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Review

Esophageal Lichen Planus–Contemporary Insights and Emerging Trends

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Abstract

Background: Lichen planus (LP) is a common inflammatory disease affecting skin, mucous membranes, hairs, and nails, with an unpredictable course involving remissions and relapses. LP is a Type-I-Inflammation disease involving IFN-γ and IL-17 as key inflammatory mediator. **Materials and Methods:** We searched PubMed/MEDLINE and Google scholar search engines for studies on esophageal manifestation of lichen planus over an unlimited time frame. Articles were searched with combinations of Medical Subject Heading (MeSH) terms. Given the limited number of publications, no exclusion criteria were applied. **Results:** Esophageal lichen planus (ELP) is an underreported manifestation of LP that primarily affects middle-aged women. Its prevalence among LP patients remains to be defined. Though potentially clinically silent, ELP can significantly impact patient wellbeing and serve as a precursor to esophageal squamous cell carcinoma. While dysphagia is the primary symptom, the condition may also remain subclinical. The endoscopic hallmark of ELP are mucosal denudation and tearing, trachealization, and hyperkeratosis. Chronic disease progression may lead to scarring esophageal stenosis. Histologically, ELP shows mucosal detachment, T-lymphocytic infiltrations, epithelial cell apoptosis (Civatte bodies), dyskeratosis, and hyperkeratosis. Fibrinogen deposits along the basement membrane zone distinguish ELP from various immunological esophageal diseases. There is currently no standardized therapy available. Topical steroids provide symptomatic and histologic improvement in two-thirds of patients. Severe or refractory cases require immunosuppressive therapy, whereas JAK-inhibitors represent a promising emerging option. Endoscopic dilation helps symptomatic stenosis. Considering ELP's precancerous potential, timely diagnosis and treatment are crucial in preventing complications such as stenosis or invasive esophageal squamous cell carcinoma. **Conclusion:** ELP is an underdiagnosed and underreported manifestation of LP. While it may remain clinically silent, it can nevertheless significantly affect patients' wellbeing and life-expectancy. This narrative review aims to initiate multidisciplinary cooperation among gastroenterologists, dermatologists, oral health professionals, and histopathologists to support clinical diagnosis and management.

Keywords: autoimmunity; dysphagia; eosinophilic esophagitis; esophageal epidermoid metaplasia; esophagitis; JAK inhibitors; lichen planus; precancerous condition; squamous cell carcinoma

1. Lichen Planus

Lichen planus is a common inflammatory and autoimmune disease of skin, mucous membranes, hair, and nails. [1–5]. Its population-based prevalence was estimated to reach an average of 1.3%

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[1,6,7]. A meta-analysis showed varying prevalence of oral LP (0.57% in Asia, 1.39% in South America, and 1.68% in Europe) [6,7]. Lesions of skin, oral, and genital mucosa are the most frequent manifestations. Involvement of nails, scalp, genito-anal mucosa, eyes, ears, urinary bladder, or nasal mucosa can also be seen. Generally, the clinical course is benign with fluctuating symptoms. Classic cutaneous LP presents as flat, reddish, itching papules on the face, arms, and wrists, with a tendency to progress to hyperpigmentation. Cutaneous LP is generally self-limiting and occasionally pruritic, with the majority of cases resolving spontaneously over months to years. Oral LP is considered the most predominant mucosal manifestation affecting two-thirds of patients with cutaneous LP [8–11] . Oral LP differs markedly from its cutaneous counterpart in clinical behavior. It is typically chronic, treatment-resistant, and associated with considerable morbidity due to both its malignant potential and impact on quality of life. It exhibits characteristic fine white buccal lines (Wickham striae) or visible erosions or ulcerations on buccal mucosa, gingiva, palate, or tongue. Patients with oral LP generally complain of oral discomfort or pain. Importantly, oral LP is recognized as an oral potentially malignant disorder (OPMD), with reported rates of malignant transformation ranging from 0.44% to 2.28%. The risk is particularly elevated in patients with erosive or atrophic subtypes, tongue involvement, significant alcohol or tobacco consumption, or concurrent hepatitis C virus infection. Emerging research further suggests an association between vitamin D deficiency and oral LP development, highlighting potential nutritional factors in its pathogenesis [12].

Genital LP, on the other hand, may cause itching lesions on genital mucosa and may present with inflammation with erythema, erosions, plaque formation, and scarring. LP pemphigoides is a rare variant of LP, exhibiting characteristics of bullous pemphigoid with autoantibody deposition along the dermal-epidermal-junction zone (e.g. reactivity against collagen XVII) [13]. Due to multiple organ manifestations, LP requires multidisciplinary approach involving dermatologists, oral health professionals, gynecologists, gastroenterologists, and histopathologists [8–11]. The European guidelines for therapy of LP have recently been published [14,15]. Timely diagnosis and therapy are essential as mucosal LP carries a recognized risk of malignant transformation.

2. Pathogenesis of LP

The exact pathogenesis of LP is not completely understood [16,17]. LP may be triggered by several drugs, *e.g.* NSAIDs, beta-blockers, ACE-inhibitors, and checkpoint inhibitors [18]. Agents such as amalgam, mercury, or gold may also induce oral LP [19,20]. Distinguishing true LP from lichenoid reactions is essential, as various drugs and dental restorative materials can induce lesions that mimic LP clinically and histologically. Lichenoid drug reactions typically resolve upon discontinuation of the offending agent, whereas true LP persists independently of external triggers. Additionally, oral LP may exhibit the Koebner phenomenon, in which chronic trauma or mechanical irritation can result in exacerbation or new lesion formation at sites of injury. Concomitant diabetes mellitus or smoking may influence the clinical severity in LP [21]. An association with different autoimmune disorders such as primary biliary cholangitis, autoimmune thyroiditis, myasthenia gravis, alopecia areata, vitiligo, thymoma, and autoimmune polyendocrinopathy [10,22–24] has been described. The assumed association with chronic hepatitis C remains controversial [25,26]. Psychological components may influence disease progression [27–29].

According to Eyerich et al., the immune response in immune-mediated skin diseases can be classified into six response patterns [30]. LP is categorized as Type-I-Inflammation disease [30] driven by CD8 cytotoxic T-cells targeting the basal layer of keratinocytes resulting in apoptosis and leading to the characteristic interface dermatitis [31–34]. In oral LP, certain key proteins are implicated in pathogenesis. Osteopontin, a multifunctional phosphoprotein, promotes T-cell activation and migration, thereby contributing to chronic inflammatory state. CD44, a cell surface adhesion molecule, facilitates lymphocyte homing and retention within the oral mucosa. Survivin, an anti-apoptotic protein, is dysregulated in oral LP and may contribute to persistence of inflammatory infiltrates and altered keratinocyte survival. The central pathogenetic mechanism involves a sequential cascade. IFN-γ binds to its receptors on both keratinocytes and infiltrating lymphocytes.

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This binding activates JAK1 and JAK2 signalling in both cell types. [35–37]. STAT1 is then activated, primarily in keratinocytes, leading to upregulation of MHC-I expression. JAK2 activation in lymphocytes and STAT-1 activation in keratinocytes in active LP may also be possible [38,39]. This process creates inflammatory amplification by enhancing keratinocyte responsiveness to inflammatory signal. Upregulation of IFN-γ, TNF-α, and IL-1, -6, and -8 cause basement membrane disruption [31–34]. The lichenoid infiltrates are predominantly composed of type-1 lymphocytes (Tc1-cells, Th1 cells, ILC1, NKT, and NK) with reaction to exogenous or altered self-antigens presented by APCs, DCs, or keratinocytes . The inflammatory Th1-response leads to secretion of proinflammatory cytokines (e.g. IL-23, IL-17, and IFN-γ), perforin, granulysin, and granzyme B as cytotoxic molecules. This inflammatory cascade ultimately causes basement membrane disruption and keratinocyte apoptosis, resulting in distinct clinical manifestations depending on the anatomical location affected. In cutaneous LP, this process manifests as the characteristic violaceous, polygonal papules. When mucosal surfaces are involved, keratinocyte apoptosis results in painful erosive lesions that can significantly impact quality of life. In follicular lichen planus, damage to basal keratinocytes within hair follicles leads to irreversible scarring alopecia due to destruction of follicular stem cells.

At present, there are no specific data on pathogenesis of ELP. Since at least histopathologic lesions of oral LP and ELP are comparable, a similar pathogenesis may be anticipated.

Accordingly, the use of JAK inhibitors in LP, as well as in other dermatological conditions with similar pathogenesis (e.g. vitiligo), provides a rational basis for targeted therapy compared with conventionally prescribed glucocorticosteroids or broader immunosuppressants [4,40–42].

3. Esophageal Lichen Planus

ELP was first described in 1982 [43]. It was initially regarded as a rare manifestation of LP [44–46] . However, further studies showed an esophageal involvement in up to 50% of patients with cutaneous or oral LP [47,48]. Despite growing interest in ELP, the number of cases in these studies were limited and patients were partly preselected and non-randomized in LP cohorts. ELP does not necessarily correlate with oral involvement [49]. However, oral LP is observed in most patients with severe ELP [50]. Esophageal manifestation is also associated with occurrence of other mucosal involvement such as genital LP [51]. The median age at presentation is 60 years and 70 - 80% of patients are female [49,52–54]. The clinical spectrum ranges from asymptomatic presentations to severe symptoms, such as dysphagia and bolus obstruction, upper gastrointestinal bleeding, and potentially ends in the development of esophageal squamous cell carcinoma. The percentage of ELP patients presenting with symptoms remains unknown. Previous studies found that 17-50% of patients with mild ELP did not report dysphagia [49,50]. However, treatment decisions should not rely exclusively on symptom severity, as asymptomatic ELP cases may also warrant therapy. Patients with symptomatic dysphagia should always undergo endoscopic evaluation.

Determining the true prevalence of ELP remains a challenge. This would require endoscopic screening in a large group of LP patients, regardless of disease localization or clinical symptoms. Consequently, even asymptomatic LP patients should undergo EGD. However, cost-benefit and risk-benefit considerations must be taken into account, even if screening would be of practical rather than only academic interest. Limiting assessment to LP patients with esophageal symptoms, e.g. dysphagia, would underestimate the true prevalence of ELP [55]. On the other hand, the selection bias of several studies would overestimate its population-based prevalence. Assuming that only 10% of all LP patients have esophageal involvement, the estimated prevalence in the general population could reach 0.1%, which would surpass the reported prevalence of eosinophilic esophagitis (0.04%–0.05% in Western countries) [56].

Many aspects of ELP are still poorly understood and the disease itself remains underreported and underdiagnosed. Within the last two decades, ELP has gained increasing recognition among dermatologists, gastroenterologists, and histopathologists. Table 1 presents a representative selection of newer publications (only studies with more than 10 ELP patients and reviews) addressing various aspects of this disease.

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Table 1. Selection of important newer studies on esophageal lichen planus (Only studies with more than ten ELP patients or reviews. Numbers in braces indicate number/percentage of patients from the cohort to which the criterion applies).

