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Penile Frenuloplasty: A Comprehensive Review of Energy-Based and Non-energy-Based Surgical Techniques, Clinical Outcomes, Complications, and Future Directions

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Abstract

Penile frenuloplasty is an established surgical procedure performed to lengthen or reconstruct the penile frenulum in cases of frenulum breve (short frenulum), frenular chordee, recurrent tearing, dyspareunia, or premature ejaculation (PE) attributed to an anatomically constrained frenulum. While the procedure is widely practiced, there is no current consensus on the optimal surgical technique. Broadly, techniques are classified into non-energy (cold/mechanical) methods, which rely on scalpel incision and suture-based tissue rearrangement, and energy-based approaches, which employ diathermy (electrosurgery) or laser technology to incise, coagulate, and remodel the frenular tissue.

This narrative literature review aims to systematically appraise, organize, and critically evaluate all available published research on both energy-based and non-energy-based penile frenuloplasty techniques, encompassing anatomy, indications, procedural descriptions, surgical outcomes, patient-reported outcomes, complications, and future research directions.

A comprehensive search of PubMed/MEDLINE, Embase, Scopus, and Google Scholar was performed using the terms: frenuloplasty, frenulectomy, frenulum breve, penile frenulum surgery, CO₂ laser frenuloplasty, electrosurgery frenulum, pull-and-burn frenuloplasty, V-Y plasty frenulum, Z-plasty frenulum, and PE frenulectomy. All English-language publications meeting relevance criteria were included. Studies pertaining exclusively to the lingual, labial, or other non-penile frenula were excluded.

A total of 12 primary studies and reports were identified and reviewed, in addition to anatomical references, guideline documents, and related commentaries. Non-energy (cold) techniques, including simple transverse incision with longitudinal closure, V-Y plasty, Z-plasty, and frenular grafting, demonstrate overall patient satisfaction rates of 89-97%, with subsequent circumcision rates of 8-20% and minor complication rates of approximately 8%. Energy-based techniques, including the electrosurgical pull-and-burn method and CO₂ laser frenuloplasty, offer sutureless, bloodless outpatient alternatives. The pull-and-burn method has been validated in a 15-year, 236-patient retrospective series with favorable safety data. CO₂ laser frenuloplasty has demonstrated statistically significant improvement in Short Form Health Survey (SF-12) Physical Component Summary (PCS) and Mental Component Summary (MCS) scores ($p < 0.001$), with complete tissue healing in two weeks. Frenulectomy in patients with a short frenulum and lifelong PE resulted in a statistically significant increase in intravaginal ejaculatory latency time (IELT) from a mean of 1.65 to 4.11 minutes ($p < 0.0001$).

All reviewed techniques demonstrate acceptable safety and efficacy; however, the overall evidence base consists primarily of case series and retrospective cohorts at Level 3-4 evidence. No high-quality randomized controlled trial (RCT) directly comparing energy-based and non-energy-based frenuloplasty techniques has been published to date. The choice of technique should be individualized based on clinical anatomy, surgeon expertise, and patient preference. Future prospective comparative RCTs with standardized selection criteria and outcome measures are needed to establish a definitive evidence hierarchy.

Categories: Urology

Keywords: co2 laser, dyspareunia, electrocautery, frenular chordee, frenulectomy, frenulum breve, penile frenuloplasty, premature ejaculation, v-y plasty, z-plasty

Introduction And Background

The penile frenulum - or frenulum praeputii penis - is a small but physiologically significant band of elastic tissue located on the ventral aspect of the glans penis [1]. Rich in sensory nerve endings - densely innervated by branches of the dorsal penile nerve - it is among the most sensitive structures of the male genitalia [2]. The anatomy of the frenulum is described in more detail below. Frenulum breve, also referred to as a short frenulum or tight frenulum, is a congenital or acquired condition in which the frenulum is

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abnormally shortened, restricting normal foreskin retraction during erection and coitus [3]. The condition may manifest as: dyspareunia (painful intercourse), recurrent frenular tearing with or without bleeding from the frenular artery, frenular chordee (ventral curvature of the glans of $\geq 20^\circ$ on foreskin retraction), difficulty in maintaining penile hygiene, and in certain patients, a mechanical contribution to premature ejaculation (PE) [3]. Frenulum breve may be underdiagnosed because there are no universally standardized diagnostic criteria and because presentation and clinical recognition may vary; no large-scale epidemiological prevalence studies exist, though it is considered a common cause of male dyspareunia and an underappreciated factor in PE [3].

Since the first description by Whelan in 1977, who proposed adult circumcision as treatment for male dyspareunia related to a short frenulum, surgical correction has evolved considerably [4]. Frenulotomy is a minor surgical procedure that cuts or releases the frenulum, in contrast to frenulectomy, which is a surgical procedure that removes part or all of a frenulum [5,6]. Frenuloplasty, the subject of this review, refers to the surgical lengthening or reconstruction of the frenulum and has emerged as the preferred foreskin-sparing alternative to circumcision for most patients with isolated frenular pathology [7]. Multiple techniques have been described over the decades, broadly categorized as non-energy (cold/mechanical) methods and energy-based modalities including electrosurgery (diathermy) and laser systems.

