IJIR: Your Sexual Medicine Journal
https://doi.org/10.1038/s41443-021-00438-3

REVIEW ARTICLE

A review on the history of and treatment options for foreskin reconstruction after circumcision

Floyd Wilhelmus Timmermans[1,2,3] · Sterre Elisabeth Mokken[1,2,4] · Sahaand Cris Zoë Poor Toulabi[1] · Mark-Bram Bouman[1,2,4] · Müjde Özer[1,2,4]

Received: 23 December 2020 / Revised: 16 March 2021 / Accepted: 31 March 2021

Abstract
Circumcision is arguably one of the most performed procedures in the world and transcends cultures, nationalities, and religions. New insights into the motivations of men seeking circumcision reversal was the incentive to further investigate known reconstructive therapies. Therefore, the purpose of this study is to present an overview of the historical context and treatment options known for foreskin reconstruction. This review was written after a comprehensive literature search on PubMed, EMBASE, Web of Science, MEDLINE, SCHOLAR databases, and additional Google searches. The practice of foreskin manipulation and the undoing of penile circumcision has a long and turbulent history going back to antiquity. Nowadays, the available data on treatment options remains sparse, focusing primarily on surgical techniques and is generally poorly documented. Nonsurgical methods of reconstruction are rarely mentioned in literature. Nonetheless, nonsurgical methods, such as manual stretching and device-assisted tissue expansion, are commonplace among those who pursue foreskin reconstruction. Although the nonsurgical methods have yielded good results with minimal adverse effects, no proper medical research has been performed to quantify these outcomes. Future studies should also be performed to assess the impact that foreskin reconstruction has on quality of life in this population.

Introduction

The act of foreskin removal, whether partly or in its entirety, is known as circumcision. Circumcision has been executed for millennia, and is arguably the most performed surgical procedure in the world [1, 2]. The prepuce has long been considered rudimentary, and histologically unrelated to sexual function [3]. Yet, it appears to have several functions, from which sexual and immunological seem the most prominent [4, 5]. Circumcision remains a commonplace practice to this day. Nowadays, concerns are being raised regarding its widespread practice and its implications later on in life [6]. Newfound interest into the subject of foreskin reconstruction was illustrated in a recent study, that looked into the motivations and self-taken actions of men seeking foreskin reconstruction [7]. This review aims at exploring the past and current understandings of foreskin reconstruction and the known therapeutic strategies. Firstly, we aim to provide a historic summary of foreskin reconstruction, to allow for a broader understanding on the subject. Secondly, we aim to present an overview of all treatment options in order to assist in the practical treatment of this small, yet significantly impacted group of patients.

Method

Search strategy and study selection

A systematic literature search was conducted using the PUBMED, MEDLINE, EMBASE, and SCHOLAR databases.

✉ Müjde Özer
m.ozer@amsterdamumc.nl

1 Department of Plastic, Reconstructive and Hand Surgery, Amsterdam University Medical Center, Location VUMC, Amsterdam, The Netherlands

2 Center of Expertise on Gender Dysphoria, Amsterdam University Medical Center, Location VUMC, Amsterdam, The Netherlands

3 Amsterdam Movement Sciences Research Institute, Amsterdam University Medical Center, Location VUMC, Amsterdam, The Netherlands

4 Amsterdam Public Health Research Institute, Amsterdam University Medical Center, Location VUMC, Amsterdam, The Netherlands

Published online: 14 April 2021

Table 1 Prespecified inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Performed circumcision	Studies on foreskin reconstruction after hypospadias
Historic background of foreskin reconstruction	Non-English language
Patient motivations	Abstracts, commentaries, conferences
Surgical interventions	
Nonsurgical interventions	

A medical librarian was consulted to assist in establishing the appropriate search terms. The following index terms (MeSH) used were: "foreskin", "preputium", "prepuce", "praeputium" "reconstructive surgical procedures", "restoration", "reconstruction", "circumcision", "uncircumcision", "decircumcision" AND "post-circumcision". The Embase and Medline search terms were the following: "foreskin restoration" "foreskin reconstruction", and "uncircumcision". Inclusion and exclusion criteria were prespecified (Table 1). The results of the literature search were first screened on title and abstract, consequently the full text was screened. The screening process was performed by two authors (FWT, MO) independently, based on the set inclusion and exclusion criteria and conflicting decisions were resolved in agreement. Studies that assessed foreskin reconstruction after male circumcision were included in this review. Studies on foreskin reconstruction after hypospadias were excluded. No restrictions were imposed regarding age of participants, duration of follow-up, time of, and method of data collection. Information from commentaries, conferences, and published abstracts was excluded. No restrictions were placed on date of publication. See Fig. 1 for the PRISMA flow chart of the complete search strategy [8]. Additional references through other web sources were also identified to assist in completing possible hiatuses in published works.

Data extraction

A standardized template was constructed to organize and extract the data relevant to the treatment outcomes of the review. The author's name, the article's publication year, the study design, the sample size, the treatment indication, the technique, the complications, the results, patient reported satisfaction, and the follow-up information were extracted from the articles. The search was performed on the 20th of March 2020. Our search revealed a total of 213 articles, five additional articles were identified through other sources. After removing duplicates, 205 articles were screened of which nine suitable articles were included.