Authors, References and publication year	cohort/ study design	number of ELP cases	further manifestation sites of LP	macroscopic findings as described in the manuscript	histologic findings as described in the manuscript	symptoms	therapy
Quispel [48] 2009	24 LP patients	12	oral and/or cutaneous (all)	whitish papules (10) hyperemic lesions (3) mucosal detachment (2) submucosal plaques (3)	lymphohistiocytic infiltrations para-/hyperkeratosis hyperplasia Civatte bodies glycogen acanthosis	dysphagia (4) odynophagia (3) heart burn (3) regurgitation (2)	
Katzka [33] 2010	retrospective review (10 years) of data base/ esophageal biopsies from patients with dysphagia	27 (female 92%)	oral (19) genital (13) cutaneous (3) ELP as initial manifestation (13)	strictures (18) proximal (11), distal (3), both (4), mucosal detachment (11) erythema, plaques, whitish mucosa, superficial ulcerations Koebner effect after dilation	lichenoid lymphocytic infiltration damage of epithelial basal layer Civatte bodies squamous cell carcinoma (1)	dysphagia (27) odynophagia (2)	dilatation of strictures (17) prednisone (6) intralesional corticosteroids (2) swallowed fluticasone/ budesonide (2)
Fox [50] 2011	review of published ELP cases until 2009	72 (female 87%)	oral (89%) genital (42%) cutaneous (38%)	pseudomembranes, bleeding, fragility, inflammation	Lichenoid lymphocytic infiltrates	dysphagia (81%)	

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	(including 4 own cases)		scalp (7%) nails (3%) eyes (1%) ELP as initial manifestation (14)	- proximal (64%) - distal (11%) - both (26%) stenosis (47%)	dysplasia/ squamous cell carcinoma (6%)	odynophagia (24%) weight loss (14%) heart burn regurgitation hoarseness asymptomatic (17%)	
Podboy [57] 2017	retrospective analysis of a cohort of ELP-patients	40 (female 80%)	cutaneous (4) oral (19 genital (15) ELP as only manifestation (13)	strictures (29) ring formation (29) ulcerations (8) mucosal detachment (6) other mucosal lesions (14) squamous cell carcinoma (2)	esophagitis (20) focal ulcerations (13) mucosal hyperplasia (10) intraepithelial lymphocytic infiltrate (13), eosinophilia (13) dyskeratosis (11) *DIF in 20 cases:* positive, lichenoid (2) equivocal (5) not evaluable because of mucosal detachment (13)	dysphagia for solid food (32) even for fluids (8) odynophagia (6) reflux (1)	topical corticosteroids budesonide in honey 2x3mg (32) fluticasone spray 880µg 2x/d (8) *response rate:* endoscopic (72,5%) clinical (62%)
Ravi [34] 2019	retrospective analysis of ELP patients	132 (female 80%)		„Clinical diagnosis" (77)	„Specific histology" (55) esophageal carcinoma (8)		response to topical steroids (84) immunosuppressive therapy (38)

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Kern [52] 2016 **Schauer [49] 2019**	52 patients with proven LP on other site (♀ 75%)	34 -mild (18) -severe (16)	oral 78-100% in ELP 78% in non-ELP) genital 44-61% in ELP 6% in non-ELP cutaneous 25-44% in ELP 28% in non-ELP	mucosal detachment - iatrogenic (12) - spontaneous (16) hyperkeratosis (7) trachealization (10) stenosis/strictures (7)	epithelial detachment lymphocytic infiltration Civatte bodies dyskeratosis *DIF:* fibrinogen deposits (17) (85% in severe ELP)	dysphagia - severe ELP: 15 - mild ELP: 8	topical steroids (12) - budesonide gel 3x0,5mg - fluticasone *Stenosis:* - topical steroids - dilation
Aby [58] 2023	Descriptive multicenter report	78 ELP (female 86 %)	Oral (14) Skin (6) Multisystemic (18)	Strictures (42) Denudation (39) Narrow caliber esophagus (21)	Not listed	Not mentioned	PPI alone Topical steroids Systemic steroids Intralesional steroids PPI + intralesional + topical steroids Immunosuppressors.
Diehl [55] 2025	Prospective analysis of LP with dysphagia	21 ELP (female 71 %)	Oral (17) Genital (9) Nail (8), Hair (7) Skin (5), Anal (1), Eye (1)	Denudation (13) Hyperkeratosis (9) Trachealization (15) Stenosis (13)	Civatte bodies (7) Dyskeratosis (12) Epithelial detachment (7) Lymphocytic infiltrate (16) DIF: fibrinogen deposits (13)	Dysphagia Food bolus obstruction Heart burn	Not listed in detail
Decker [54] 2022	Review						
Jacobs [31] 2022	Review						

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Blonski [59] 2023	Review						
Ghai [60] 2025	Review						

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4. Diagnostic Features of ELP

4.1. Clinical Symptoms

Dysphagia is the leading symptom found in the majority of patients with ELP. It may include persistent swallowing difficulties, recurrent food impaction, and retrosternal chest pain [55]. Other reported complaints include odynophagia, heartburn, regurgitation, hoarseness, chronic unproductive cough, and weight loss. A substantial subset of ELP patients (between 20% [53] and more than 50%) does not present with any esophageal symptoms. As documented in a previous study, 94% of patients with endoscopically assessed severe ELP reported dysphagia, while only 44.4% of patients with mild ELP complained about dysphagia [49]. Conversely, LP patients without esophageal involvement may also have dysphagia, especially in LP with oral manifestation. Clinical differentiation between oropharyngeal and esophageal dysphagia could prove difficult, thus endoscopic evaluation is warranted. Since in a considerable percentage of ELP patients the macroscopic aspect of the esophagus is ambiguous, histologic evaluation is necessary included to confirm ELP [58]. ELP should be as differential diagnosis in all patients with dysphagia or food impaction (see Table 3).

4.2. Macroscopy

Denudation or sloughing of the esophageal mucosa are the endoscopic hallmark of ELP in nearly all studies. It may occur spontaneously or arise during the endoscopic procedure. “Trachealization” (endoscopically observed as ring forming common in EoE) and presence of a rough and whitish surface of the mucosa are nonspecific signs. The latter is the macroscopic correlate of a hyperkeratosis seen in histology [49,50,52,58]. As in other inflammatory esophageal diseases, chronic and uncontrolled inflammation can lead to stenoses or strictures. Figure 1 shows endoscopic images of mucosal alterations in ELP. These alterations can be observed mainly in the middle third of the esophagus. As reflux esophagitis often occurs simultaneously with ELP, macroscopic and histologic alterations directly above the gastroesophageal junction may be ambiguous. Hence, biopsies should be taken at least 5 cm above the gastroesophageal junction. It is recommended that biopsies be obtained from all three thirds of the esophagus, regardless of macroscopic findings.

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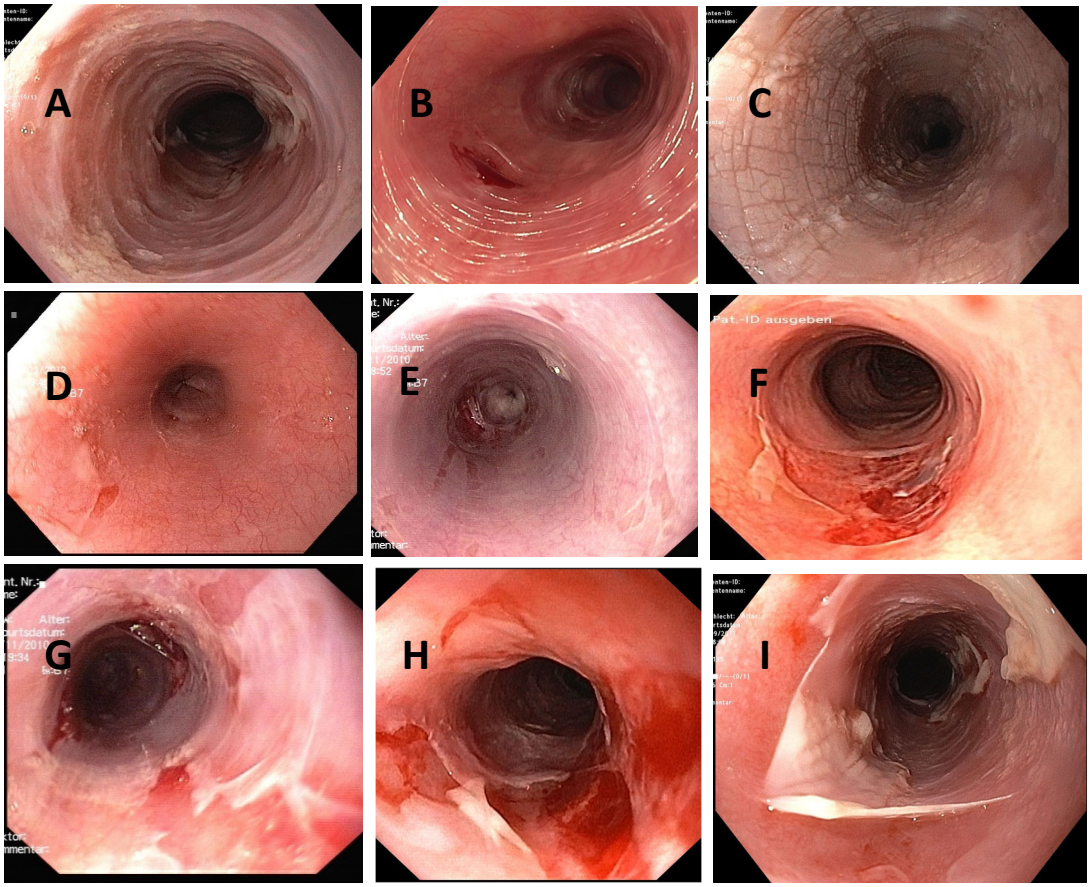

Figure 1. Endoscopic findings in esophageal lichen planus. A: Trachealization; B: Trachealization and fragile mucosa; C: Hyperkeratosis; D and E: Tearing; F and G: Tearing and localized denudation of the mucosa; H and I: Tearing and spacious denudation of the mucosa.

4.3. Key Morphologic and Immunophenotypic Features of ELP

Early histologic signs of esophageal involvement in LP may be subtle (Figure 2 A-D). Predominantly CD3 positive T-lymphocytes aggregate at the interface between the superficial tunica propria and the squamous epithelium and spill over through the basal membrane into the basal epithelial layer (Figure 2 C) [49,52,54]. The infiltration pattern is generally more pronounced in stromal papillae (Figure 2 A). Deposits of fibrinogen, immunoglobulins and/or complement may be detected by immunofluorescence studies [52]. The migration of lymphocytes in the epithelium is associated with intraepithelial edema, spongiosis, and apoptosis of scattered epithelial cells resulting in "Civatte bodies" (Figure 2 B). Intraepithelial splitting may be observed. In more advanced stages, dense subepithelial and intraepithelial lymphocytes blur the interface zone (Figures 2 E, F). According to our observation, subepithelial T-cells predominantly express CD4 (Figure 2 G) while intraepithelial T-cells may comprise various proportions of CD4- and CD8-positive cells (Figures 2 D, H; 3 E). In the lamina propria not only T-lymphocytes but also scattered B-cells, plasma cells, and macrophages may be present. The infiltrate may involve the higher epithelial layers and may be admixed with a small granulocytic component. Destruction of the basement membrane and partial or complete detachment of the squamous epithelium from the lamina propria may result in epithelial membranes that are, in contrast to sloughing esophagitis [61], not necrotic (Figures 2 E, 3 A, B). Loss of the epithelium may trigger a more pronounced mixed-type inflammatory infiltrate of the lamina propria and the submucosa followed by fibrosis and scarring. Adjacent to zones of denudation, the regenerative epithelium may show an increased Ki67 positive proliferation fraction (Figure 3 F).