Despite its common practice, the surgical management of frenulum breve lacks high-quality comparative evidence. The available literature is predominantly composed of case series, retrospective cohorts, and small prospective studies. To the best of our knowledge, no randomized controlled trial (RCT) directly comparing surgical techniques for penile frenuloplasty has been published as of 2026. Furthermore, outcome reporting is heterogeneous, with patient satisfaction, cosmesis, subsequent circumcision rates, complication rates, and functional sexual outcomes all used inconsistently across studies.

The objective of this literature review is to provide clinicians, urologists, and researchers with a narrative synthesis of the published evidence, including an appraisal of its level and quality, on both energy-based and non-energy-based penile frenuloplasty techniques. Lingual, labial, and other non-penile frenuloplasty literature is explicitly excluded from this review.

This review updates and extends the 2022 review by Pyrgidis et al., which was e-published in 2021 [5]. It adds the more recent studies on CO₂ laser frenuloplasty and differs in its focus on energy-based versus non-energy-based techniques, functional and sexual outcomes, complications, patient selection, and the place of frenuloplasty among the available surgical options.

Anatomy and pathophysiology of the penile frenulum

Anatomy

The penile frenulum is located at the ventral junction of the glans and the prepuce, at the level of the corona [1]. It forms a thin triangular fold of mucosa that connects the inner foreskin to the skin of the penile shaft at the coronal margin [1]. Embryologically, it develops from the same mucosal lining that forms the inner prepuce; its fusion and elongation occur during fetal development, and failure of adequate elongation results in congenital frenulum breve [1].

The frenulum is histologically composed of elastic connective tissue, smooth muscle fibers, and is richly vascularized by the frenular artery - a terminal branch of the external pudendal arterial system - and drained by corresponding veins [2]. Its dense innervation arises from terminal branches of the dorsal penile nerve (itself a branch of the pudendal nerve, S2-S4), providing protopathic and epicritic sensibility [2]. Halata and Munger (1986) identified the neuroanatomical basis for the extraordinary sensitivity of the glans and frenular region [8]. This neurovascular anatomy has direct surgical relevance: frenuloplasty techniques that fail to preserve the frenular artery risk ischemic complications, while thermal techniques that generate uncontrolled heat may damage the sensory nerve terminals and potentially diminish sexual sensation [9].

Classification of Frenulum Breve

No universally accepted grading system for frenulum breve exists. Dockray et al. (2012) proposed a practical grading system based on the degree of frenular restriction and anatomical deformity at clinical examination, ranging from mild (minor restriction without visible chordee) to severe (marked ventral glans deflection and significant functional impairment) [7]. Gallo et al. (2010) defined a short frenulum operationally as one producing a ventral curvature of the glans of $\geq 20^\circ$ upon manual foreskin retraction [6]. The absence of standardized diagnostic criteria remains a significant limitation in the frenuloplasty literature, making cross-study comparisons difficult.

Pathophysiology and Clinical Consequences

In cases of frenulum breve, the short frenular band creates abnormal tension on the ventral glans during erection and intercourse [3]. This tension may cause: (1) pain on erection or during intercourse

(dyspareunia); (2) incomplete foreskin retraction or paraphimosis risk; (3) frenular tearing, which may occur during the first sexual encounter in young men and which tends to heal with fibrotic scar tissue - further shortening the frenulum and creating a cycle of progressive restriction; (4) frenular chordee, a ventral curvature of the glans that can interfere with penetrative intercourse; and (5) a mechanical shortening of intercourse stroke length due to pain avoidance, potentially contributing to PE through habituation to a faster ejaculatory threshold [4].

A short frenulum may also be absent (as in first-degree hypospadias), combined with phimosis (tight foreskin), or associated with inflammatory skin conditions such as lichen sclerosus, balanoposthitis, or sexually transmitted infections - any of which may further restrict frenular tissue [4].

Review

Methodology

This narrative literature review was conducted as a structured literature search with narrative synthesis. It is not a systematic review, was not prospectively registered, and does not aim to identify all available evidence. PRISMA reporting principles were used only to guide transparent reporting of the search and selection process. Electronic databases searched on 4 April 2026 included PubMed/MEDLINE, Embase, Scopus, Cochrane Library, and Google Scholar. The following search terms were used individually and in combination: "penile frenuloplasty," "frenulectomy," "frenulum breve," "short penile frenulum," "penile frenulum surgery," "CO2 laser frenuloplasty," "laser frenulum," "electrocautery frenuloplasty," "diathermy frenuloplasty," "pull and burn frenuloplasty," "V-Y plasty frenulum," "Z-plasty frenulum," "frenular grafting," "frenular chordee," and "premature ejaculation frenulectomy." The date range of the search was 1976-2026.

Titles and abstracts were screened against these criteria, followed by review of the full text of potentially eligible articles, and the reference lists of included articles were also searched by hand. The PubMed/MEDLINE search was re-run on 3 October 2026 for reporting purposes, restricted to English-language articles from 1976 to 2026, using the string: (frenuloplasty OR frenulectomy OR frenulotomy OR "frenulum breve" OR "short frenulum" OR "penile frenulum" OR "frenular chordee" OR "pull and burn" OR ("frenulum" AND (laser OR electrocautery OR diathermy OR "V-Y" OR "Z-plasty" OR "premature ejaculation"))). It retrieved 13 records. For the other databases and for the original search of 4 April 2026, the number of records retrieved and excluded at each stage was not recorded, and a PRISMA-style flow diagram is therefore not provided. This is a limitation: the search can be reproduced in terms of databases, terms, and date, but exact record counts and study-selection decisions for the other databases cannot be reported.