Results

Historic background

Foreskin manipulation was first documented in Ancient Greek society as a reflection of their specific standards for the human physique [9]. They valued a longer prepuce and pathologized the exposed glans, considering it an affliction called *lipodermos* (lacking skin). Radical steps were taken to prevent the unwanted exposure of the glans and developed different techniques to elongate the prepuce. Known methods included different conservative procedures using traction. Dioscorides (41–68 CE), a famous physician, recommended applying a combination of honey and warm water to soften the foreskin, prior to applying manual traction to lengthen the prepuce. Another tractional method was the *kynodesme*, literally translated to *dog leash*. The *kynodesme* was a leather thong, wound around the most distal part of the foreskin that pulled the penis upwards and was tied in a bow and fastened around the waist. This practice was a mainly used by athletes to prevent glans exposure during naked sporting events. Proof of this practice can be found on Attic red figure calyx vases dating back to 520–510 BC [9]. A more invasive method was the infibulation of the prepuce and inserting a metal clasp, string or ring, known as *krikos*, to shut the prepuce and prevent glans exposure (Fig. 2) [9]. Later on, Martial (38–102 AD), the famous Roman poet, described the *krikos* as a covering sheet that had the tendency to slide off [10].

A distinction has to be made between prepuce manipulation, performed in Ancient Greece, and uncircumcision, which is actively pursuing the undoing of a circumcision. One of the first mentions of actual uncircumcision can be traced back to the Old Testament (I Maccabees 1:14–15) "Whereupon they built a place of exercise at Jerusalem according to the customs of the heathens. And made themselves uncircumcised and forsook the holy covenant…". This passage was written during the reign of Antiochus IV (168 BC), the Hellenistic king of the Seleucid Empire, and illustrated the dominating Hellenized culture of that age. Antiochus is known for his persecution of Jews and strict opposition to circumcision, even making the act punishable by death (I Maccabees 1:60–61). Jewish individuals were forced to hide their identity, so as not to be persecuted, to evade high temple taxes, to prevent military recruitment, and to improve their socioeconomic status [11, 12]. At this time, Jewish customs pertained a less radical circumcision, called *brit milah* (covenant of circumcision), which left some of the inner layer of the prepuce intact. Techniques were devised to stretch the residual foreskin with weights called the *pondus judaeus* (Fig. 2). This was a funnel-shaped copper tube that was placed around the penile shaft. Consequently, the weight stretched

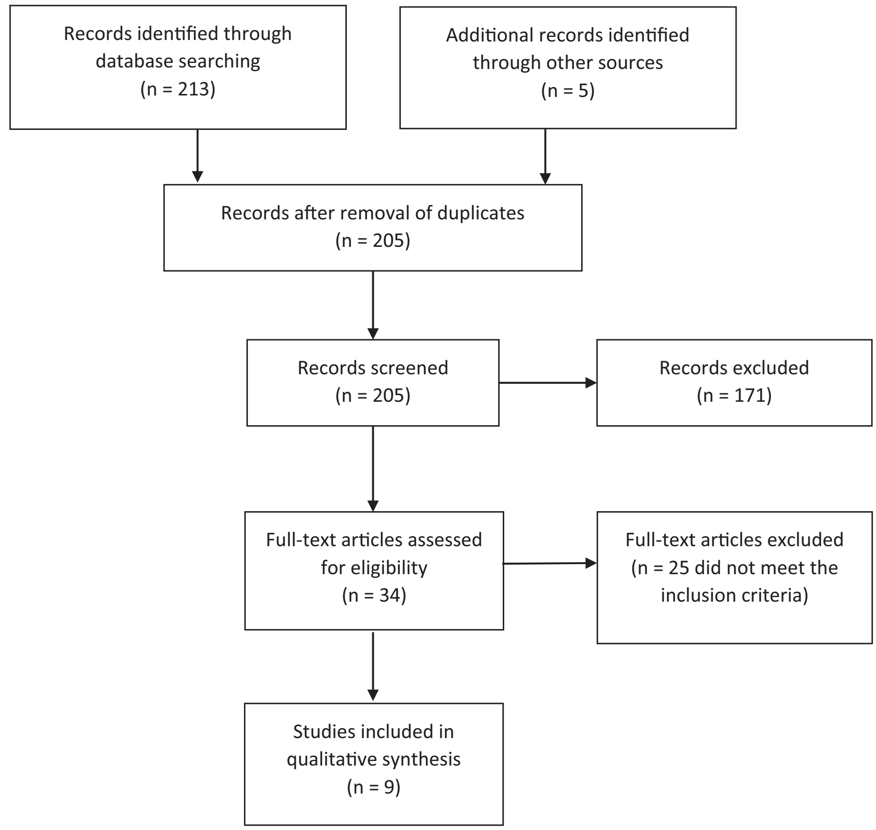

Fig. 1 A PRISMA flow chart on the literature search. PRISMA flow chart.

