourniquet. Treatment consisted of application of Nair® (Church & Dwight Co., Inc., Ewing, NJ) or calcium thioglycolate on the hair tourniquet for 3 to 30 min prior to washing the area with water. Treatment cycles were repeated up to three times. Fifty-four percent (n = 45) of patients had resolution of their HTTS after one cycle of treatment with depilatory agents. A second cycle was effective in 26% of cases (n = 10). None had resolution after three cycles. Aside from incomplete removal of the hair tourniquet, no studies report any other complications resulting from the use of depilatory agents.

Discussion

This is the first review to comprehensively review and summarize the available evidence for the use of depilatory agents in the treatment of HTTS. Depilatory agents seem to be an effective treatment for HTTS and have been

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Table 1. Table of Studies Describing the Use of Depilatory Agents in HTTS Without the Inclusion of Outcome Data

Study	Country	Type of Study	Benefits	Contraindications	Complications	Conclusions
Diaz-Morales et al., 2020 (3)	Spain	Case report		Female genitalia Mucous membranes		
Gottlieb et al. 2019, (12)	United States	Review article	Painless Non-invasive	Fabric tourniquet	Skin irritation/ burning/ blistering	Depilatory agents should be considered first.
Aslantürk et al., 2019 (4)	Turkey	Case series		Near mucous membranes e.g. female genitalia. >2 interventions with depilatory agents. Deep HTTS		Surgical treatment was preferred as there were no depilatory agents available and clinicians had no experience in their use.
Dunphy et al., 2017 (2)	United Kingdom	Case report		Broken skin Allergy Polyester/cotton/rayon tourniquet		Treatment algorithm proposed.
Rawls et al., 2020 (5)	United States	Case series	Well tolerated	Mucosal surface Thread/fabric tourniquet	Incomplete removal of hair strands	
Harris, 2002 (7)	United States	Case series		Deep HTTS with tendon involvement		
Kesu Belani et al., 2018 (13)	Malaysia	Conference abstract – case report				Depilatory agents can be used in the treatment of HTTS.
O'Gorman & Ratnapalan, 2011 (10)	Canada	Case report	Minimal discomfort			Physicians should consider depilatory agents.
Alruwaili et al., 2015 (8)	Saudi Arabia	Case series		Deep HTTS Allergy Broken skin		Depilatory agents should be used in superficial HTTS.

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Table 1. (*continued*)

Bean et al., 2015 (1)	United States	Case series	Relatively painless; can be used in male genitalia	Mucous membranes. Tissue necrosis/ ischemia. > 2 interventions with depilatory agents. Female genitalia		The local Emergency Department stores depilatory agents. Treatment algorithm proposed.
Douglas et al., 1977 (11)	United States	Case series				Time permitting, depilatory agents should be tried.
De Vitis et al., 2020 (6)	Italy	Case report	Can be used in female genitalia	Mucous membranes		1 trial with depilatory agents is reasonable.
Barton et al., 1988 (14)	United States	Case series				Depilatory agents have been successful in literature. The constricting material must be completely removed.
Baştuğ et al., 2015 (15)	Turkey	Case report				It has been reported that depilatory agents may be used.
Kesu Belani et al., 2019 (16)	Malaysia	Case report	Minimal discomfort	Non-hair tourniquet		Use of depilatory cream is possible.
Kamal et al., 2014 (17)	Saudi Arabia	Case series		Deep HTTS Nature of constricting band unclear	Incomplete removal	Depilatory agents can be used.
Loloi et al., 2020 (18)	United States	Case report				Depilatory agents can be used.
Imam et al., 2019 (19)	United States	Case report		Mucous membranes		Depilatory agents have been used in literature.
O'Quinn et al., 2006 (9)	United States	Case report		Broken skin		Depilatory agents must be used with caution as they are chemical irritants.

HTTS = hair-thread tourniquet syndrome.