No formal risk-of-bias tool was applied. Instead, the level of evidence of each study was assigned using the Oxford Centre for Evidence-Based Medicine (CEBM) levels, and the main methodological limitations of each study (design, sample size, response rate, follow-up, control group, and outcome definition) are listed below. These were used to interpret the findings and not to include or exclude studies. A formal certainty-of-evidence assessment (e.g., using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach) was not performed because no pooled synthesis was undertaken.

Inclusion criteria included any study, case series, prospective cohort, or case report describing a surgical technique applied specifically to the penile frenulum, including outcome data. Anatomical reviews, guideline documents, and relevant editorials/commentaries were included for clarity and as supporting evidence.

Exclusion criteria included studies pertaining exclusively to lingual, labial, or other non-penile frenula; studies not available in English; and purely in vitro or animal studies.

A total of 12 publications (11 primary studies and reports and one earlier review) were identified and reviewed. Due to the heterogeneous nature and low level of evidence of available studies, formal meta-analysis was not performed; a quantitative meta-analysis was considered but deemed inappropriate because of the substantial clinical and methodological heterogeneity. Findings are synthesized narratively with tabular summaries of key studies.

Non-energy (cold/mechanical) techniques

Non-energy techniques rely entirely on scalpel- or scissor-based tissue incision and suture-based reapproximation, without the use of any thermal or electromagnetic energy source. These constitute the historically dominant approach to frenuloplasty and represent the "gold standard" in most contemporary urology textbooks and guidelines, including the British Association of Urological Surgeons (BAUS) patient leaflet [10].

Simple Transverse Incision With Longitudinal Closure

The most elementary frenuloplasty employs the Heineke-Mikulicz principle: a transverse incision across the tight frenular band is sutured in a longitudinal direction, effectively converting transverse tension into longitudinal gain [11]. The procedure is performed under local anesthetic infiltration and requires no

specialized equipment.

Rajan et al. (2006) published the first dedicated outcome study of frenuloplasty, reporting on 213 procedures performed over 12 years at a single UK center [12]. Questionnaire data were obtained from 48 of 209 eligible patients (23% response rate - a recognized methodological limitation) [12]. Among respondents, median satisfaction was 8/10, and 34 of 48 would recommend the procedure to a peer [12]. The subsequent circumcision rate within the reporting unit was 11%, with an estimated true failure rate of 15-20% when accounting for the low response rate [12]. Despite its limitations, this paper remains the longest-duration single-center report and validated frenuloplasty as worthwhile even when initially presented alongside circumcision as an equally viable option [12].

Arora (2016) reported a prospective Indian case series of 50 men (ages 19-32) with recurrent frenular tearing, all undergoing simple transverse-to-longitudinal frenuloplasty under local anesthesia in an outpatient setting [11]. Minor wound dehiscence occurred in two patients (4%), with no other significant complications [11]. All patients reported subjective improvement in symptoms, confirming the technique's reproducibility and accessibility in resource-limited environments [11].

V-Y Plasty

V-Y plasty is a plastic surgical technique adapted from scar-lengthening procedures [7]. A V-shaped incision is made in the frenular tissue and sutured in a Y configuration, redistributing the skin tension to gain effective length [7]. This method is favoured when the frenular restriction is isolated and moderate in degree.

The largest and most methodologically robust study of frenuloplasty outcomes to date is that of Dockray et al. (2012), published in BJU International [7]. This prospective 10-year study enrolled 106 consecutive men presenting with frenular pain, recurrent tearing, or scarring [7]. Techniques employed were V-Y plasty, Z-plasty, or a combination of both, selected at the surgeon's discretion based on anatomy [6]. Follow-up was 100% at three months and 91% (96/106) at ≥1 year [7]. Mean patient satisfaction was 8.9/10; mean cosmesis score was 8.9/10; 97% of long-term responders said they would recommend the procedure; subsequent circumcision was required in 8% (9/96); and minor complications (bruising, superficial infection, partial wound dehiscence) occurred in 8% (9/96) [7]. The study also proposed a grading system for frenular pathology and provided decision-making data for patient counselling [7]. This remains the most cited and authoritative outcome study in the penile frenuloplasty literature.

Z-Plasty

Z-plasty is a well-established reconstructive plastic surgery technique used to lengthen a scar or tight band by transposing two triangular skin flaps [7]. Applied to the penile frenulum, two triangular flaps are raised from either side of the frenulum and transposed, gaining effective length and reorienting the scar along a less restrictive axis [7]. Z-plasty is particularly suited to frenular pathology where a significant component of scar contracture is present (e.g., following repeated frenular tearing or prior failed frenulotomy) [7].

Z-plasty was included among the techniques reported in the Dockray et al. (2012) series and is endorsed by Pyrgidis et al. (2022) in their comprehensive review [5,7]. Griffin and Kroovand (1990) described frenular chordee as a distinct clinical entity and discussed Z-plasty among the operative options [13]. No dedicated RCT comparing Z-plasty specifically to other plasty techniques has been published in the penile frenuloplasty literature.

Frenular Grafting

Frenular grafting represents a more complex reconstructive approach reserved for cases where simple plasty techniques cannot provide sufficient tissue for lengthening - most commonly when frenulum breve coexists with significant phimosis, or following prior failed frenuloplasty with extensive scarring [14]. In these cases, a tissue graft (most commonly buccal mucosa, preputial inner mucosa, or oral mucosa) is used to bridge the deficiency [14].