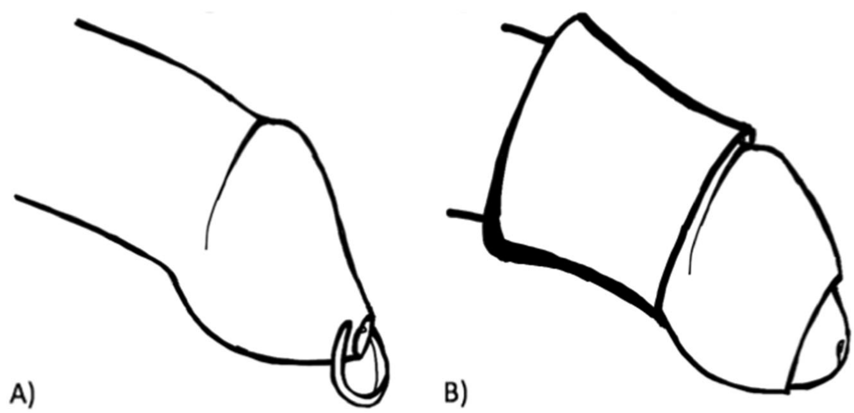

Fig. 2 A presentation of the two historical approaches to cover the glans. A *Krikos* with ring-infibulation performed in Ancient Greece and the **B** *Pondus Judaeus*.

the residual prepuce distally in order to cover the glans [11, 13]. Men, attempting prepuce reconstruction were called *epispaticos* (Greek: *epispao*; to pull over) by the Greeks or *recutitio* (Latin: reskinned) by the Romans [14, 15]. But after the successful Jewish revolt and the subsequent establishment of the Maccabean reign (141 BC) within the Seleucid Empire, the custom of prepuce restoration disappeared. Around 63 BC, and the fall of the Seleucid Empire, the Romans took control of Judea as a province. The Rabbis of that time introduced a new way of circumcision, called *bris periah* (uncovering). This entailed a more radial circumcision, including a frenectomy and the removal of the entirety of the inner layer of the prepuce [16]. Effectively rendering it impossible, with the known conservative methods of that time, to reconstruct the prepuce [12]. In more recent times, Jewish people in Europe (1933–1945) were in imminent danger of persecution, and consequently sent to internment camps during the Nazi Era. In an effort to hide their identity, many sought out ways for uncircumcision. There are some reported cases of reconstructions, provided by Polish and German doctors during the war, in exchange for large sums of money. However, few accounts exist and very little is known about the techniques used.

Surgical techniques

Several different surgical reconstructive options have been proposed. Most of the techniques consider reconstruction using cutaneous and fascial layers. All of the following techniques are summarized in Table 2.

Surgical reconstructions using cutaneous layers

Celsus, the eminent Roman physician (25 BC–50 AD), was the first to give a detailed description of two surgical techniques in his *De Medicina*. The first (1) method was primarily used on children or men with a congenitally short foreskin. The skin was incised in a circular fashion, around the base of the penis, and mobilized distally, stretching over the glans. The neoprepuce was ligated, leaving a small opening for urinating. The neoprepuce was untied only when the base of the penis was healed properly through delayed healing. The second (2) method was proposed for circumcised men. A subcoronary incision was made, and a full thickness dissection was performed of the shaft. The elastic penile skin would be pulled over the glans, ligated at the distal neoprepuce and a non-adherent lead-oxide plaster would be applied to the single layered skin to prevent adhesion to the glans and promote epithelisation (Fig. 3) [17].

Johann Friedrich Dieffenbach (1792–1874) published one of the first more recent details on foreskin reconstruction [18]. In his works, he compiled a whole chapter to what he called posthioplasty. In addition, he recapitulates Celsus' method, offering a minor technical improvement by suggesting distal narrowing of the neoprepuce, to prevent postoperative failure [12].

Feriz [19] was one of the first to publish works concerning preputial reconstructions in the twentieth century, after performing them in the occupied Netherlands (1942–1945). He describes a two-stage operation, but did not disclose a patient population. First, he degloved the penis and buried the denuded shaft under a tunnel of the ventral scrotum. During the second stage, he mobilized the penis, and primarily closed the scrotal defect. No complications were recorded and reported the patients to be satisfied (Fig. 4).

Penn [20] published a case report, performing a one-stage procedure, similar to the first technique described by Celsus. He made a circular incision at the base of the penis, moved the penile skin distally, and a free graft was then applied to cover the entire new area from the tip of the new prepuce to the coronal ridge. He noted that the patient was satisfied with the results and no complications were documented.

Tushnet [11] gave a description of three techniques performed in occupied Poland. The first technique was to pull over the skin from behind the corona, scarifying the edges and suturing the scarified edges to create an artificial phimosis. Infections were frequent and the sutures often extruded, causing retraction of the neoprepuce. The second method was a modification of a method described by Celsus [17]. A circular subcoronal incision was made and the entire penile skin of the shaft was bluntly dissected. The penile skin was mobilized distally, creating a double-layered prepuce, and was closed with a circular suture to prevent retraction. The denuded skin at the base of the penis would then be wrapped in layers of gauze. The results were reported to be satisfactory. The third method was reported by two patients. A circular incision was made around the preputial area and the wound separated. Secondly, a long oblong skin graft was excised from the iliac crest. The narrow edges of the strip were sutured together and folded longitudinally to create an inner and outer lining. The neoprepuce was then sutured to the circular incision and left untouched for 3 days. The wounds healed completely in 2 weeks, but the patients reported to have some "rough edges" with regards to the prepuce.