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Table 2. Table of Studies Reporting Outcome Data for the Use of Depilatory Agents in HTTS

Study	Country	Type of study	Patient Group	Area of HTTS	Assessment		Treatment	Outcome	Author Recommendation
O'Gorman et al., 2011 (10)	Canada	Case report	12-week-old male	Toe	1 Cap refill 2 Edema 3 Erythema 4 Laceration 5 Hair visualized	2s + + + +	0.5 μL of calcium thioglycolate applied for 30 min prior to washing.	Completely healed within a few days.	To consider depilatory agents in the treatment of HTTS.
Alruwaili et al., 2015 (8)	Saudi Arabia	Case series	A 6-month-old male	Toe	1 Cap refill 2 Edema 3 Erythema 4 Laceration 5 Hair visualized	3s + − U −	Depilatory agent (Nair®) applied for 10 min prior to washing.	Telephone follow-up indicated complete resolution.	Depilatory cream should be used for superficial HTTS.
			A 15-day-old male	Toe	1 Cap refill 2 Edema 3 Erythema 4 Laceration 5 Hair visualized	3s + + U +	Depilatory agent (unknown) applied for 10 min prior to washing.		
Bean et al., 2015 (1)	United States	Case series	78 children eligible for depilatory agent.	Toe (n = 69), finger (n = 5), and genital (n = 4)	1 Cap refill 2 Edema 3 Erythema 4 Laceration 5 Hair visualized	U U U U U	Depilatory agent (Nair®) applied for 3 min prior to washing. If unsuccessful, a second treatment with depilatory agent (Nair®) is applied for 10 min prior to washing.	51% effective after 1 application, 64% effective after 2 applications, no further effectiveness with more than 2 applications.	Treatment algorithm proposed for the treatment of HTTS.

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Table 2. (*continued*)

Douglas, 1977 (11)	United States	Case series	A 10-month-old	Finger	1 Cap refill 2 Edema 3 Erythema 4 Laceration 5 Hair visualized	U + U U U	Depilatory agent (Nair®) applied for 15 min prior to washing.	Resolution of HTTS.	Time permitting, a depilatory could be tried.
			A 11-month-old female	Toe	1 Cap refill 2 Edema 3 Erythema 4 Laceration 5 Hair visualized	U + U U U			
De Vitis et al., 2020 (6)	Italy	Case report	5-year-old female	Genital	1 Cap refill 2 Edema 3 Erythema 4 Laceration 5 Hair visualized	U + + U +		Unsuccessful. Partial degradation of fibers was noted in theatre.	One trial of depilatory cream should be trialed prior to surgical intervention.

HTTS = hair-thread tourniquet syndrome; Cap refill = capillary refill; + = positive sign; − = negative sign; U = unknown.

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used successfully in toe, finger, and genital HTTS in 55 patients.

Most studies do not recommend the use of depilatory agents on mucosal surfaces, but there is differing opinion regarding their use in cases of female genitalia HTTS (1,3–6). Some view it as an absolute contraindication, whereas others have proven limited effectiveness (6). It would seem reasonable that with clinical discretion, if depilatory agents can be applied carefully without their use on mucosal surfaces, female genitalia HTTS may not be a contraindication. Similarly, some studies do not recommend the use of depilatory agents on open wounds (2,7–9). However, O'Gorman and Ratnapalan have successfully used depilatory agents on HTTS with a laceration (10). Caution is advised with application near open wounds, and clinicians should be advised by manufacturing guidelines in such cases.

Tissue ischemia may be a contraindication to the use of depilatory agents, which instead requires urgent surgical management, as reported by Bean et al. (1). Assessment should include the capillary refill time, skin color, temperature, presence of edema, and skin integrity. No studies describing the use of depilatory agents in HTTS had signs of complete vascular compromise, although capillary refill was prolonged in two cases and edema was present in six cases, indicating a degree of ischemia (6,8,10,11). Where there are early signs of vascular compromise, and where surgical treatment will not be delayed, a trial of treatment with a depilatory cream may be appropriate.