Kayes et al. (2007) described frenular grafting as an alternative to circumcision in a small case series of six men presenting with the combination of tight frenulum and phimosis [14]. The technique preserved the foreskin and demonstrated good functional outcomes in a difficult clinical subset, though patient numbers were limited and long-term follow-up data were not available [14]. The authors positioned grafting as the next step in the surgical hierarchy when standard frenuloplasty techniques had been exhausted [14].

Suture Ligation (Non-incisional Thread Technique)

A minimally invasive, non-incisional approach has also been described, in which a suture is threaded through the base of the frenular membrane and tied tightly around the frenular band [11]. Over the course of

several days, the band undergoes ischemic necrosis and separates, effectively dividing the frenulum without surgical incision [11]. This technique avoids any sharp instrument and can theoretically be performed without a formal operating environment [11]. However, no controlled outcome data have been published, and concerns exist regarding the reliability of the division plane, risk of infection, and control over the degree of lengthening achieved. Its use remains anecdotal and is not recommended by current expert opinion.

Scalpel Division Without Plasty (Simple Frenulotomy)

Simple division of the frenulum without any formal tissue rearrangement represents the most minimal surgical intervention. A single transverse or diagonal cut is made across the frenulum and either left to heal by secondary intention or closed with a single suture [4]. While effective for mild cases, this technique carries the highest risk of inadequate lengthening and scar contracture [4]. It is most commonly described in pediatric urological settings for frenular chordee correction during hypospadias repair [13].

Whelan's landmark 1977 BMJ paper - which described adult circumcision as the primary solution - implicitly described simple frenulotomy as insufficient, prompting the development of formal frenuloplasty techniques as we know them [4]. The BAUS (2024) patient information leaflet describes surgical treatment as "dividing the skin across and re-stitching it in a lengthwise fashion," which is the de facto description of simple transverse-to-longitudinal closure without formal plasty flaps [10].

Energy-based techniques

Energy-based techniques employ thermal, electromagnetic, or photonic energy to incise, coagulate, and modify frenular tissue. The principal modalities applied to penile frenuloplasty are (1) electrosurgery/diathermy (monopolar electrocautery) and (2) laser systems - predominantly the CO₂ laser.

These techniques share the advantage of simultaneous hemostasis, the potential elimination of sutures, reduced operative time, and minimally invasive outpatient execution [15,16]. They differ in their mechanisms of tissue interaction, thermal spread characteristics, depth of penetration, and evidence base.

Electrosurgery/Diathermy

The pull-and-burn method (monopolar electrocautery frenulotomy): The most extensively described energy-based technique for penile frenuloplasty correction is the suture-free "pull-and-burn" method, developed and reported by Gyftopoulos [15]. The technique operates on a simple principle: the frenulum is placed under maximal tension using forceps or manual traction, and monopolar electrocautery at the point of maximum tension divides the frenular band [15]. A controlled vertical tear is then effected by gentle pulling, exploiting the altered tissue planes [15]. Minor bleeding points are sealed with targeted diathermy [15]. No sutures are required, local anesthesia (topical EMLA cream or local infiltration) is sufficient, and the procedure can be completed in an office or outpatient clinic setting within minutes [15].

Gyftopoulos first described this method in detail in the Journal of Sexual Medicine (2009), reporting on 127 patients treated with the technique under topical EMLA anesthesia [15]. The method was described as preserving the frenular artery and yielding excellent functional and cosmetic results without the need for sutures, with no serious complications reported in the initial series [15]. The technique was positioned as superior to scalpel frenulotomy in terms of hemostasis, simplicity, and postoperative recovery [15].

Gyftopoulos subsequently published a 15-year retrospective follow-up encompassing 236 patients treated between November 2002 and November 2017 [16]. This represents the largest single-center energy-based frenuloplasty series published to date with excellent long-term follow-up time. The 2018 paper specifically addressed the concern about meatal stenosis - a theorized complication of thermal damage near the urethral meatus - demonstrating that the pull-and-burn method, when performed with anatomical precision, does not increase the risk of meatal stenosis [16]. The integrity of the urethral meatus was preserved in all cases [16]. Mean follow-up and patient satisfaction data were reported as favorable, though detailed numerical outcome data were not universally replicated in this follow-up [16].

The technique has been further referenced in the context of penile length changes following frenuloplasty. A Turkish study (cited in Pyrgidis et al., 2022 and Duarte and Correia, 2009) of 52 patients undergoing circumcision with concomitant pull-and-burn frenuloplasty demonstrated a ventral surface increase of 20-177% following the procedure, with this change found to be predictable (62.5% precision, $p < 0.01$) using pre-operative ventral inner mucosa length [5,17]. This has potential implications for surgical planning of penile reconstruction and length-augmentation procedures [5,17].

General electrosurgery evidence applicable to frenuloplasty: While no RCT has directly compared diathermy to scalpel for penile frenuloplasty, the broader surgical literature provides applicable evidence. Ly et al. (2012) conducted a systematic review and meta-analysis published in the British Journal of Surgery, comparing cutting diathermy versus scalpel for skin incisions across a broad range of procedures [18]. Cutting diathermy resulted in significantly less blood loss (mean difference 0.72 mL/cm²; $p < 0.001$) and

shorter incision times, with no statistically significant difference in wound complication rates [18]. Aird and Brown (2015) published a double-blind RCT in the British Journal of Surgery and found no significant difference in cosmetic outcomes between diathermy and scalpel incisions at six-week follow-up [19]. These findings are cautiously extrapolatable to the penile frenuloplasty context, though direct comparative evidence remains absent.