Greer [21] devised a four-stage procedure similar to Feniz, performing their procedure on eight individuals. During the first stage, a circular incision was made at the base of the penis, dissected, and turned over to create a cylindrical single layer flap that would become the inner lining of the neoprepuce. The bipedicle scrotal flap was then elevated and the shaft was placed in the scrotal tunnel. After healing, which could take months, the penis was released and closed accordingly. He described two cases of hematoma, one case of epididymitis with partial scrotal flap necrosis, in addition to transient edema in most patients for up to a year. Patient satisfaction was good, most patients reported increased glandular sensitivity. No erectile complications were reported.

Goodwin [22] published a report of a two-stage operation, without disclosing a patient population. A circular incision was made at the penile base, mobilized distally through blunt dissection of the shaft and three or four small transverse incisions were made at the tip of the neoprepuce. The transverse incisions were closed in a vertical fashion for a total of 5–6 days. Two transverse incisions were made in the anterior scrotum and the penile shaft was placed in the tunnel. After 3 weeks, the second stage was performed, lifting the penis out of the scrotum through the use of a Z-plasty. Patients reported transient edema (Fig. 4).

Lynch and Pryor [23] published a case report of a one-stage procedure. A circular incision was made at the penile base and moved distally [23]. Similar to Goodwin, three to four transverse incision of 1–2 cm were made at the tip of the neoprepuce, as to narrow the prepuce. A full thickness flap of scrotal skin with Dartos muscle and fascia was prepared and used to close the defect of the shaft. No

Table 2 Overview of all documented surgical and nonsurgical treatment options and outcomes and additional proposed treatment options.

Study	Date	Method	*N*	Indication	Technique	Complication	Results	Reported outcome	Follow-up
Surgical treatment options									
Feriz [19]	1962	Case report	N/A	Religious persecution	Two-stage: shaft deglovement, distal mobilization, scrotal burying and subsequent release	None	N/A	Satisfactory	N/A
Penn [20]	1963	Case report	1	Psychological burden	One-stage: penile base dissection of the skin, distal mobilization and placement of free graft on denuded base	None	Physically satisfactory	Satisfactory and complete psychological rehabilitation	N/A
Tushnet [11]	1965	Case report	N/A	Religious persecution	One-stage: scarring and suturing the ridges of the intended neoforeskin	Infections, retraction	N/A	N/A	N/A
Tushnet [11]	1965	Case report	N/A	Religious persecution	One-stage: subcoronal incision, shaft dissection with distal mobilization. Delayed healing of denuded shaft	N/A	N/A	Satisfactory	N/A
Tushnet [11]	1965	Case report	2	Religious persecution	One-stage: use of folded skin graft, attached to the subcoronal ridge	N/A	Rough edges	N/A	N/A
Greer et al [21].	1982	Case series	8	Patient requests	Four-stage: circular incision at the penile base, dissected and mobilized distally. A bipedicle scrotal flap was elevated, the shaft placed in a scrotal tunnel and closed accordingly	Hematoma, epididymitis, partial scrotal flap necrosis, transient edema (>1 year)	Increased glandular sensitivity, slight difference of color	Satisfactory	1 year
Goodwin [22]	1990	Case report	N/A	N/A	Two-stage: shaft deglovement and scrotal burying, release and closing using Z-plasty	Transient edema	N/A	N/A	N/A
Lynch and Pryor [23]	1993	Case report	1	N/A	One-stage: circular incision at the penile base, mobilized distally. Full thickness graft of scrotal skin used to cover denuded shaft	None	N/A	Satisfactory	N/A
Nonsurgical treatment options									
Ozer and Timmermans [7]	2020	Clinical assessment	11	Patient requests	Manual stretching or stretching devices	None	Increased skin pliability and full glans coverage	Mostly satisfactory	3 months–10 years
Treatment proposal									
Mcaninch [25]	1993	Technique proposal	N/A	N/A	Subcoronal incision through Dartos and Buck's facia, dissection toward penile base. Folding of the Buck's fascia, moved distally and covering the inner and out lining of the neoprepuce with a split skin graft from the inner thigh				
Brandes [13]	1999	Technique proposal	N/A	N/A	Circular dissection and distal mobilization, double layering the Buck's fascia and covering the outer lining with a split skin graft from the inner thigh				

N/A not available.