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The squamous epithelium may undergo epidermoid metaplasia with development of a granular layer and a cap of orthokeratosis or parakeratosis (see Figure 3 Ref. [54]) Squamous dysplasia in hyperplastic or atrophic epithelium may be observed involving the lower or the upper half of the epithelium, thus corresponding to low-grade or high-grade dysplasia/intraepithelial neoplasia. Such rare cases progress to an invasive squamous carcinoma.

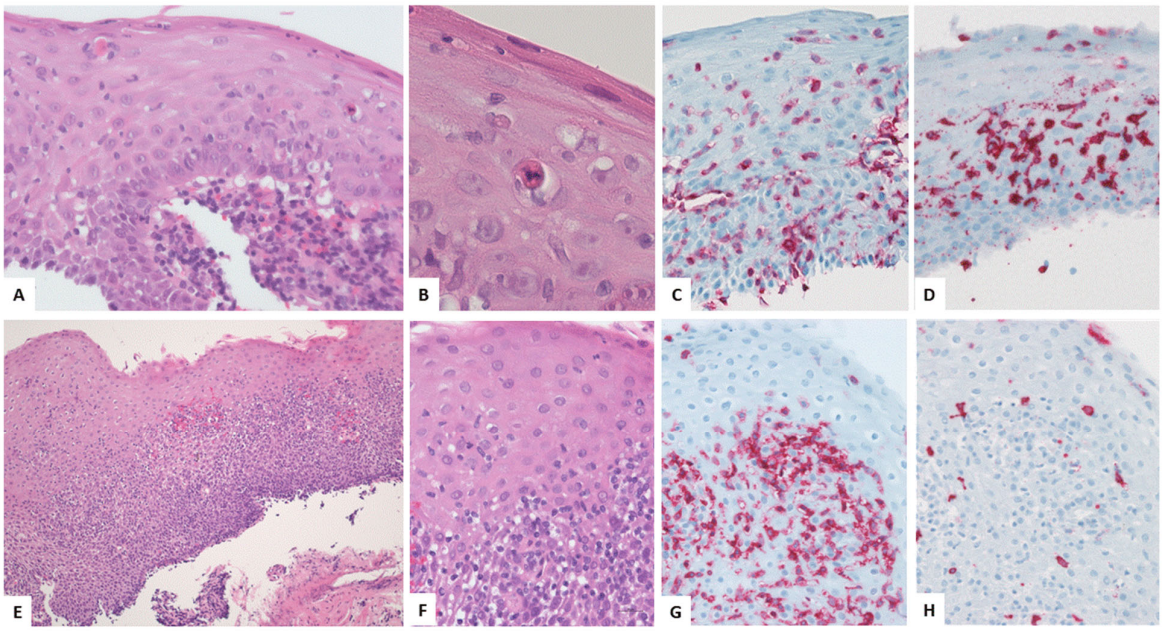

Figure 2. Histopathologic features of ELP: Band-like lymphocytic infiltrate in the superficial tunica propria most prominent at the rete ridges spilling over to the squamous epithelium (A). Scattered epithelial apoptosis (Civatte bodies, B). Intraepithelial CD3-positive T-cells (C) enriched in a CD8-positive subpopulation (D). Focal detachment of the squamous epithelium from the tunica propria (E). Example of a case with intraepithelial lymphocytes (F) composed of CD4 positive T-cells (G) and only a small number of CD8-positive cells (H). A, B, E, F: hematoxylin and eosin; C, D, G, H: immunohistochemical stains for CD3, CD4 or CD8.

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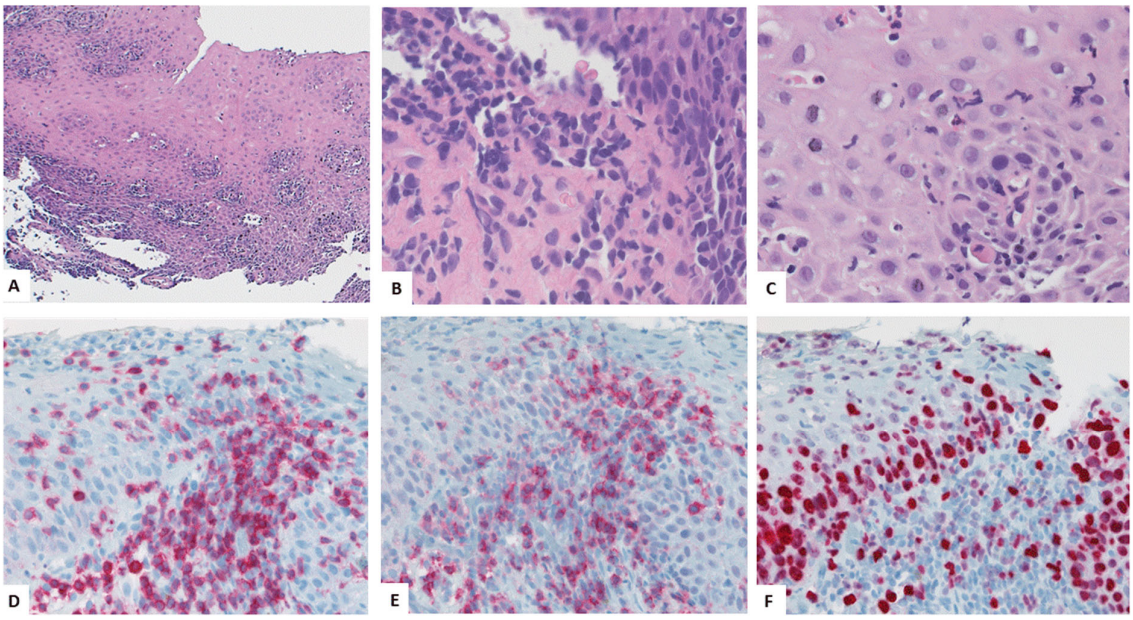

Figure 3. Dissection of the esophageal squamous epithelium at the junctional zone associated with confluent inflammatory infiltrates (A-C) Abundant CD3-positive T-cells (D) predominantly expressing CD4 in this case (E). Increased Ki67-positive proliferation fraction of the squamous epithelium (F). A-C: hematoxylin and eosin; D-F: immunohistochemical stains for CD3, CD4 or Ki67.

4.4. ELP histopathology: General Points and Caution

Histopathologists should be aware of the spectrum of diseases which can initiate a T-cell-rich inflammatory tissue injury of the esophageal mucosa that may be suggestive of ELP. Generally, ELP fits in the broad category of disorders for which the term lymphocyte-rich esophagitis has been coined [62]. Following an international expert consensus, this category includes three different morphologic forms i.e. 1. lymphocytic, 2. lichenoid, and 3. lymphocyte-predominant esophagitis. According to this proposal for a standardized terminology lymphocytic esophagitis (type 1) is defined by an intraepithelial infiltrate of ≥40 or as previously stated >20 lymphocytes per high power field (HPF) without a relevant neutrophilic component and without apoptotic epithelial cells ("Civatte bodies") [62–64]. Figure 5 A-C shows an example of a lymphocytic gastritis associated with a lymphocytic esophagitis (Figure 4 A, B) and numerous CD3-positive intraepithelial T-cells in a patient with Helicobacter pylori infection. The inflammatory infiltrate of the lymphocyte-predominant form (type 3, Figure 4 D-F) is characterized by a mixed inflammatory infiltrate [65] . Examples include an EoE harboring abundant eosinophils (≥15 per HPF, Figure 5 D) or an erosive Candida esophagitis rich in neutrophils and CD3-positive T-cells (Figure 4 E, F). The lichenoid form of lymphocyte-rich esophagitis (type 2) encompasses both the manifestation of an ELP and pathogenetically different lesions with features suggestive of ELP [62,66,67]. Examples include viral infections such as those associated with HIV [68]. A common morphologic finding observed in both disorders is a band-like lymphocyte-rich infiltrate of the lamina propria involving the overlaying epithelium causing apoptosis of keratinocytes ("Civatte bodies"). However, the differentiation of a true ELP versus a lichenoid inflammation is of utmost importance as these conditions have different prognoses, require different therapeutic approaches, and since mucosal LP is a precancerous condition with a documented risk of malignant progression [69–71]. It has been proposed that negative immunofluorescence studies may help discriminate true ELP from a lichenoid lesion but are infrequently performed [10,72,73]. Our findings indicate that complete detachment of the squamous epithelium from the tunica propria is rarely observed in non-ELP lichenoid esophagitis.

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Consideration of histopathologic and immunophenotypic features in light of clinical and endoscopic findings, as well as pathophysiologic aspects are necessary and provide important adjuncts to the final diagnosis. This is particularly essential, when esophageal biopsies show histologic features compatible with either ELP or non-ELP-associated lichenoid inflammation. In the future, a more detailed understanding of the characteristic inflammatory cell populations, cytokines in the microenvironment, and molecular genetic epithelial alterations may contribute to the reliable differentiation between true ELP and its clinical mimickers.

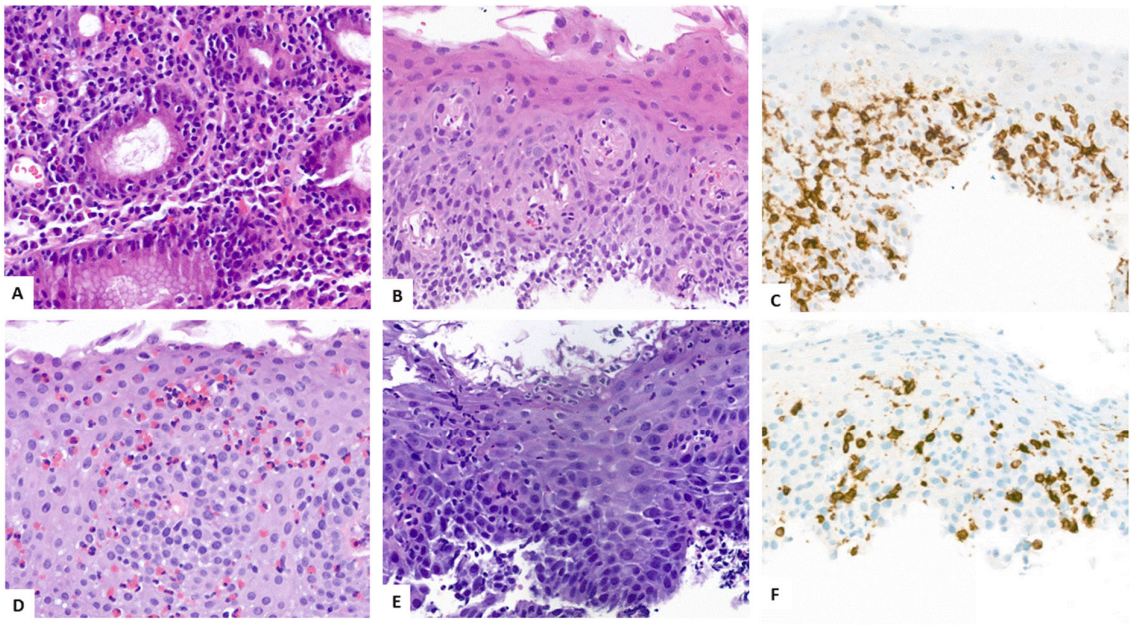

Figure 4. Conditions mimicking ELP: Lymphocytic gastritis (A) associated with a lichenoid esophagitis (B) with numerous CD3-positive T-cells (C); eosinophilic esophagitis (D) and erosive Candida esophagitis (E) characterized not only by a granulocytic but also a CD3-positive T-cell component (F). A, B, D: hematoxylin and eosin; E: periodic acid Schiff reaction; C, F: immunohistochemical stains for CD3.