Safety concerns and expert recommendations regarding diathermy: Despite the clinical appeal of the pull-and-burn method's simplicity, expert consensus as expressed in the most comprehensive published review recommends against diathermy near the penile frenulum [5]. The concern centers on thermal spread from monopolar electrocautery potentially damaging the frenular artery - which, if injured, may lead to ischemic necrosis of the glans tip - and the neurosensory terminals of the dorsal penile nerve [5]. The recommendation is to divide the frenulum with a cold scalpel and reapproximate with 4-0 absorbable interrupted sutures, maintaining the frenular artery [5]. It must be emphasized, however, that this recommendation is based on theoretical anatomical risk and expert opinion rather than direct comparative clinical evidence.

Laser Frenuloplasty

CO₂ laser - classical vaporization mode: The CO₂ laser operates at a wavelength of 10,600 nm (infrared spectrum), which is highly absorbed by tissue water, producing precise vaporization of cellular tissue with minimal lateral thermal spread compared to monopolar diathermy [20]. In its classical focused mode, it can be used to vaporize the frenular tissue layer by layer with simultaneous hemostasis of small vessels [20].

Duarte and Correia (2009) published the earliest description of CO₂ laser frenuloplasty for frenulum breve in the Journal of Cosmetic and Laser Therapy [17]. Three male patients with symptomatic short frenulum underwent CO₂ laser vaporization of the frenular band in an outpatient dermatological setting [17]. All three achieved complete resolution of dyspareunia at follow-up, with good cosmetic results and no significant wound complications [17]. The authors highlighted the reduced risk of postoperative hemorrhage, wound infection, and scarring compared to conventional scalpel surgery as theoretical advantages of the laser approach [17]. While very small in number and not formally controlled, this case series established the proof of concept for CO₂ laser in penile frenuloplasty and is widely cited as the foundational reference [17].

CO₂ laser - defocused non-ablative thermal elongation (novel technique): A technically distinct and innovative application of CO₂ laser technology was reported by Amato et al. from the University of Rome La Sapienza group [21]. Rather than using the laser in its classical focused ablative mode, the technique uses a 7-inch defocused handpiece at low parameters (20 Hz, 0.3 W) to deliver broad, controlled thermal passes over the frenular tissue while manual traction is applied simultaneously [21]. The thermal energy renders the collagen fibers of the frenulum more malleable and gradually elongates the tissue without vaporizing or ablating it [21]. This represents a fundamental mechanistic departure from classical laser frenuloplasty, favoring gradual remodeling over tissue removal.

The study enrolled 15 patients between 25 and 50 years of age with symptomatic frenulum breve. Results demonstrated: complete absence of hemorrhage intraoperatively, no cases of secondary fibrosis or scarring, tissue healing within two weeks in all patients, and statistically significant improvements in quality of life as measured by the Short Form Health Survey-12 (SF-12) [21]. The mean Physical Component Summary (PCS) score rose from 32.5 to 47.5 ($p < 0.001$), and the mean Mental Component Summary (MCS) score rose from 39.3 to 52.3 ($p < 0.001$) [21]. The authors noted a typical complete recovery time of approximately five days on average - substantially shorter than reported recovery periods for scalpel-based techniques [21]. The approach required no operating room, no venous access, and minimal staffing, representing a meaningful reduction in procedural infrastructure requirements [21].

The mechanistic basis for this technique's superiority over diathermy and scalpel in terms of fibrosis prevention is grounded in the biological effects of CO₂ laser irradiation on connective tissue: CO₂ laser stimulates fibroblast proliferation while simultaneously increasing the expression of basic fibroblast growth factor (bFGF, which reduces collagen synthesis) and inhibiting transforming growth factor-beta 1 (TGF-beta 1, the principal pro-fibrotic cytokine) [21]. The net result is a more biologically favorable wound-healing environment with reduced collagen deposition and scar formation compared to thermally nonspecific techniques such as monopolar diathermy [21].

A directly related case report by Lodi et al. described the application of CO₂ laser frenuloplasty in a 25-year-old male who had sustained a frenulum perforation following aggressive cryotherapy for recurrent genital condylomas [22]. The perforated, scarred frenulum was divided, and the proximal and distal ends were vaporized using the CO₂ laser [22]. At one-month follow-up, the patient reported significant symptom improvement, well-healed tissue with minimal visible scarring, and no functional limitations [22]. This case extends the application of CO₂ laser frenuloplasty to the re-operative and trauma-related frenular pathology setting, where the anti-fibrotic properties of laser technology are particularly advantageous [22].

Functional outcomes: sexual function and PE

The relationship between frenulum breve and PE represents one of the most clinically significant and understudied aspects of frenular pathology. The mechanical hypothesis holds that a short, taut frenulum limits stroke length during intercourse, prompting habituation to a faster ejaculatory pattern; simultaneously, the heightened tension may amplify sensory input from the densely innervated frenular tissue, further lowering the ejaculatory threshold [3].