If a tourniquet cannot be seen on direct visualization, topical application of depilatory agents may be less effective. Visualization not only helps with ensuring topical delivery of depilatory agents, it also reassures the clinician that a hair tourniquet is present, as opposed to fabric, thread, or metal. Depilatory agents will prove ineffective on materials other than hair forming a tourniquet (20). Alruwaili et al. describe one successful case of deep HTTS (where hair tourniquet was not visualized) resolving after depilatory agent application, indicating that if the depilatory agent can reach the hair tourniquet, its dissolving effects should take place (8).

Depilatory agents have been used in a number of different regimes (Table 2). The depilatory agent should be applied directly to the area of HTTS and washed off after a set amount of time (3 to 30 min). The optimum duration of application is unclear and clinicians should be guided by manufacturing advice. A second application may be effective in some cases (1). This is evident by the study conducted by Bean et al., whereby the reapplication of a depilatory agent had successfully resolved the hair tourniquet in 26% of patients (n = 10) (1).

De Vitis et al. report a case of female genitalia HTTS that was initially treated with depilatory agents but subsequently needed surgical management (6). In the operating room, they note partial degradation of hair fibers. Although a second application of depilatory agents was not trialed, it is clear that depilatory agents are not always effective. This highlights the importance of appropriate assessment to ensure resolution of the hair tourniquet when using depilatory agents, and patients should not be discharged until complete resolution has been achieved.

Treatment algorithms have been proposed by Bean et al. and Dunphy et al. (1,2). Dunphy et al. would consider depilatory agents after assessment of all HTTS, whereas Bean et al. would consider its use only in non-female genitalia HTTS and where ischemia is not present (1,2). A novel treatment algorithm based on the findings of this review is proposed. In contrast to Bean et al., the authors recommend that the use of depilatory agents may be considered in female genitalia HTTS if topical application on mucosal surfaces can be avoided and manufacturing guidelines are taken into account (Figure 2) (1). The authors also emphasize the importance of emergent surgical intervention in cases of vascular compromise. However, in patients with early signs of vascular compromise and where surgical treatment will not be delayed, trial of a depilatory agent should be considered. Care should be taken when attempting mechanical removal of a hair thread, as this may leave damaged skin complicating the potential use of depilatory agents. Failed treatment with depilatory agents is an indication for surgical treatment, and complete resolution of the HTTS must be confirmed prior to discharging the patient.

Depilatory agents are widely available and inexpensive; an 80-mL bottle can be purchased over the counter for £2. In contrast, minor surgery in the United Kingdom has been shown to cost £449 in primary care and £1222 in the hospital (21). Although comprehensive cost-effectiveness analysis was not completed in this review, use of depilatory agents is likely to be highly cost-effective.

Limitations

Although this review includes a comprehensive search of the literature using a search strategy developed with a research librarian, it is possible that some studies may not have been identified. All studies reporting on the use of depilatory agents in HTTS were case reports (n = 2) or case series (n = 3), and are therefore at high risk of bias (Table 2). There is a disproportionate representation in the total number of patients (78 of 84) by one large case series, which may skew results (1). Articles commonly lack assessment of HTTS, making it difficult to determine the degree of constriction and ischemia where depilatory agents can safely be used. The authors advocate that further research is required to elucidate the optimal use of