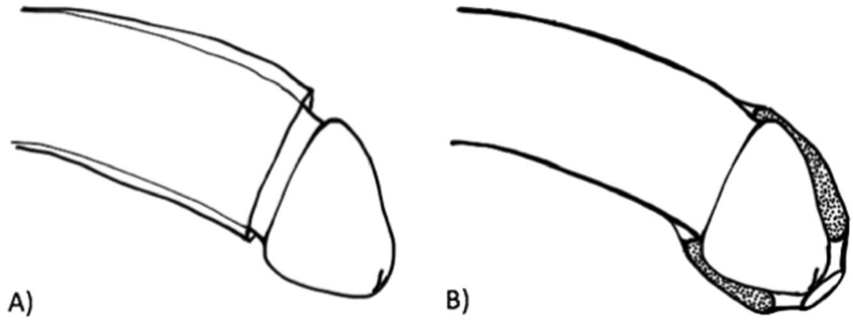

Fig. 3 Second procedure proposed by Celsus. A Subcoronal incision and blunt dissection of the skin toward the penile base. **B** Distal mobilization of the skin and applying lead-oxide plaster under the one-layered neoprepuce.

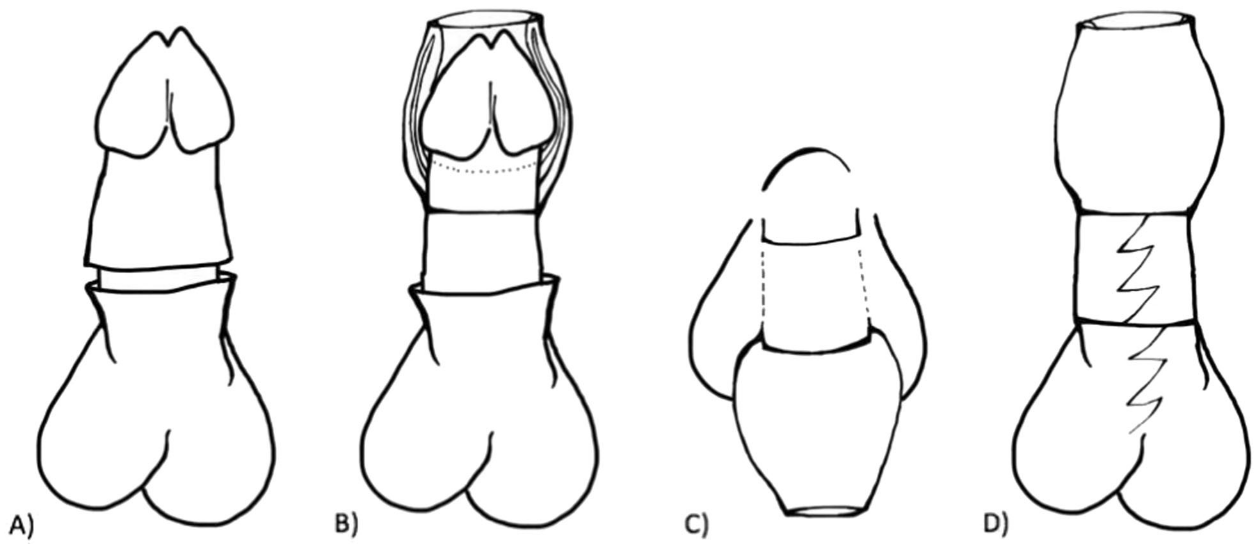

Fig. 4 Procedure by Goodwin, a modification of a method previously described by Feniz. A Circular incision of the skin. **B** Mobilizing the skin distally to create a double-layered neoprepuce. **C** Burying the denuded shaft in the scrotal tunnel. **D** Release of the penile corpus using Z-plasty.

complications were reported, and the results were reportedly satisfactory.

Surgical reconstructions using fascial layers

Brandes [13] proposed two methods using either the fascial or a fasciocutaneous circular penile flap [13, 24]. Both flaps are harvested from the distal penis and rely on the highly vascularized Buck's fascia. The first method entails a circular incision at the existing circumcision line, extending through the Dartos and Buck's fascia to the penile base. The Buck's fascia is then distally folded onto itself and mobilized distally and sutured in place. The defect is then covered with a split skin graft that is harvested from the inner thigh. The second proposed method is a modification of a flap technique described by McAninch, initially developed for treatment of urethral strictures [25]. An island flap of penile skin based on the Buck's fascia is dissected in a circular fashion, moved distally, and folded inward onto itself. The skin flap is then sutured in place at the subcoronal ridge, to form the inner lining of the neoprepuce. A split skin graft from the inner thigh is used to cover the exposed fascia that will function as the outer lining of the neoprepuce. No reports exist, regarding performing these two hypothesized methods.

Tissue engineering

In more recent years, Foregen, a crowd-funded nonprofit organization, is applying the principles of regenerative medicine in foreskin reconstructive research [26]. A recent publication by their study group was able to successfully decellularized and allogeneic extracellular foreskin scaffold, which in due time, might allow for foreskin reconstruction including all its specialized structures [27].