Gallo et al. (2010) published the first and most influential prospective study addressing this question in the *Journal of Sexual Medicine* [6]. Between January and December 2008, 137 patients presenting to a private Italian center for treatment of lifelong PE underwent thorough physical examination [6]. A short frenulum (defined as producing $\geq 20^\circ$ ventral glans deflection on foreskin retraction) was identified in 59 of 137 patients (43%) [6]. All 59 patients who consented underwent frenulectomy (complete frenulum excision) [6]. Intravaginal ejaculatory latency time (IELT) was measured at baseline and at mean follow-up of 7.3 months (± 3.18) using a stopwatch [6]. Mean IELT increased from 1.65 minutes (± 1.15) at baseline to 4.11 minutes (± 1.77) post-frenulectomy - a statistically significant increase of 2.46 minutes ($p < 0.0001$) [6]. Mean PE Questionnaire score decreased from 15.8 (± 2.85) to 9.85 (± 3.2) - a statistically significant reduction of 5.95 points ($p < 0.0001$) [6]. No surgical complications occurred [6]. The authors concluded that short frenulum should be formally excluded at physical examination in all patients presenting with lifelong PE, and proposed frenulectomy as first-line treatment in confirmed cases [6].

This study generated immediate and significant commentary. Jannini acknowledged the surprisingly high prevalence of short frenulum among PE patients and the impressive IELT gains, while raising important methodological concerns: the single-center design, the absence of a control group, the subjective definition of frenulum breve, and the possibility of case selection bias in a private practice environment [23]. Gallo et al. replied in *European Urology*, defending the diagnostic criteria and methodology, and emphasizing that the study was the first of its kind in the literature [24]. The debate stimulated interest in the frenulum-PE relationship, though no subsequent RCT addressing this specific question has been completed.

Hosseini et al. (cited in Pyrgidis et al., 2022) separately investigated the role of frenular web preservation on ejaculation latency time in a cohort of circumcised patients, demonstrating a significant relationship between residual frenular web tissue after circumcision and reduced IELT, lending independent support to the frenulum-PE association [25]. The European Association of Urology (EAU) Guidelines on Sexual and Reproductive Health (2021 update) acknowledge the frenulum-PE hypothesis but do not include surgical frenulectomy among their primary treatment recommendations due to insufficient high-level evidence [26]. The 2026 updated EAU Guidelines do not specifically reference frenuloplasty [27].

The argument against surgical treatment of PE centres on the irreversibility of surgery and the availability of pharmacological options [28]. However, these counterarguments apply most forcefully to cases where PE is not mechanically linked to frenulum breve [28]. In patients with confirmed anatomically short frenulum and corresponding mechanical symptoms, the surgical rationale is distinct and arguably stronger [5].

Comparative summary of evidence

Table 1 summarizes the primary studies identified in this review, with technique, sample size, evidence level, key outcomes, and limitations for each.

Study (Year) Journal Name	Technique	n	Key Outcomes	Evidence Level	Limitations
Whelan (1977) BMJ [4]	Circumcision/frenulotomy	N/A (case description)	Landmark description; proposed circumcision for frenular dyspareunia	Level 5 - case description	No formal outcome data
Rajan et al. (2006) Ann R Coll Surg [12]	Cold - scalpel plasty	213 procedures (48 responded)	Median satisfaction 8/10; circumcision rate 11%; 34/48 would recommend	Level 4 - case series	23% questionnaire response rate; technique not fully described
Dockray et al. (2012) BJU Int [7]	Cold - V-Y/Z-plasty	106 (91% long-term follow-up)	Satisfaction 8.9/10; cosmesis 8.9/10; 97% recommend; 8% circumcision rate; 8% minor complication	Level 4 - prospective case series	Single center; no control group; mixed techniques
Arora (2016) IJSR [11]	Cold - transverse/longitudinal	50	All improved; 4% wound dehiscence; effective under local anesthesia in outpatient setting	Level 4 - case series	Short-term follow-up; no validated PROs
Kayes et al. (2007) J Sex Med [14]	Cold - frenular grafting	6	Circumcision-sparing; effective for combined phimosis + frenulum breve	Level 4 - case series	Very small no; limited follow-up
Gallo et al. (2010) J Sex Med [6]	Cold - frenulectomy (PE indication)	59 (from 137 PE patients)	IELT: 1.65 → 4.11 min (+2.46 min; p<0.0001); PE score: 15.8 → 9.85 (p<0.0001)	Level 3b - prospective cohort	Single center; no control; subjective frenulum definition; private practice bias
Gyftopoulos (2009) J Sex Med [15]	Energy - diathermy (pull-and-burn)	127	Bloodless; sutureless; EMLA sufficient; frenular artery preserved; excellent cosmesis	Level 4 - case series	Single surgeon; no formal PRO tool; limited follow-up detail
Gyftopoulos (2018) Urol Ann [16]	Energy - diathermy (pull-and-burn)	236 (15-year series)	Safe; no meatal stenosis; urethral meatus preserved in all cases	Level 3b - retrospective cohort	Single surgeon; retrospective; no validated PRO tool
Duarte and Correia (2009) J Cosmet Laser Ther [17]	Energy - CO ₂ laser (vaporization)	3	Complete symptom resolution; good aesthetics; no bleeding; no sutures	Level 5 - case reports	n = 3; no control; short follow-up
Amato et al. (2024) MDPI Surgeries [21]	Energy - CO ₂ laser (defocused thermal elongation)	15	PCS: 32.5→47.5; MCS: 39.3→52.3 (p < 0.001); two-week healing; no hemorrhage; no fibrosis	Level 3b - prospective pilot	Small n = 15; short follow-up; no control arm
Lodi et al. (2025) AME Case Reports [22]	Energy - CO ₂ laser (re-operative setting)	1	Frenulum perforation repaired; healed with minimal scarring at one month; pain-free	Level 5 - case report	Single case; one-month follow-up only
Pyrgidis et al. (2022) Int J Impot Res [5]	Comprehensive review - all techniques	N/A (review)	All techniques show acceptable results; scalpel + 4-0 absorbable sutures recommended; no RCT data exist	Level 5 - narrative review	No original data; conclusions are expert-opinion-based