4.5. Direct Immunofluorescence

DIF often highlights fibrinogen deposits along the basal membrane as another important criterion in ELP**.** In oral diseases, linear fibrinogen deposition (or granular IgG and IgM deposits) in DIF could discriminate LP from other lichenoid lesions [73] and mucous membrane pemphigoid [10,72]. Therefore, positive results in DIF support the conventional histopathologic diagnosis of ELP and, in turn, differentiate ELP from diseases like mucous membrane pemphigoid or pemphigus vulgaris in erosive stages. Furthermore, in cases with lichenoid infiltration of the esophagus without positive DIF and without extraesophageal manifestation of LP, the term lichenoid esophageal pattern may be preferred [67].

4.6. Proposed Criteria for Diagnosis of ELP

Comparable macroscopic and histologic criteria for diagnosis of ELP have been well-documented in literature. While some findings are typical of ELP, others show similarities with different esophageal disorders, such as eosinophilic esophagitis, lymphocytic esophagitis, and sloughing esophagitis [63,65,74–81]. We recently integrated existing criteria and our findings into a comprehensive and reproducible scoring system (Table 2. Taken from Ref. [54]. Copyright with the authors). This scoring system makes the grading of esophageal lesions in LP patients (into no ELP, mild ELP, and severe ELP) feasible [53]. Simplified diagnostic criteria were suggested: (1) Endoscopic

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denudation of any grade, accompanied by either a positive histopathological finding, or positive DIF for fibrinogen depositions; (2) At least one of the possible endoscopic signs (stenosis, hyperkeratosis, or trachealization), along with either a positive histopathological result or positive DIF result, or along with dermatological confirmation of LP manifestation in other areas and histological exclusion of other common esophageal differential diagnoses [55]. In 77 of 132 patients in the study by Ravi et al., the diagnosis of ELP was made based on clinical symptoms alone, without characteristic esophageal biopsies [82]. However, we advocate for the use of semiquantitative grading system which incorporates characteristic histological features [53].

Table 2. Diagnostic and grading for ELP modified according to [49].

Macroscopic-endoscopic criteria	
Specific signs D Denudation/sloughing of the mucosa D1 Iatrogenic denudation (caused by biopsies) D2 Spontaneous localized denudation < 1 cm^2 D3 Spontaneous spacious denudation > 1 cm^2	**Possible signs** S Stenosis/stricture S1 Passable with standard endoscope S2 Not passable with standard endoscope H Hyperkeratosis (whitish, rough mucosa) T Trachealization N None of the criteria fulfilled
Microscopic criteria – histopathology (HP) and direct immunofluorescence (F)	
HP Sloughing of the epithelia (subepithelial, intraepithelial) Lymphocytic infiltrate, mainly T-lymphocytes, subepithelial, intraepithelial, junctional (region of the basal membrane) Intraepithelial apoptosis of keratinocytes "Civatte bodies" Dyskeratosis HP0 negative HP1 weakly positive HP2 positive HP3 strong positive	**F** Fibrinogen deposits along the basal membrane F0 no visible reaction F1 weak positive, discrete deposits visible F2 marked fibrinogen deposits along the basal membrane
Grading	

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Severe LP	≥ D2 and HP ≥ 1	OR	≥ D2 and F ≥ 1
Mild ELP	D1 and HP ≥ 1 and/or F ≥ 1	OR	S, H, T, N and HP ≥ 1 and F ≥ 1
No ELP	Criteria not fulfilled in a patient with LP on other localization		

5. Differential Diagnoses

Among inflammatory esophageal disorders, reflux esophagitis is the most commonly encountered [83]. However, clinicians must consider a wide range of differential diagnoses [61,62,74,84,85]. Infectious agents include Candida spp. and various viruses, e.g. HSV or CMV. Viral esophagitis is primarily associated with compromised immune function [86]. Chemical esophagitis may result from accidental ingestion of corrosive substances or drugs, while radiation-induced esophagitis is a therapy-related injury. Immunologically mediated esophageal disorders include Crohn's disease [87], Behçet's disease [88], graft-versus-host disease following allogeneic stem cell transplantation [89], immune checkpoint inhibitor-related esophagitis [90], and the well-characterized EoE [75–77,91]. Lymphocytic esophagitis (LE) is a rare form of immune-mediated esophagitis [62,65,78] first described in 2006. In contrast to ELP, LE is characterized by lymphocytic infiltration predominantly in the peripapillary regions, rather than the band-like distribution typical of ELP. Additionally, Civatte bodies, commonly seen in ELP, are absent in LE. In cases where a lichenoid infiltrate is observed, but DIF is negative and there are no cutaneous LP manifestations, the term lichenoid esophagitis or lichenoid esophageal pattern (LEP) may be applied [67]. Hussein et al. have questioned whether LE represents a distinct disease entity, proposing instead that it may reflect a histologic variant of more common esophageal conditions [92]. Notably, the endoscopic appearance of LE can closely resembles that of EoE. International consensus is needed to establish a standardized histopathological definition, develop a validated endoscopic severity scoring system, and define an evidence-based management algorithm. Sloughing esophagitis [93,94] represents another poorly defined subtype of esophagitis, characterized histologically by the presence of granulocytes and bacterial colonization [61]. Differential diagnoses should also include the esophageal involvement in autoimmune cutaneous bullous diseases, such as mucous membrane pemphigoid (MMP) or pemphigus vulgaris (PV) [72]. Additionally, epidermolysis bullosa acquisita may present with esophageal manifestation [95,96]. This review specifically focuses on ELP as an additional form of esophagitis with autoimmune features. Table 3 presents the differential diagnoses of inflammatory diseases of the esophagus.

Table 3. Differential diagnoses of ELP.

Chemical or physical damages
Reflux esophagitis
Chemical esophagitis (acids, leach)
Radiation esophagitis
Drug-induced esophagitis, e.g. NSAID, bisphosphonates, tetracyclines, KCl, ferric sulfate, ascorbic acid
Infectious esophagitis
Candida spp.
Viruses, e.g. Herpes simplex, CMV, HIV
Immune mediated esophagitis
Eosinophilic esophagitis
ELP
Lymphocytic esophagitis

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	Mucus membrane pemphigoid
	Pemphigus
	Lichenoid esophagitis
	Crohn's disease
	GVHD
	Behçet's disease
	Systemic sclerosis
	Immune checkpoint inhibitors
Others	
	Epidermolysis bullosa congenita or acquisita
	Esophageal intramural pseudodiverticulosis (EIPD)
	Sloughing esophagitis

6. Therapy

Therapeutic guidelines are established for cutaneous and oral LP [4,14,42]. However, large phase III studies are still lacking for this indication. Due to the scarcity of studies on ELP, no standardized or generally accepted therapeutic guidelines exist for this manifestation. Oral retinoids such as acitretin, although parts of the standard therapeutic repertoire, have not been effective in preventing of treating ELP [49,73,97,98], with the exception of few cases using alitretinoin [99]. Understanding the pathogenesis of ELP informs therapeutic decisions. Corticosteroids remain the cornerstone of treatment due to their broad suppression of the inflammatory cascade. However, targeted therapies that address specific pathogenic pathways may offer greater therapeutic precision and efficacy.

Topical corticosteroids constitute the standard treatment for ELP. Notably, fluticasone and budesonide have demonstrated promising clinical and/or endoscopic response rates of up to 75% [33,49,52,57]. Viscous syrups or gels may enhance mucosal adherence and improve response rates [49]. Orodispersible tablets developed for EoE might offer an alternative delivery option [100,101], although these are not currently approved for use in ELP. Intralesional injection of glucocorticosteroids, especially in cases involving inflammatory stenoses, has been effective in some cases [44,97,102]. Systemic corticosteroids can be considered for induction therapy in severe cases [103]. However, long-term therapy is limited by the risk of systemic side effects. In more severe or refractory cases unresponsive to topical corticosteroids, systemic immunosuppression may be required. Agents such as adalimumab, hydroxychloroquine, mycophenolate, azathioprine, cyclosporine, tacrolimus, and rituximab have all been reported with varying degrees of success [40,97,104–109]. Nonetheless, some cases remain refractory to multiple lines of immunosuppression [110]. In one of our patients, multiple immunosuppressors failed to achieve sustained improvement. Cyclophosphamide provided partial clinical benefit, while the JAK inhibitor tofacitinib ultimately led to stable clinical, endoscopic, and histologic remission [111]. Secukinumab, an Anti-IL-17 antibody, had shown efficacy in mucosal LP [112], suggesting potential utility in ELP, although further studies are needed to evaluate its role.

JAK inhibitors represent the most rational, pathogenesis-based therapeutic approach for LP by directly targeting the IFN-γ/JAK/STAT pathway central to disease pathogenesis [41,42,113–115] . This has been supported by several smaller studies and case series and a recent review has summarized the outcomes of LP patients treated with a JAK inhibitor [113]. Emerging evidence from case reports also indicates a positive therapeutic response of ELP to JAK inhibition [32,111,116].

As ELP typically represents a manifestation of systemic or multilocular LP, treatment should be coordinated through a multidisciplinary approach, involving at least gastroenterologists, dermatologists, and histopathologists to ensure optimal management and monitoring.

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6.1. Complications: Esophageal Stenosis and Food Impaction

As in other inflammatory diseases of the gastrointestinal tract (e.g. reflux esophagitis, Crohn's disease), chronic inflammation in ELP may lead to the development of inflammatory or scarring stenosis. In a few cases, anti-inflammatory therapy with budesonide alone has provided relief from inflammatory stenosis [49]. In cases of symptomatic scarring symptomatic stenosis of the esophagus, endoscopic dilation may be necessary [33,117]. When combined with anti-inflammatory treatment, dilation may be more effective, as it can reduce mucosal fragility, minimize mechanical stress, and help prevent recurrence of stenosis. Aby et al. reported that multiple dilations were required in most patients, with a low complication rate of 1.9% [58]. ELP should be considered as a potential cause of food impaction [118], or unexplained esophageal stenosis, particularly when other causes have been ruled out [119–121].

6.2. ELP as Precancerous Condition

LP is a generally considered a benign condition with low impact on life expectancy, although it can affect quality of life. However, mucosal LP is increasingly recognized as a precancerous condition, despite ongoing debate regarding the exact rate of malignant transformation [69,122–125]. The correlation between ELP and the development of esophageal squamous cell carcinoma (ESCC) is well documented. A growing number of case reports have described progression from inflammatory and hyperkeratotic lesions to squamous cell dysplasia/IEN or invasive ESCC [34,126,127]. Ravi et al. reported ESCC progression in six of 132 ELP patients during 44 months of follow-up period [82]. Notably, in our most recent prospective study, 10 % of dysphagic ELP patients (2/21) developed ESCC [55].