Nonsurgical techniques

Various nonsurgical methods have been developed, and can subsequently be divided in *taping* and *tapeless* methods. A recent study concludes that "the non-surgical methods seem promising, but these rely heavily on lay-sources found online." [7] All information regarding the nonsurgical interventions are collected from lay sources and patient groups, united in organizations such as "The National Organization of Restoring Men" and "The National Organization to Halt the Abuse and Routine Mutilation of Males" [28, 29]. Furthermore, in 1994 the book "Joy of Uncircumcising" was published as a guide for men seeking help or guidance for foreskin reconstruction and is often ascribed to on these platforms [30].

Taping

In 1982, the Brothers United for Future Foreskins method (BUFF) was proposed as one of the first modern nonsurgical methods for reconstruction. It consists of both cross-taping the prepuce over the glans and ring-taping it at the base of the intended neoprepuce [31]. It is reportedly successful, however this approach is considered one of the slowest methods of restoration (Table 3). MTC-taping is another method developed in the early 1990's, using T-taping [32]. Two long strips of 7–10 cm wide cloth tape are folded lengthwise and stuck together, creating a longitudinal T-shaped tape. The T-tape is applied around the base of the glans, pulled distally, and clipped or tied to an elastic band. It is reportedly a faster method than the BUFF, but a more difficult method for manipulating the shape of the growing foreskin. The set regimen is 24 hours a day, apart from urinating and washing. Complete restoration is expected after 2–4 years.

In case of sufficient skin, weights could be used in addition to taping. Foreballs are two connected, spherical stainless-steel weights, weighing up to 200 grams or more. One of the spherical weights is placed under the neoprepuce and then ring-taped over the foreball as to create downwards-weighing traction. Another weighted device is the Penile Uncircumcision Device (PUD), which is a funnel-shaped weight used similar to foreballs. Patients are advised to use these for at least 12–24 months, and clinical results remain vague, and are often not mentioned [33]. In all cases, the patients should be cautious for ischemia and are advised not wear these contraptions during urination, sleep, erection, or any form of discomfort [31].

Tapeless

Various instructions for manual tugging have been proposed for different degrees of circumcision. They all consist of gripping the foreskin and penile skin and stretching it distally. These methods are reportedly satisfactory with an initial growth of 6 mm in the first month. Patients are advised to tug the prepuce 1–2 hours a day. No specific duration of the therapy has been disclosed [31]. Different commercial devices offer tapeless restoration, most of

Table 3 Overview of unofficially documented treatment options discussed on online forums.

Technique	Method	Instructions	Effectiveness	Results
Taping				
BUFF method [31]	Cross-taping the residual prepuce over the glans	N/A	Slow	N/A
MTC-taping [32]	T-taping the site of the neoprepuce, then clipped or tying it with an elastic band	24 h a day, 1–2 years	Faster than BUFF method, more difficult to influence the shape	N/A
Foreballs [31]	Use of spherical weights, placed under the neoprepuce and ring-taped	N/A	N/A	N/A
PUD [33]	Funnel-shaped weight, placed under the neoprepuce and ring-taped	1–2 years	N/A	N/A
Tapeless				
Manual tugging [31]	Gripping the foreskin and penile skin and stretching it distally	1–2 h a day	Initial growth 6 mm in first month	Reported satisfactory
TLC tugger [34]	Two cone-shaped components entrapping the neoprepuce and tractional force by using either elastic bands, tying it to the upper leg, or weighting it down	8–12 h a day, 3–4 years	Initial growth 3 mm in first month	Reported satisfactory
Foreskin Natural Restorer [31]	A stainless-steel bell that uses elastic bands for downward traction	N/A	N/A	N/A
DILE-insert [35]	Two cone-shaped components entrapping the neoprepuce and two hemi-oval compartments on an adjustable bell, which helps to stretch the inner lining of the neoprepuce while creating downward traction	N/A	N/A	N/A
Dual Tension Restorer (DTR) [36]	Two components, a pusher plate, and an adjustable nylon bell. Silicone grippers hold the foreskin in place while two rubber bands provide downward traction	6–8 h a day	N/A	N/A

N/A not available.

which are not provided with official instructions or results (Table 2). One method is the Tapeless Conical (TLC) tugger [34]. It consists of a two cone-shaped component, which entraps the residual prepuce. Traction is achieved through the use of an elastic band, weights or strapping it to the upper leg (Fig. 5). Men are advised to wear it for 8–12 hours a day, with the exception of sleeping, when erect or in case of discomfort. Initial gain is 3 mm a month, with therapy taking 3–4 years to reach its' final results (Fig. 6) [29, 34].

The Foreskin Natural Restorer is a stainless-steel bell that fits over the glans, and uses elastic bands for traction. Some other methods are based on both pushing the glans whilst pulling the skin simultaneously, making these instruments bi-directional devices. One device using this technique is the Dual-action Incremental Longitudinal Expander insert (DILE-insert) [35]. The DILE-insert consists of a conical entrapment part, similar to TLC, but also contains two hemi-oval components on an adjustable bell, which helps to stretch the inner lining of the neoprepuce when creating downward traction. Another tractional device is the Dual Tension Restorer (DTR) [36]. This contraption that also consists of two components: a pusher plate, and an adjustable nylon bell. Silicone grippers hold the foreskin in place while two rubber bands provide downward traction. The CAT II works similar to the DTR [37]. It contains a pusher plate, an adjustable bell, and a silicone prepuce gripper. Traction is achieved by adjusting the tractional setting of the bell, instead of rubber bands, making this a less flexible method. It should be noted that the aforementioned methods are advocated on various commercial websites. None of these websites, however, were capable of providing adequate therapeutic instructions or results.