TABLE 1: Comparative Summary of Evidence
PE: premature ejaculation; IELT: intravaginal ejaculatory latency time; PCS: Physical Component Summary; MCS: Mental Component Summary; RCT: randomized controlled trial; PRO: patient-reported outcome

Discussion

Overall Evidence Base

The penile frenuloplasty literature is characterized by a notable absence of high-quality comparative evidence. Of all studies identified in this review, none is an RCT comparing different surgical techniques or comparing energy-based to non-energy-based approaches. The vast majority are case series (Level 4 evidence) or retrospective cohorts (Level 3b). The highest-quality prospective data come from Dockray et al. (2012) and Gallo et al. (2010), both of which are single-center prospective cohorts without control arms [6,7].

Appraisal of the included studies (level of evidence and limitations in Table 1) showed recurring weaknesses: the absence of control groups, single-centre designs, mixed techniques within a single series, low questionnaire response rates (23% in Rajan et al.), subjective or undefined definitions of frenulum breve and

of treatment success, and short follow-up for energy-based techniques (two weeks in Amato et al.). Differences in study populations (e.g., dyspareunia versus PE indications), outcome definitions, and surgical technique are the main reasons for the heterogeneity between studies and explain why pooling was not appropriate. Together with likely publication bias, these limitations mean that the reported satisfaction and complication rates should be interpreted as indicative rather than definitive. The lack of a formal risk-of-bias tool and of recorded screening numbers (see Methodology) is a further limitation of this review.

This evidence gap is particularly significant given that frenuloplasty is a commonly performed outpatient urological procedure. The absence of standardized outcome measures across studies, patient satisfaction scales, validated sexual function instruments, complication grading systems, and functional definitions of success varies widely, making cross-study comparisons difficult and unreliable. There will also be inherent publication bias in such studies since investigators are more likely to publish positive findings. This, together with the marked heterogeneity of the outcomes reported in different studies, means that the limited number of studies cannot be compared with any validity.

Non-energy Techniques: Strengths and Limitations

Cold plasty techniques (V-Y and Z-plasty) are supported by the strongest volume of outcome data [5,7]. The 10-year prospective data from Dockray et al. (2012) demonstrate consistent patient satisfaction of approximately 90%, with low complication and re-operation rates [7]. These techniques offer precision of incision, no risk of thermal damage to the frenular artery or dorsal penile nerve, and a well-established procedural framework understood by all urologists [5,7]. Their principal limitation is the requirement for sutures, which prolongs procedural time and introduces a small risk of wound dehiscence (approximately 4-8% in reported series) [7,11].

Simple scalpel division without plasty (frenulotomy) is rapid but carries the highest risk of inadequate lengthening and recurrent scar contracture [4]. It is appropriate only for mild, isolated cases without significant fibrosis [4]. Frenular grafting, while highly effective for complex presentations, requires additional surgical expertise, a donor site, and a longer recovery period [14]. Its use remains reserved for refractory or complex cases [14].

Energy-Based Techniques: Strengths and Limitations

The pull-and-burn diathermy technique offers a compelling combination of simplicity, accessibility, bloodlessness, and the elimination of sutures [15]. Gyftopoulos's 15-year series provides the largest patient volume for any single energy-based frenuloplasty technique and demonstrates a satisfactory long-term safety profile [16]. The principal theoretical concerns - thermal spread, frenular artery injury, and meatal stenosis - are addressed directly by Gyftopoulos, who argues that anatomically precise application of diathermy mitigates these risks [16]. The disconnect between the expert-opinion caution of Pyrgidis et al. and the clinical evidence from Gyftopoulos highlights the need for a direct comparative trial [5,16].

CO₂ laser frenuloplasty, particularly in the innovative defocused thermal elongation mode described by Amato et al. (2024), offers several distinct theoretical and clinical advantages: controlled, targeted tissue interaction with minimal lateral thermal spread, anti-fibrotic biological mechanisms (bFGF upregulation, TGF-beta 1 suppression), sutureless technique, office-based execution, and rapid recovery (approximately five days in the 2024 series versus 10-14 days typically reported for scalpel techniques) [21]. However, the evidence base for laser frenuloplasty remains exceptionally small - the largest primary study includes only 15 patients with two-week follow-up - and laser equipment represents a significant capital investment that limits accessibility [21]. Longer-term follow-up data and larger cohorts are urgently needed.

The PE Dimension

The Gallo et al. (2010) prospective study introduced a paradigm-shifting question: is frenulum breve an underrecognized organic contributor to lifelong PE in a meaningful proportion of affected men? [6] If confirmed, this would place the penile frenuloplasty within the broader therapeutic landscape of sexual medicine - not merely as a comfort procedure for dyspareunia, but as a potential first-line curative intervention for a subset of PE patients who have thus far been managed solely with pharmacotherapy or behavioral interventions [6].