ELP-associated esophageal precancerous squamous lesions are typically found in areas of "esophageal epidermoid metaplasia" (EEM) [128–131]. In low-grade dysplasia, cytologic and structural epithelial abnormalities are confined to the lower half of the esophageal epithelium, whereas high-grade dysplasia involves more than half of the epithelial cell layers and is characterized by lack of surface maturation. Therefore, endoscopically visible areas of EEM/leukoplakia should be systematically sampled for histologic evaluation, as these lesions are a hallmark of orthokeratotic dysplasia. Invasive ESCC may arise beneath or adjacent to EEM, emphasizing the need for careful endoscopic surveillance.

Molecular studies have further supported the neoplastic potential of ELP. According to Singhi et al. [129], TP53 mutations correlate with the presence of ESCC or progression of EEM to ESCC. In our cohort, p53 overexpression was frequently observed on immunohistochemistry. However, additional molecular analyses are needed to identify reliable biomarkers for early detection of high-risk ELP with potential for malignant progression.

7. Proposal for Management of ELP

We recommend EGD in all patients with LP (whether presenting with cutaneous or mucosal manifestation) who report any esophageal symptoms. The diagnosis of ELP can be established using either the original criteria or the simplified diagnostic criteria (Table 3). Importantly, it must be emphasized that severe ELP can occur in asymptomatic individuals. Therefore, the threshold for performing EGD should be liberally defined in clinical practice. We recommend initial treatment of all ELP cases with topical corticosteroids and to reevaluate the response after approximately three months. In our clinical experience, a commonly used regimen consists of 0.5 mg budesonide in 5 mL viscous solution, administered three times a day, with gradual tapering based on clinical response. Further therapy should be guided by whether a clinical and/or histological remission has been achieved. If remission is not attained, systemic immunosuppressive therapy may be warranted. Systemic options include systemic glucocorticoids or traditional immunosuppressants such as azathioprine or mycophenolate. Emerging evidence also supports the use of JAK-inhibitors as a promising alternative in refractory cases. In patients with symptomatic esophageal stenosis

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unresponsive to anti-inflammatory therapy, endoscopic dilation is indicated. Esophageal candidiasis is a common adverse effect of steroid therapy and should be treated with antifungal agents. Endoscopic monitoring is recommended at least once annually, with frequency adjusted based on the individual clinical course. All patients diagnosed with ELP without known LP at other sites should undergo dermatological evaluation.

Currently, there is no consensus on the optimal management of asymptomatic ELP patients, particularly in cases presenting with esophageal hyperkeratosis, which may signal a risk for EEM, a potential precursor of ESCC. A "wait-and-see" approach may be appropriate in select cases [49,53]. However, in patients with confirmed EEM, we recommend EGD every six months to monitor for the development of dysplasia. In the event of dysplastic transformation, esophageal mucosal resection should be performed in a specialized center.

8. Emerging Trends

Multiple studies have shown positive outcomes with topically applied corticosteroids in the treatment of ELP. However, the optimal treatment duration and long-term maintenance strategies remain undefined. An orally dissolving budesonide preparation, approved for the treatment of EoE, represents a promising therapeutic option for ELP, though current evidence is limited to case reports [77,132].

Emerging data on the pathogenesis of LP suggest a disturbance in the IL12/23 cytokines and/or IL-17 axis in ELP, similar to mechanisms implicated in psoriasis or vitiligo [133–137], Although IL-17 and IL-23 inhibitors have undergone phase II evaluation for (E)LP, these trials failed to achieve the primary endpoint for treatment response. In contrast, JAK inhibitors showed the most therapeutic potential, as they target the IFN-γ JAK/STAT pathway and have yielded superior results in LP therapy. Future therapy may be guided by treatment paradigms established in inflammatory bowel disease [138–141]. Potential candidates include ozanimod and etrasimod, S1P-receptor agonists recently approved for ulcerative colitis [142–145]. Another promising agent is deucravacitinib, a tyrosine-kinase 2-inhibitor that modulates IL-12 and IL-23 pathways and has demonstrated efficacy in other autoimmune diseases such as Crohn's disease, ulcerative colitis [146] and localized or systemic lupus erythematosus [147–150].

As with other immune-mediated diseases, environmental or lifestyle factors including psychological stress may play an important role. Identification of potential environmental factors (e.g. dental fillings with gold or amalgam) could offer new avenues for prevention and management.

Notably, the majority of ELP patients are postmenopausal women [49,55]. A correlation between menopause and oral LP is well established [151], possibly linked to declining estrogen and progesterone levels during perimenopause. Although this hormonal relationship has not been directly studied in ELP [152], it is known that postmenopausal women have a higher proinflammatory immune profile, rendering them more susceptible to inflammatory diseases [153].

While the progression from ELP to ESCC is increasingly reported, the reverse association has not been investigated. It would be valuable to assess the prevalence of undiagnosed ELP in ESCC patients, particularly in non-smokers, non-drinkers, and women, who lack classical ESCC risk factors. Such a study could further support the hypothesis that menopause and chronic mucosal inflammation may contribute to ESCC pathogenesis.

The oncogenic potential of inflammatory esophageal diseases warrants further exploration. Chronic reflux esophagitis can progress to adenocarcinoma of the esophago-gastric junction – typically via Barrett's esophagitis, whereas chronic ELP may evolve into ESCC often through a precursor stage of EEM/leukoplakia. In contrast, EoE, another immune-mediated esophagitis, is not considered a precancerous condition, highlighting the unique malignant potential of ELP among inflammatory esophageal diseases.

Author Contributions: The present manuscript was conceptualized by the ELP working group at the Medical Center – University Freiburg, Germany. For this review, studies were collected using

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PubMed/Medline and single case reports were excluded. Table 1 presents an overview of these studies and their key findings. Data obtained from the cohort of the ELP working group in Freiburg were integrated in the evaluation. The ELP working group consists of WK and AD from the Department of Gastroenterology, RD and FS from the Department of Dermatology, and ASG from the Department of Clinical Pathology. All authors contributed to writing the text. The final stylistic corrections were made by AL from the Institute of Exercise and Occupational Medicine. All authors worked at the Medical Center of the University Freiburg, Freiburg, Germany.

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Abbreviations

The following abbreviations are used in this manuscript:

EGD	esophagogastroduodenoscopy
TNFα	tumor necrosis factor α
IFN-γ	interferon γ
SCC	squamous cell carcinoma
ILC1 cells	group 1 innate lymphoid cells
NKT	natural killer T-cells
NK	natural killer cells
EoE	eosinophilic esophagitis
APC	antigen presenting cells
MHC	major histocompatibility complex
JAK	janus kinase
STAT	signal transducers and activators of transcription
LP	lichen planus
ELP	esophageal lichen planus
EEM	esophageal epidermoid metaplasia

References

1. Le Cleach, L.; Chosidow, O. Clinical Practice. Lichen Planus. *N. Engl. J. Med.* **2012**, *366*, 723–732, doi:10.1056/NEJMcp1103641.
2. Payette, M.J.; Weston, G.; Humphrey, S.; Yu, J.; Holland, K.E. Lichen Planus and Other Lichenoid Dermatoses: Kids Are Not Just Little People. *Clin. Dermatol.* **2015**, *33*, 631–643, doi:10.1016/j.clindermatol.2015.09.006.
3. Weston, G.; Payette, M. Update on Lichen Planus and Its Clinical Variants. *Int. J. Womens Dermatol.* **2015**, *1*, 140–149, doi:10.1016/j.ijwd.2015.04.001.
4. Solimani, F.; Forchhammer, S.; Schloegl, A.; Ghoreschi, K.; Meier, K. Lichen Planus - a Clinical Guide. *J. Dtsch. Dermatol. Ges. J. Ger. Soc. Dermatol. JDDG* **2021**, *19*, 864–882, doi:10.1111/ddg.14565.
5. Chaudhry, S.; Manmohan, G..; Yadav, K.A.; Madhulika, G. Lichen Planus – A Refractory Autoimmune Disorder. *IP Indian J. Clin. Exp. Dermatol.* **2023**, *9*, 20–27, doi:10.18231/j.ijced.2023.003.
6. Li, C.; Tang, X.; Zheng, X.; Ge, S.; Wen, H.; Lin, X.; Chen, Z.; Lu, L. Global Prevalence and Incidence Estimates of Oral Lichen Planus: A Systematic Review and Meta-Analysis. *JAMA Dermatol.* **2020**, *156*, 172–181, doi:10.1001/jamadermatol.2019.3797.
7. González-Moles, M.Á.; Warnakulasuriya, S.; González-Ruiz, I.; González-Ruiz, L.; Ayén, Á.; Lenouvel, D.; Ruiz-Ávila, I.; Ramos-García, P. Worldwide Prevalence of Oral Lichen Planus: A Systematic Review and Meta-Analysis. *Oral Dis.* **2021**, *27*, 813–828, doi:10.1111/odi.13323.
8. Ma, C.; Limketkai, B.N.; Montgomery, E.A. Recently Highlighted Non-Neoplastic Pathologic Entities of the Upper GI Tract and Their Clinical Significance. *Gastrointest. Endosc.* **2014**, *80*, 960–969, doi:10.1016/j.gie.2014.09.009.

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Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 7 October 2025 doi:10.20944/preprints202510.0517.v1