Fig. 5 A depiction of the TLC tugger and additional strapping to the upper leg [38].

Discussion

This review aimed at presenting an overview of the broader historical context and treatment options for foreskin reconstruction. Men have, historically, been seeking foreskin reconstruction with varying motives, such as aesthetic preferences and evading persecution. Recent motives include sexual considerations, concerns with body integrity and contra-cultural reasons [7]. Medical professionals should recognize that these individuals often feel like victims of genital mutilation, resulting in an impaired sense of body autonomy and integrity. Feelings of being misunderstood, whether by society or medical professionals, and feelings of ridicule, shame, and anger are often expressed [7, 39]. Proper counseling may aid in preventing and managing such affective reactions [7].

The unruly history of uncircumcision has led to different means of reconstruction. Recent literature on surgical

Fig. 6 Progress shown using the TLC tugger at, respectively, 3, 22, and 42 months [38].

treatment options is scarce and nonexistent for nonsurgical treatment options, save from being mentioned in our recent study [7]. Mention of novel surgical techniques has been nonexistent since 1999, and current methods are based on anecdotal evidence with poor follow-up. Therefore, none of these surgical options seem suitable in modern day, evidence-based practice. We have encountered promising outcomes after nonsurgical interventions in our clinical practice, whether by manual tugging, taping, or device-assisted methods. These methods are mostly recommended on web-based forums without providing proper directions for use or peer-reviewed results. Individuals whom decide on pursuing noninvasive methods of foreskin reconstruction should be counseled on the time-consuming process and uncertain results. Involvement with a physician is highly recommended, especially taking into account the lack of proper research with regard to the outcomes and possible complications.

Skin stretching alone has shown us in our practice, that it has the potential to allow for full coverage of the glans, but might come with certain downsides that might need corrective surgery. Foreskin stretching may lead to widening of the distal part of the neoforeskin, as it lacks the rigged band seen in unaffected foreskin. Tightening of the distal part of the foreskin may be requested. Furthermore, the skin is not stretched only at the top, but also at the penile base. This indirect stretching of the penile base can result in prominent penoscrotal webbing. This can be perceived as less aesthetically pleasing and correction may be requested [40].

As of now, no gold standard or treatment protocol exists for foreskin reconstruction. Patients should be informed on every possible option, made aware of limited results following surgical interventions and the lack of data on complications and cosmetic outcomes. The apparent lack of treatment options and counseling adds strength to the need of evidence-based medicine, and not solely experience-based reports. Nonsurgical techniques of skin stretching, both taping and tapeless methods, seem promising, but scientific evidence is still lacking. We would, therefore, advise that future studies regarding nonsurgical interventions focus on aesthetic, psychological, and functional outcomes.

Conclusion

Foreskin manipulation and reconstruction have a history going back to antiquity. Although circumcision is still a commonplace practice, still very little is known about foreskin reconstruction. To date, only surgical reports on reconstructive therapies exist with low-quality and dated methodology. New insights into the motivations and undertaken actions by patients seeking foreskin reconstruction have brought nonsurgical therapies to the attention. In practice, these nonsurgical methods such as manual stretching and device-assisted stretching yield good results but no official clinical records exist on the effectiveness of these methods. Future studies have to be performed to quantify these outcomes and the impact that foreskin reconstruction has on quality of life in this population.

Data availability

Pubmed Search: ((“Foreskin”[Mesh] OR foreskin*[tiab] OR prepuce*[tiab] OR praeputium[tiab] OR preputium [tiab] OR praeputial[tiab] OR preputial[tiab]) AND (“Reconstructive Surgical Procedures”[Mesh] OR reconstruct*[tiab] OR restor*[tiab] OR rehab*[tiab] OR repair*[tiab])) AND (“Circumcision, Male”[Mesh] OR circumcis*[tiab] OR uncircumcis*[tiab] OR post-circumcision[tiab] OR decircumcision[tiab] OR uncircumcision[tiab]). Embase/Medline Search: Circumcision AND Decircumcision OR Foreskin OR Foreskin Restoration OR Reconstruction OR Restoration AND Uncircumcision.

Author contributions FWT: methodology, investigation, writing—original draft; SEM: writing—review and editing, visualization; SCZPT: writing—review and editing, visualization; M-BB: writing—review and editing; MÖ: conceptualization, investigation, supervision, and project administration.

Compliance with ethical standards

Conflict of interest The authors declare no competing interests.