The practical implication is straightforward: physical examination of the penile frenulum should be included in the routine assessment of men presenting with lifelong PE, as advocated by Gallo et al. [6]. Those with confirmed frenulum breve and mechanical symptoms should be offered frenulectomy as an evidence-based first-line option alongside - or in preference to - pharmacotherapy, depending on patient preference and clinical judgment [6]. The EAU (2020 and 2026) has not yet incorporated this recommendation formally, reflecting the need for independent replication of the Gallo et al. findings [26,27].

Complications Across Techniques

The reported complication profile across all frenuloplasty techniques is generally mild. Reported complications include wound dehiscence (approximately 4-8% in cold technique series), superficial infection (approximately 4%), bruising and hematoma formation, frenular artery hemorrhage requiring surgical intervention (rare), reduced glans sensitivity (explicitly mentioned as a risk by BAUS, 2024), penile meatal stenosis (theoretical risk for diathermy; not confirmed in Gyftopoulos's 15-year series), and failure to provide sufficient lengthening requiring subsequent circumcision (8-20% of cold technique cases; not well-reported for energy-based techniques) [10,15].

The most significant long-term functional concern - reduced penile sensitivity after frenuloplasty - is acknowledged by Jannini's commentary on the study by Gallo et al., which notes acquired PE as a potential consequence of poorly performed frenulectomy causing local chronic irritation of the scar [23]. This underscores the importance of technical precision regardless of the modality chosen.

Practical Recommendations for Clinical Practice

Based on the totality of available evidence, the following practical framework can be proposed. For the majority of patients presenting with straightforward frenulum breve without significant scarring, V-Y or Z-plasty performed with a cold scalpel and absorbable sutures remains the recommended standard of care, supported by the strongest available outcome data [7]. The pull-and-burn diathermy technique represents a valid alternative in experienced hands, particularly when the operating environment lacks suturing capability or when rapid, sutureless completion is desirable, with the 15-year safety series providing reassurance regarding meatal safety [15,16]. CO₂ laser frenuloplasty - particularly in the defocused remodeling mode - is a promising innovation with compelling mechanistic advantages and early outcome data, but its routine adoption should await larger confirmatory studies [17,21,22]. For complex cases involving combined phimosis, extensive frenular scarring, or prior failed frenuloplasty, frenular grafting or referral to specialist reconstructive urology centers should be considered [14].

Gaps in the literature and future research directions

Multiple important gaps in the frenuloplasty evidence base warrant prioritization for future research. First and most urgently, a multicenter RCT comparing at least two techniques - for example, cold scalpel V-Y plasty versus the pull-and-burn diathermy method versus CO₂ laser frenuloplasty - is needed. Such a trial should utilize standardized and validated patient-reported outcome instruments (e.g., validated sexual function questionnaires, pain visual analog scales, cosmesis scales, and IELT measurement). This would reduce the heterogeneity of outcome reporting and publication bias in existing small studies.

Second, a standardized, validated grading system for frenulum breve severity should be developed and adopted universally; this would reduce selection bias so enabling reproducible patient selection and cross-study comparison. The preliminary grading proposed by Dockray et al. (2012) could serve as the foundation for such a standardized tool [7].

Third, longer-term follow-up studies - particularly for energy-based techniques - are needed. The study by Amato et al. (2024) on CO₂ laser reported only two-week follow-up outcomes; rates of late recurrence, scar contracture, and sustained quality-of-life improvement require study at one, two, and five years post-procedure [21].

Fourth, the PE-frenulum connection requires formal prospective multicenter validation with controlled methodology. A randomized trial of frenuloplasty versus pharmacotherapy (e.g., dapoxetine) versus combined treatment in men with confirmed short frenulum and lifelong PE would be both clinically impactful and feasible.

Fifth, a health economic analysis comparing the outpatient modalities - particularly the higher capital cost of laser technology versus the lower ongoing procedural costs - would assist healthcare systems in making evidence-based commissioning decisions.

Conclusions

Penile frenuloplasty is a well-established, predominantly outpatient surgical procedure with documented efficacy for the relief of dyspareunia, frenular tearing, and frenular chordee caused by frenulum breve. Both non-energy (cold/mechanical) and energy-based techniques demonstrate acceptable safety and patient satisfaction in the available literature. Non-energy V-Y and Z-plasty techniques are supported by the largest cumulative evidence base, with prospective 10-year data demonstrating 90% patient satisfaction and an 8% requirement for subsequent circumcision. Energy-based techniques - the pull-and-burn diathermy method and CO₂ laser frenuloplasty - offer sutureless, bloodless outpatient alternatives with respective strengths in procedural simplicity and anti-fibrotic biological mechanisms. The critical overarching finding of this review is the near-complete absence of high-quality comparative evidence. No RCT comparing techniques has been published. All primary studies are case series or retrospective cohorts at Level 3b-4 evidence. The most substantial evidence gaps concern long-term outcomes of energy-based techniques, standardized

complication reporting, and the relationship between frenulum breve and PE. Until high-quality comparative evidence is available, individual clinical judgment, surgeon expertise, patient anatomy, and patient preference should guide technique selection. Physical examination of the penile frenulum should be incorporated into the assessment of all men presenting with lifelong PE. A multicenter RCT comparing surgical modalities, with standardized outcome measures and adequate follow-up, represents the most important priority for the frenuloplasty research community.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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