9. Kuten-Shorrer, M.; Menon, R.S.; Lerman, M.A. Mucocutaneous Diseases. *Dent. Clin. North Am.* **2020**, *64*, 139–162, doi:10.1016/j.cden.2019.08.009.
10. Gru, A.A.; Salavaggione, A.L. Lichenoid and Interface Dermatoses. *Semin. Diagn. Pathol.* **2017**, *34*, 237–249, doi:10.1053/j.semdp.2017.03.001.
11. Gorouhi, F.; Davari, P.; Fazel, N. Cutaneous and Mucosal Lichen Planus: A Comprehensive Review of Clinical Subtypes, Risk Factors, Diagnosis, and Prognosis. *ScientificWorldJournal* **2014**, *2014*, 742826, doi:10.1155/2014/742826.
12. Saeed, S.; Choudhury, P.; Ahmad, S.A.; Alam, T.; Panigrahi, R.; Aziz, S.; Kaleem, S.M.; Priyadarshini, S.R.; Sahoo, P.K.; Hasan, S. Vitamin D in the Treatment of Oral Lichen Planus: A Systematic Review. *Biomedicines* **2022**, *10*, 2964, doi:10.3390/biomedicines10112964.
13. Hübner, F.; Langan, E.A.; Recke, A. Lichen Planus Pemphigoides: From Lichenoid Inflammation to Autoantibody-Mediated Blistering. *Front. Immunol.* **2019**, *10*, 1389, doi:10.3389/fimmu.2019.01389.
14. Ioannides, D.; Vakirlis, E.; Kemeny, L.; Marinovic, B.; Massone, C.; Murphy, R.; Nast, A.; Ronnevig, J.; Ruzicka, T.; Cooper, S.M.; et al. European S1 Guidelines on the Management of Lichen Planus: A Cooperation of the European Dermatology Forum with the European Academy of Dermatology and Venereology. *J. Eur. Acad. Dermatol. Venereol. JEADV* **2020**, *34*, 1403–1414, doi:10.1111/jdv.16464.
15. Lodi, G.; Manfredi, M.; Mercadante, V.; Murphy, R.; Carrozzo, M. Interventions for Treating Oral Lichen Planus: Corticosteroid Therapies. *Cochrane Database Syst. Rev.* **2020**, *2*, CD001168, doi:10.1002/14651858.CD001168.pub3.
16. Deng, X.; Wang, Y.; Jiang, L.; Li, J.; Chen, Q. Updates on Immunological Mechanistic Insights and Targeting of the Oral Lichen Planus Microenvironment. *Front. Immunol.* **2023**, *13*, 1023213, doi:10.3389/fimmu.2022.1023213.
17. Alarcón, I.; Alarcón, C.; Arellano, J. Overview of Lichen Planus Pathogenesis and Review of Possible Future Therapies. *JAAD Rev.* **2025**, *3*, 146–154, doi:10.1016/j.jdrv.2025.01.011.
18. Cheng, Y.-S.L.; Gould, A.; Kurago, Z.; Fantasia, J.; Muller, S. Diagnosis of Oral Lichen Planus: A Position Paper of the American Academy of Oral and Maxillofacial Pathology. *Oral Surg. Oral Med. Oral Pathol. Oral Radiol.* **2016**, *122*, 332–354, doi:10.1016/j.oooo.2016.05.004.
19. McParland, H.; Warnakulasuriya, S. Oral Lichenoid Contact Lesions to Mercury and Dental Amalgam--a Review. *J. Biomed. Biotechnol.* **2012**, *2012*, 589569, doi:10.1155/2012/589569.
20. Rasul, T.F.; Anderson, J.; Bergholz, D.R.; Faiz, A.; Prasad, R.R. Gold Dental Implant-Induced Oral Lichen Planus. *Cureus* **2022**, doi:10.7759/cureus.21852.
21. Torrente-Castells, E.; Figueiredo, R.; Berini-Aytés, L.; Gay-Escoda, C. Clinical Features of Oral Lichen Planus. A Retrospective Study of 65 Cases. *Med. Oral Patol. Oral Cirugia Bucal* **2010**, *15*, e685-690, doi:10.4317/medoral.15.e685.
22. Cassol-Spanemberg, J.; Rodríguez-de Rivera-Campillo, M.-E.; Otero-Rey, E.-M.; Estrugo-Devesa, A.; Jané-Salas, E.; López-López, J. Oral Lichen Planus and Its Relationship with Systemic Diseases. A Review of Evidence. *J. Clin. Exp. Dent.* **2018**, *10*, e938–e944, doi:10.4317/jced.55145.
23. Hasan, S.; Ahmed, S.; Kiran, R.; Panigrahi, R.; Thachil, J.; Saeed, S. Oral Lichen Planus and Associated Comorbidities: An Approach to Holistic Health. *J. Fam. Med. Prim. Care* **2019**, *8*, 3504, doi:10.4103/jfmpc.jfmpc_749_19.
24. Fromme, M.; Schneider, C.V.; Schlapbach, C.; Cazzaniga, S.; Trautwein, C.; Rader, D.J.; Borradori, L.; Strnad, P. Comorbidities in Lichen Planus by Phenome-Wide Association Study in Two Biobank Population Cohorts. *Br. J. Dermatol.* **2022**, *187*, 722–729, doi:10.1111/bjd.21762.
25. Georgescu, S.R.; Tampa, M.; Mitran, M.I.; Mitran, C.I.; Sarbu, M.I.; Nicolae, I.; Matei, C.; Caruntu, C.; Neagu, M.; Popa, M.I. Potential Pathogenic Mechanisms Involved in the Association between Lichen Planus and Hepatitis C Virus Infection. *Exp. Ther. Med.* **2019**, *17*, 1045–1051, doi:10.3892/etm.2018.6987.
26. Nagao, Y.; Nishida, N.; Toyo-oka, L.; Kawaguchi, A.; Amoroso, A.; Carrozzo, M.; Sata, M.; Mizokami, M.; Tokunaga, K.; Tanaka, Y. Genome-Wide Association Study Identifies Risk Variants for Lichen Planus in Patients With Hepatitis C Virus Infection. *Clin. Gastroenterol. Hepatol.* **2017**, *15*, 937-944.e5, doi:10.1016/j.cgh.2016.12.029.

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Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 7 October 2025 doi:10.20944/preprints202510.0517.v1

27. De Porras-Carrique, T.; González-Moles, M.Á.; Warnakulasuriya, S.; Ramos-García, P. Depression, Anxiety, and Stress in Oral Lichen Planus: A Systematic Review and Meta-Analysis. *Clin. Oral Investig.* **2022**, *26*, 1391–1408, doi:10.1007/s00784-021-04114-0.
28. Cerqueira, J.D.M.; Moura, J.R.; Arsati, F.; Lima-Arsati, Y.B. de O.; Bittencourt, R.A.; Freitas, V.S. Psychological Disorders and Oral Lichen Planus: A Systematic Review. *J. Investig. Clin. Dent.* **2018**, *9*, e12363, doi:10.1111/jicd.12363.
29. Adamo, D.; Calabria, E.; Coppola, N.; Lo Muzio, L.; Giuliani, M.; Bizzoca, M.E.; Azzi, L.; Croveri, F.; Colella, G.; Boschetti, C.E.; et al. Psychological Profile and Unexpected Pain in Oral Lichen Planus: A Case–Control Multicenter SIPMO Studya. *Oral Dis.* **2022**, *28*, 398–414, doi:10.1111/odi.13787.
30. Eyerich, K.; Eyerich, S. Immune Response Patterns in Non-Communicable Inflammatory Skin Diseases. *J. Eur. Acad. Dermatol. Venereol. JEADV* **2018**, *32*, 692–703, doi:10.1111/jdv.14673.
31. Jacobs, J.W.; Kukreja, K.; Camisa, C.; Richter, J.E. Demystifying Esophageal Lichen Planus: A Comprehensive Review of a Rare Disease You Will See in Practice. *Am. J. Gastroenterol.* **2022**, *117*, 70–77, doi:10.14309/ajg.0000000000001485.
32. Kozlov, M.; Levit, E.K.; Silvers, D.N.; Brichkov, I. Severe Esophageal Lichen Planus Treated With Tofacitinib. *Cutis* **2023**, *111*, 155–163, doi:10.12788/cutis.0717.
33. Katzka, D.A.; Smyrk, T.C.; Bruce, A.J.; Romero, Y.; Alexander, J.A.; Murray, J.A. Variations in Presentations of Esophageal Involvement in Lichen Planus. *Clin. Gastroenterol. Hepatol. Off. Clin. Pract. J. Am. Gastroenterol. Assoc.* **2010**, *8*, 777–782, doi:10.1016/j.cgh.2010.04.024.
34. Ravi, K.; Codipilly, D.C.; Sunjaya, D.; Fang, H.; Arora, A.S.; Katzka, D.A. Esophageal Lichen Planus Is Associated With a Significant Increase in Risk of Squamous Cell Carcinoma. *Clin. Gastroenterol. Hepatol. Off. Clin. Pract. J. Am. Gastroenterol. Assoc.* **2019**, *17*, 1902-1903.e1, doi:10.1016/j.cgh.2018.10.018.
35. Barrat, F.J.; Crow, M.K.; Ivashkiv, L.B. Interferon Target-Gene Expression and Epigenomic Signatures in Health and Disease. *Nat. Immunol.* **2019**, *20*, 1574–1583, doi:10.1038/s41590-019-0466-2.
36. Damsky, W.; King, B.A. JAK Inhibitors in Dermatology: The Promise of a New Drug Class. *J. Am. Acad. Dermatol.* **2017**, *76*, 736–744, doi:10.1016/j.jaad.2016.12.005.
37. Damsky, W.; Wang, A.; Olamiju, B.; Peterson, D.; Galan, A.; King, B. Treatment of Severe Lichen Planus with the JAK Inhibitor Tofacitinib. *J. Allergy Clin. Immunol.* **2020**, *145*, 1708-1710.e2, doi:10.1016/j.jaci.2020.01.031.
38. Shao, S.; Tsoi, L.C.; Sarkar, M.K.; Xing, X.; Xue, K.; Uppala, R.; Berthier, C.C.; Zeng, C.; Patrick, M.; Billi, A.C.; et al. IFN-γ Enhances Cell-Mediated Cytotoxicity against Keratinocytes via JAK2/STAT1 in Lichen Planus. *Sci. Transl. Med.* **2019**, *11*, eaav7561, doi:10.1126/scitranslmed.aav7561.
39. Brumfiel, C.M.; Patel, M.H.; Severson, K.J.; Zhang, N.; Li, X.; Quillen, J.K.; Zunich, S.M.; Branch, E.L.; Nelson, S.A.; Pittelkow, M.R.; et al. Ruxolitinib Cream in the Treatment of Cutaneous Lichen Planus: A Prospective, Open-Label Study. *J. Invest. Dermatol.* **2022**, *142*, 2109-2116.e4, doi:10.1016/j.jid.2022.01.015.
40. Solimani, F.; Meier, K.; Ghoreschi, K. Emerging Topical and Systemic JAK Inhibitors in Dermatology. *Front. Immunol.* **2019**, *10*, 2847, doi:10.3389/fimmu.2019.02847.
41. Solimani, F.; Dilling, A.; Ghoreschi, F.C.; Nast, A.; Ghoreschi, K.; Meier, K. Upadacitinib for Treatment-Resistant Lichen Amyloidosis. *J. Eur. Acad. Dermatol. Venereol. JEADV* **2023**, *37*, e633–e635, doi:10.1111/jdv.18756.
42. Didona, D.; Caposiena Caro, R.D.; Sequeira Santos, A.M.; Solimani, F.; Hertl, M. Therapeutic Strategies for Oral Lichen Planus: State of the Art and New Insights. *Front. Med.* **2022**, *9*, 997190, doi:10.3389/fmed.2022.997190.
43. Al-Shihabi, B.M.; Jackson, J.M. Dysphagia Due to Pharyngeal and Oesophageal Lichen Planus. *J. Laryngol. Otol.* **1982**, *96*, 567–571, doi:10.1017/s0022215100092835.
44. Franco, D.L.; Islam, S.R.; Lam-Himlin, D.M.; Fleischer, D.E.; Pasha, S.F. Presentation, Diagnosis, and Management of Esophageal Lichen Planus: A Series of Six Cases. *Case Rep. Gastroenterol.* **2015**, *9*, 253–260, doi:10.1159/000437292.
45. Nielsen, J.A.; Law, R.M.; Fiman, K.H.; Roberts, C.A. Esophageal Lichen Planus: A Case Report and Review of the Literature. *World J. Gastroenterol.* **2013**, *19*, 2278–2281, doi:10.3748/wjg.v19.i14.2278.