Publisher’s note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

1. UNAIDS. Male circumcision: global trends and determinants of prevalence, safety and acceptability. UNAIDS; WHO; 2019. p. 42.
2. Raveenthiran V. The evolutionary saga of circumcision from a religious perspective. J Pediatr Surg. 2018;53:1440–3.
3. Cox G, Krieger JN, Morris BJ. Histological correlates of penile sexual sensation: does circumcision make a difference? Sex Med. 2015;3:76–85.
4. Nayyar C, Chander R, Gupta P, Sherwal B. Co-infection of human immunodeficiency virus and sexually transmitted infections in circumcised and uncircumcised cases in India. Indian J Sexually Transmitted Dis. 2014;35:114–7.
5. Gebremedhin S. Assessment of the protective effect of male circumcision from HIV infection and sexually transmitted diseases: evidence from 18 demographic and health surveys in Sub-Saharan Africa. East Afr J public health. 2010;7:295–9.
6. Morris BJ, Moreton S, Krieger JN. Critical evaluation of arguments opposing male circumcision: a systematic review. J Evid Based Med. 2019;12:263–90.
7. Ozer M, Timmermans F. An insight into circumcised men seeking foreskin reconstruction: a prospective cohort study. Int J Impot Res. 2020;32:641.

8. Moher DLA, Tetzlaff J, Altman DG,The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009;6:e1000097
9. Hodges F. The ideal prepuce in ancient Greece and Rome: male genital aesthetics and their relation to lipodermos, circumcision, foreskin restoration, and the kynodesme. Bull Hist Med. 2001;75:375–405.
10. Isaacs D. Circumcision. J Paediatrics Child Health. 2011;47:1–2.
11. Tushnet L. Uncircumcisio. Med. Times. 1965;93:588–93.
12. Schultheiss D, Truss M, Stief C, Jonas U. Uncircumcision: a historical review of preputial restoration. Plast Reconstr Surg. 1998;101:1990–8.
13. Brandes S, McAninch J. Surgical methods of restoring the prepuce: a critical review. BJU Int. 1999;1999:109–113.
14. Futaba K, Bowley D. The foreskin: problems and pathology. Surgery (Oxford). 2010;28:387–90.
15. Lascaratos J, Kostakopoulos A, Liapi E, Lascaratos G. Unknown methods of uncircumcision according to Oribasius (4th century AD). Urology. *2003*;2003:62.
16. Werblowsky R. The Oxford dictionary of the Jewish religion. Oxford: Oxford University Press; 1997.
17. Rubin J. Celsus' decircumcision operation: medical and historical implications. Urology. 1980;16:121–4.
18. Gilman S. Decircumcision: the first aesthetic surgery. Mod Jud. 1997;17:201–10.
19. Feriz H. A simple method of plastic surgery of the prepuce after radical (ritual) circumcision. Munch Med Wochenschr. 1962;104: 1406–7.
20. Penn J. Penile reform. Br J Plast Surg. 1963;16:287–8.
21. Greer D. Technique for foreskin reconstruction and some preliminary results. J Sex Res. 1982;18:324–30.
22. Goodwin W. Uncircumcision: a technique for plastic reconstruction of a prepuce after circumcision. J Urol. 1990;144:1203–5.
23. Lynch M, Pryor J. Uncircumcision: a one-stage procedure. Br J Urol. 1993;72:257–8.
24. Haseebuddin M, Brandes S. The prepuce: preservation and reconstruction. Curr Opin Urol. 2008;18:575–82.
25. McAninch J. Reconstruction of extensive urethral strictures: circular fasciocutaneous penile flap. J Urol. 1993;149:488–91.
26. Foregen. Foregen: promoting genital integrity through regenerative medicine. 2017.
27. Purpura V, Bondioli E, Cunningham EJ, de Luca G, Capirossi DEN. The development of a decellularized extracellular matrix-based biomaterial scaffold derived from human foreskin for the purpose of foreskin reconstruction in circumcised males. J Tissue Eng. 2018;9:1–11.
28. MOHARMM. NOHARMM—National Organization to halt the abuse and route mutilation of males. 2020.
29. Griffiths. Restoration devices. NORM. 2017.
30. Bigelow J. The joy of uncircumcising! Hourglass Book Pub; 1994.
31. Foreskin Restoration. A recourse for techniques, advice and information about non-surgical foreskin restoration. In: Restoration. FgbF; 2020.
32. Restoring with T-Tape—a graphic guide. 2020. RestoringForeskin.org.
33. Foreskinrestorationinfo. 2020. Foreskinrestoration.info.PUD.
34. How To Tug. 2020. TLCTugger.com.
35. The DILE Insert Foreskin Restoration System. 2020. Dileinsert.com.
36. DTR. 2020. Foreskinrestore.com.
37. Foreskin Restoration—CAT II Q Device—regrow penile foreskin for better male sexual health. 2020. Catstretcher.com.
38. TLCTugger.com. Images of TCL-tugger: by courtesy of Ron Low to use these images for non-commercial purposes. 2017.
39. Wallace W. An undeniable need for recognition: What do you call a man who has undergone foreskin restoration? "Uncircumcised"? "Restored"? How about just BRAVE? A response to Hill. Clin Anat. 2015;28:962–3.
40. McLeod D, Alpert S. Double-V scrotoplasty for repair of congenital penoscrotal webbing: a hidden scar technique. J Pediatr Urol. 2014;10:810–4.