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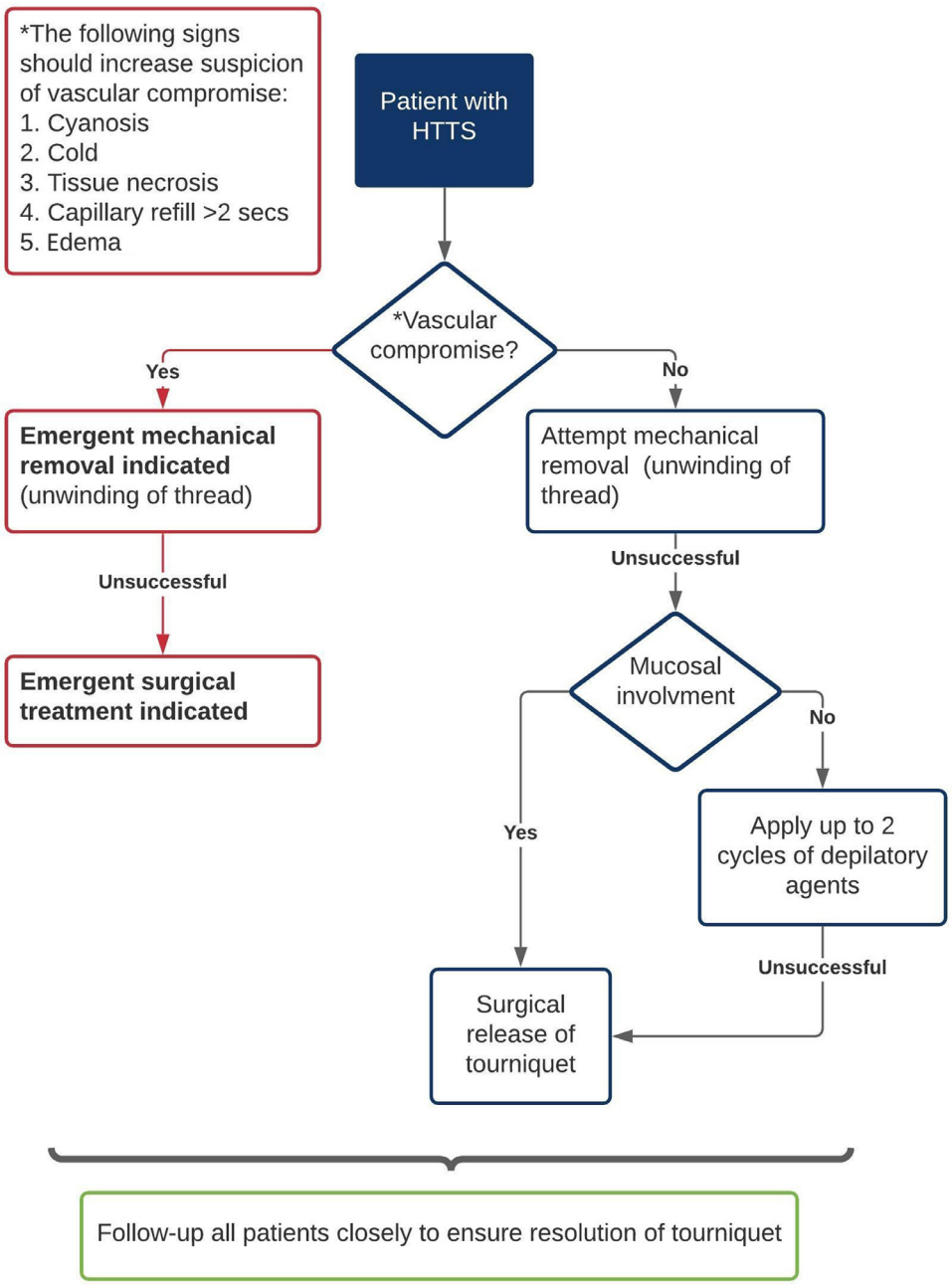

Figure 2. Hair-thread tourniquet syndrome (HTTS) treatment algorithm.

depilatory agents in HTTS, including prospective comparative studies.

Conclusion

The use of depilatory agents has multiple potential benefits; patients are less likely to need surgical intervention, it is well tolerated, and can be highly cost-effective. The authors propose a treatment algorithm for the use of depilatory agents in HTTS and recommend that all acute centers should store and train staff in their use (Figure 2).

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ARTICLE SUMMARY

1. Why is This Topic Important?

Hair-thread tourniquet syndrome (HTTS) has the potential for permanent appendage damage and loss. Depilatory agents can be used to treat HTTS whilst avoiding the risks associated with surgery.

2. What does this review attempt to show?

This review aims to evaluate the effectiveness, benefits, complications, and contraindications of depilatory agents in HTTS.

3. What are the key findings?

Depilatory agents can be used to effectively treat HTTS; the degree of ischemia and involvement of mucous membranes should determine whether depilatory agents could be trialed in HTTS; and a treatment algorithm is proposed.

4. How is patient care impacted?

HTTS treated effectively with depilatory agents may reduce the number of patients requiring surgical treatment and the associated risks.

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