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46. Miehlke, S.; Reinhold, B.; Schröder, S. [Successful treatment of Lichen planus esophagitis with topical budesonide]. *Z. Gastroenterol.* **2012**, *50*, 1104–1107, doi:10.1055/s-0032-1312979.
47. Dickens, C.M.; Heseltine, D.; Walton, S.; Bennett, J.R. The Oesophagus in Lichen Planus: An Endoscopic Study. *BMJ* **1990**, *300*, 84–84, doi:10.1136/bmj.300.6717.84.
48. Quispel, R.; van Boxel, O.S.; Schipper, M.E.; Sigurdsson, V.; Canninga-van Dijk, M.R.; Kerckhoffs, A.; Smout, A.J.; Samsom, M.; Schwartz, M.P. High Prevalence of Esophageal Involvement in Lichen Planus: A Study Using Magnification Chromoendoscopy. *Endoscopy* **2009**, *41*, 187–193, doi:10.1055/s-0028-1119590.
49. Schauer, F.; Monasterio, C.; Technau-Hafsi, K.; Kern, J.S.; Lazaro, A.; Deibert, P.; Hasselblatt, P.; Schwacha, H.; Heeg, S.; Brass, V.; et al. Esophageal Lichen Planus: Towards Diagnosis of an Underdiagnosed Disease. *Scand. J. Gastroenterol.* **2019**, *54*, 1189–1198, doi:10.1080/00365521.2019.1674375.
50. Fox, L.P.; Lightdale, C.J.; Grossman, M.E. Lichen Planus of the Esophagus: What Dermatologists Need to Know. *J. Am. Acad. Dermatol.* **2011**, *65*, 175–183, doi:10.1016/j.jaad.2010.03.029.
51. Harewood, G.C.; Murray, J.A.; Cameron, A.J. Esophageal Lichen Planus: The Mayo Clinic Experience. *Dis. Esophagus Off. J. Int. Soc. Dis. Esophagus ISDE* **1999**, *12*, 309–311.
52. Kern, J.S.; Technau-Hafsi, K.; Schwacha, H.; Kuhlmann, J.; Hirsch, G.; Brass, V.; Deibert, P.; Schmitt-Graeff, A.; Kreisel, W. Esophageal Involvement Is Frequent in Lichen Planus: Study in 32 Patients with Suggestion of Clinicopathologic Diagnostic Criteria and Therapeutic Implications. *Eur. J. Gastroenterol. Hepatol.* **2016**, *28*, 1374–1382, doi:10.1097/MEG.0000000000000732.
53. Monasterio, C.; Decker, A.; Schauer, F.; Büttner, N.; Schmidt, A.; Schmitt-Gräff, A.; Kreisel, W. Der Lichen planus des Ösophagus – Eine unterschätzte Erkrankung. *Z. Für Gastroenterol.* **2021**, *59*, 460–469, doi:10.1055/a-1378-9380.
54. Decker, A.; Schauer, F.; Lazaro, A.; Monasterio, C.; Schmidt, A.R.; Schmitt-Graeff, A.; Kreisel, W. Esophageal Lichen Planus: Current Knowledge, Challenges and Future Perspectives. *World J. Gastroenterol.* **2022**, *28*, 5893–5909, doi:10.3748/wjg.v28.i41.5893.
55. Diehl, R.; Schmitt-Graeff, A.; Kiritsi, D.; Kreisel, W.; Schmidt, A.; Decker, A.; Schauer, F. Esophageal Lichen Planus: A Prospective Interdisciplinary, Monocentric Cohort Study. *J. Dtsch. Dermatol. Ges. J. Ger. Soc. Dermatol. JDDG* **2025**, doi:10.1111/ddg.15808.
56. Straumann, A.; Katzka, D.A. Diagnosis and Treatment of Eosinophilic Esophagitis. *Gastroenterology* **2018**, *154*, 346–359, doi:10.1053/j.gastro.2017.05.066.
57. Podboy, A.; Sunjaya, D.; Smyrk, T.C.; Murray, J.A.; Binder, M.; Katzka, D.A.; Alexander, J.A.; Halland, M. Oesophageal Lichen Planus: The Efficacy of Topical Steroid-Based Therapies. *Aliment. Pharmacol. Ther.* **2017**, *45*, 310–318, doi:10.1111/apt.13856.
58. Aby, E.S.; Eckmann, J.D.; Abimansour, J.; Katzka, D.A.; Beveridge, C.; Triggs, J.R.; Dbouk, M.; Abdi, T.; Turner, K.O.; Antunes, C.; et al. Esophageal Lichen Planus: A Descriptive Multicenter Report. *J. Clin. Gastroenterol.* **2023**, *58*, 427–431, doi:10.1097/mcg.0000000000001885.
59. Blonski, W.; Slone, S.; Jacobs, J.W. Lichen Planus Esophagitis. *Curr. Opin. Gastroenterol.* **2023**, *39*, 308–314, doi:10.1097/MOG.0000000000000936.
60. Ghai, M.B.; Parsa, N.; Sloan, J.A. The Current State of Esophageal Lichen Planus. *Curr. Opin. Gastroenterol.* **2025**, *41*, 223–228, doi:10.1097/mog.0000000000001112.
61. Karaaslan, S.; Qin, L.; Hissong, E.; Jessurun, J. A Reappraisal of Oesophageal Mucosal Biopsy Specimens Showing Sloughing. *Histopathology* **2025**, doi:10.1111/his.15522.
62. Coady, L.C.; Sheahan, K.; Brown, I.S.; Carneiro, F.; Gill, A.J.; Kumarasinghe, P.; Kushima, R.; Lauwers, G.Y.; Pai, R.K.; Shepherd, N.A.; et al. Esophageal Lymphocytosis: Exploring the Knowns and Unknowns of This Pattern of Esophageal Injury. *Expert Rev. Gastroenterol. Hepatol.* **2024**, *18*, 529–539, doi:10.1080/17474124.2024.2385493.
63. Rubio, C.A.; Ichiya, T.; Schmidt, P.T. Lymphocytic Oesophagitis, Eosinophilic Oesophagitis and Compound Lymphocytic-Eosinophilic Oesophagitis I: Histological and Immunohistochemical Findings. *J. Clin. Pathol.* **2017**, *70*, 208–216, doi:10.1136/jclinpath-2016-203782.
64. Patil, D.T.; Hammer, S.; Langer, R.; Yantiss, R.K. Lymphocytic Esophagitis: An Update on Histologic Diagnosis, Endoscopic Findings, and Natural History. *Ann. N. Y. Acad. Sci.* **2018**, *1434*, 185–191, doi:10.1111/nyas.13710.

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Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 7 October 2025 doi:10.20944/preprints202510.0517.v1

65. Pittman, M.E. Lymphocytic Esophagitis: Current Understanding and Controversy. *Am. J. Surg. Pathol.* **2022**, *46*, e55–e63, doi:10.1097/PAS.0000000000001667.
66. Haque, S.; Mohammadi, S.M.K.; Singhal, A.; Sonnenberg, A.; Genta, R.M.; Rugge, M. Lichenoid Esophagitis: A Clinicopathological Comparison with Lymphocytic and Eosinophilic Esophagitis. *J. Gastrointest. Liver Dis. JGLD* **2025**, *34*, 157–162, doi:10.15403/jgld-6048.
67. Salaria, S.N.; Abu Alfa, A.K.; Cruise, M.W.; Wood, L.D.; Montgomery, E.A. Lichenoid Esophagitis: Clinicopathologic Overlap with Established Esophageal Lichen Planus. *Am. J. Surg. Pathol.* **2013**, *37*, 1889–1894, doi:10.1097/PAS.0b013e31829dff19.
68. Marschner, J.; Schmitt-Graeff, A.; Kreisel, W.; Decker, A.; Schauer, F. Case Report: Lichenoid Esophagitis Revealing an HIV Infection. *Front. Med.* **2024**, *11*, 1477787, doi:10.3389/fmed.2024.1477787.
69. González-Moles, M.Á.; Ruiz-Ávila, I.; González-Ruiz, L.; Ayén, Á.; Gil-Montoya, J.A.; Ramos-García, P. Malignant Transformation Risk of Oral Lichen Planus: A Systematic Review and Comprehensive Meta-Analysis. *Oral Oncol.* **2019**, *96*, 121–130, doi:10.1016/j.oraloncology.2019.07.012.
70. Strauss, A.L.; Fortuna, D.; Falk, G.W. Esophageal Lichen Planus and Development of Dysplasia. *Gastro Hep Adv.* **2023**, *2*, 35–36, doi:10.1016/j.gastha.2022.07.021.
71. González-Moles, M.Á.; Ramos-García, P. An Evidence-Based Update on the Potential for Malignancy of Oral Lichen Planus and Related Conditions: A Systematic Review and Meta-Analysis. *Cancers* **2024**, *16*, 608, doi:10.3390/cancers16030608.
72. Chan, L.S. Mucous Membrane Pemphigoid. *Clin. Dermatol.* **2001**, *19*, 703–711.
73. Van Maercke, P.; Günther, M.; Groth, W.; Gheorghiu, T.; Habermann, U. Lichen Ruber Mucosae with Esophageal Involvement. *Endoscopy* **1988**, *20*, 158–160, doi:10.1055/s-2007-1018165.
74. Malone, V.; Sheahan, K. Novel and Rare Forms of Oesophagitis. *Histopathology* **2021**, *78*, 4–17, doi:10.1111/his.14284.
75. Straumann, A.; Spichtin, H.P.; Bernoulli, R.; Loosli, J.; Vögtlin, J. [Idiopathic eosinophilic esophagitis: a frequently overlooked disease with typical clinical aspects and discrete endoscopic findings]. *Schweiz. Med. Wochenschr.* **1994**, *124*, 1419–1429.
76. Dellon, E.S. Eosinophilic Esophagitis: Diagnostic Tests and Criteria. *Curr. Opin. Gastroenterol.* **2012**, *28*, 382–388, doi:10.1097/MOG.0b013e328352b5ef.
77. Dellon, E.S.; Liacouras, C.A.; Molina-Infante, J.; Furuta, G.T.; Spergel, J.M.; Zevit, N.; Spechler, S.J.; Attwood, S.E.; Straumann, A.; Aceves, S.S.; et al. Updated International Consensus Diagnostic Criteria for Eosinophilic Esophagitis: Proceedings of the AGREE Conference. *Gastroenterology* **2018**, *155*, 1022-1033.e10, doi:10.1053/j.gastro.2018.07.009.
78. Rouphael, C.; Gordon, I.O.; Thota, P.N. Lymphocytic Esophagitis: Still an Enigma a Decade Later. *World J. Gastroenterol.* **2017**, *23*, 949–956, doi:10.3748/wjg.v23.i6.949.
79. Akhondi, H. Sloughing Esophagitis: A Not so Common Entity. *Int. J. Biomed. Sci. IJBS* **2014**, *10*, 282–286.
80. Hokama, A.; Yamamoto, Y.-I.; Taira, K.; Nakamura, M.; Kobashigawa, C.; Nakamoto, M.; Hirata, T.; Kinjo, N.; Kinjo, F.; Takahashi, K.; et al. Esophagitis Dissecans Superficialis and Autoimmune Bullous Dermatoses: A Review. *World J. Gastrointest. Endosc.* **2010**, *2*, 252–256, doi:10.4253/wjge.v2.i7.252.
81. Albert, D.M.; Ally, M.R.; Moawad, F.J. The Sloughing Esophagus: A Report of Five Cases. *Am. J. Gastroenterol.* **2013**, *108*, 1816–1817, doi:10.1038/ajg.2013.230.
82. Ravi, K.; Codipilly, D.C.; Sunjaya, D.; Fang, H.; Arora, A.S.; Katzka, D.A. Esophageal Lichen Planus Is Associated With a Significant Increase in Risk of Squamous Cell Carcinoma. *Clin. Gastroenterol. Hepatol.* **2019**, *17*, 1902-1903.e1, doi:10.1016/j.cgh.2018.10.018.
83. Richter, J.E.; Rubenstein, J.H. Presentation and Epidemiology of Gastroesophageal Reflux Disease. *Gastroenterology* **2018**, *154*, 267–276, doi:10.1053/j.gastro.2017.07.045.
84. Jansson-Knodell, C.L.; Codipilly, D.C.; Leggett, C.L. Making Dysphagia Easier to Swallow: A Review for the Practicing Clinician. *Mayo Clin. Proc.* **2017**, *92*, 965–972, doi:10.1016/j.mayocp.2017.03.021.
85. Almashat, S.J.; Duan, L.; Goldsmith, J.D. Non-Reflux Esophagitis: A Review of Inflammatory Diseases of the Esophagus Exclusive of Reflux Esophagitis. *Semin. Diagn. Pathol.* **2014**, *31*, 89–99, doi:10.1053/j.semdp.2014.02.002.

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86. Ahuja, N.K.; Clarke, J.O. Evaluation and Management of Infectious Esophagitis in Immunocompromised and Immunocompetent Individuals. *Curr. Treat. Options Gastroenterol.* **2016**, *14*, 28–38, doi:10.1007/s11938-016-0082-2.
87. De Felice, K.M.; Katzka, D.A.; Raffals, L.E. Crohn's Disease of the Esophagus: Clinical Features and Treatment Outcomes in the Biologic Era. *Inflamm. Bowel Dis.* **2015**, *21*, 2106–2113, doi:10.1097/MIB.0000000000000469.
88. Watanabe, K.; Tanida, S.; Inoue, N.; Kunisaki, R.; Kobayashi, K.; Nagahori, M.; Arai, K.; Uchino, M.; Koganei, K.; Kobayashi, T.; et al. Evidence-Based Diagnosis and Clinical Practice Guidelines for Intestinal Behçet's Disease 2020 Edited by Intractable Diseases, the Health and Labour Sciences Research Grants. *J. Gastroenterol.* **2020**, *55*, 679–700, doi:10.1007/s00535-020-01690-y.
89. Zeiser, R.; Blazar, B.R. Acute Graft-versus-Host Disease - Biologic Process, Prevention, and Therapy. *N. Engl. J. Med.* **2017**, *377*, 2167–2179, doi:10.1056/NEJMra1609337.
90. Colli Cruz, C.; Moura Nascimento Santos, M.J.; Wali, S.; Varatharajalu, K.; Thomas, A.; Wang, Y. Gastrointestinal Toxicities Associated with Immune Checkpoint Inhibitors Therapy: Risks and Management. *Immunotherapy* **2025**, *17*, 293–303, doi:10.1080/1750743X.2025.2473305.
91. Greuter, T.; Safroneeva, E.; Bussmann, C.; Biedermann, L.; Vavricka, S.R.; Katzka, D.A.; Schoepfer, A.M.; Straumann, A. Maintenance Treatment Of Eosinophilic Esophagitis With Swallowed Topical Steroids Alters Disease Course Over A 5-Year Follow-up Period In Adult Patients. *Clin. Gastroenterol. Hepatol.* **2019**, *17*, 419-428.e6, doi:10.1016/j.cgh.2018.05.045.
92. Hussein, M.; Mitchison, M.; Sweis, R. Lymphocytic Oesophagitis: Diagnosis and Management. *Clin. Med. Lond. Engl.* **2023**, *23*, 540–544, doi:10.7861/clinmed.2023-0440.
93. Hart, P.A.; Romano, R.C.; Moreira, R.K.; Ravi, K.; Sweetser, S. Esophagitis Dissecans Superficialis: Clinical, Endoscopic, and Histologic Features. *Dig. Dis. Sci.* **2015**, *60*, 2049–2057, doi:10.1007/s10620-015-3590-3.
94. Mastracci, L.; Grillo, F.; Parente, P.; Unti, E.; Battista, S.; Spaggiari, P.; Campora, M.; Valle, L.; Fassan, M.; Fiocca, R. Non Gastro-Esophageal Reflux Disease Related Esophagitis: An Overview with a Histologic Diagnostic Approach. *Pathologica* **2020**, *112*, 128–137, doi:10.32074/1591-951X-156.
95. Bruckner-Tuderman, L.; Has, C. Disorders of the Cutaneous Basement Membrane Zone--the Paradigm of Epidermolysis Bullosa. *Matrix Biol. J. Int. Soc. Matrix Biol.* **2014**, *33*, 29–34, doi:10.1016/j.matbio.2013.07.007.
96. Kridin, K.; Kneiber, D.; Kowalski, E.H.; Valdebran, M.; Amber, K.T. Epidermolysis Bullosa Acquisita: A Comprehensive Review. *Autoimmun. Rev.* **2019**, *18*, 786–795, doi:10.1016/j.autrev.2019.06.007.
97. Keate, R.F.; Williams, J.W.; Connolly, S.M. Lichen Planus Esophagitis: Report of Three Patients Treated with Oral Tacrolimus or Intraesophageal Corticosteroid Injections or Both. *Dis. Esophagus Off. J. Int. Soc. Dis. Esophagus* **2003**, *16*, 47–53.
98. Jobard-Drobacheff, C.; Blanc, D.; Quencez, E.; Zultak, M.; Paris, B.; Ottignon, Y.; Agache, P. Lichen Planus of the Oesophagus. *Clin. Exp. Dermatol.* **1988**, *13*, 38–41, doi:10.1111/j.1365-2230.1988.tb00648.x.
99. Kolios, A.G.A.; Marques Maggio, E.; Gubler, C.; Cozzio, A.; Dummer, R.; French, L.E.; Navarini, A.A. Oral, Esophageal and Cutaneous Lichen Ruber Planus Controlled with Alitretinoin: Case Report and Review of the Literature. *Dermatol. Basel Switz.* **2013**, *226*, 302–310, doi:10.1159/000349980.
100. Skinner, T.; Liang, S.; Sanagapalli, S. Budesonide Orodispersible Tablet for the Treatment of Refractory Esophageal Lichen Planus. *ACG Case Rep. J.* **2024**, *11*, e01460, doi:10.14309/crj.0000000000001460.
101. Bagger-Jörgensen, H.; Abdulrasak, M.; Sandeman, K.; Binsalman, M.; Sjöberg, K. Oesophageal Lichen Planus Successfully Treated with Budesonide Orodispersible Tablets: A Case Report. *Case Rep. Gastroenterol.* **2024**, *18*, 266–272, doi:10.1159/000538894.
102. Wedgeworth, E.K.; Vlavianos, P.; Groves, C.J.; Neill, S.; Westaby, D. Management of Symptomatic Esophageal Involvement with Lichen Planus. *J. Clin. Gastroenterol.* **2009**, *43*, 915–919, doi:10.1097/MCG.0b013e31819db2df.
103. Linton, M.S.; Zhao, L.; Gui, X.; Storr, M.; Andrews, C.N. Lichen Planus Is an Uncommon Cause of Nonspecific Proximal Esophageal Inflammation. *Gut Liver* **2013**, *7*, 401–405, doi:10.5009/gnl.2013.7.4.401.
104. Reissmann, A.; Hahn, E.G.; Faller, G.; Herold, C.; Schwab, D. Sole Treatment of Lichen Planus-Associated Esophageal Stenosis with Injection of Corticosteroids. *Gastrointest. Endosc.* **2006**, *63*, 168–169, doi:10.1016/j.gie.2005.07.045.

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Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 7 October 2025 doi:10.20944/preprints202510.0517.v1

105. Goñi Esarte, S.; Arín Letamendía, A.; Vila Costas, J.J.; Jiménez Pérez, F.J.; Ruiz-Clavijo García, D.; Carrascosa Gil, J.; Almendral López, M.L. [Rituximab as rescue therapy in refractory esophageal lichen planus]. *Gastroenterol. Hepatol.* **2013**, *36*, 264–267, doi:10.1016/j.gastrohep.2012.07.004.
106. Bobadilla, J.; van der Hulst, R.W.; ten Kate, F.J.; Tytgat, G.N. Esophageal Lichen Planus. *Gastrointest. Endosc.* **1999**, *50*, 268–271, doi:10.1016/s0016-5107(99)70238-5.
107. Westbrook, R.; Riley, S. Esophageal Lichen Planus: Case Report and Literature Review. *Dysphagia* **2008**, *23*, 331–334, doi:10.1007/s00455-007-9136-x.
108. Hafner, J.; Gubler, C.; Kaufmann, K.; Nobbe, S.; Navarini, A.A.; French, L.E. Apremilast Is Effective in Lichen Planus Mucosae-Associated Stenotic Esophagitis. *Case Rep. Dermatol.* **2016**, *8*, 224–226, doi:10.1159/000447051.
109. Parmentier, L.; Bron, B.-A.; Prins, C.; Samson, J.; Masouyé, I.; Borradori, L. Mucocutaneous Lichen Planus with Esophageal Involvement: Successful Treatment with an Anti-CD20 Monoclonal Antibody. *Arch. Dermatol.* **2008**, *144*, 1427–1430, doi:10.1001/archderm.144.11.1427.
110. Eustace, K.; Clowry, J.; Kiely, C.; Murphy, G.M.; Harewood, G. The Challenges of Managing Refractory Oesphageal Lichen Planus. *Ir. J. Med. Sci.* **2015**, *184*, 75–76, doi:10.1007/s11845-014-1136-x.
111. Bieneck, V.; Decker, A.; Schmitt-Graeff, A.; Kreisel, W.; Schauer, F. Remission of Refractory Esophageal Lichen Planus Induced by Tofacitinib. *Z. Für Gastroenterol.* **2024**, *62*, 1384–1388, doi:10.1055/a-2300-0375.
112. Passeron, T.; Reinhardt, M.; Ehst, B.; Weiss, J.; Sluzevich, J.; Sticherling, M.; Reygagne, P.; Wohlrab, J.; Hertl, M.; Fazel, N.; et al. Secukinumab in Adult Patients with Lichen Planus: Efficacy and Safety Results from the Randomized Placebo-Controlled Proof-of-Concept PRELUDE Study. *Br. J. Dermatol.* **2024**, *191*, 680–690, doi:10.1093/bjd/ljae181.
113. Abduelmula, A.; Bagit, A.; Mufti, A.; Yeung, K.C.Y.; Yeung, J. The Use of Janus Kinase Inhibitors for Lichen Planus: An Evidence-Based Review. *J. Cutan. Med. Surg.* **2023**, 12034754231156100, doi:10.1177/12034754231156100.
114. Mahmoudi, H.; Daneshpajooh, M.; Dadkhahfar, S.; Robati, R.M.; Tehranchinia, Z.; Farokh, P.; Shariatnia, M.; Shahidi-Dadras, M.; Moravvej, H. Efficacy and Safety of Tofacitinib in the Treatment of Adults with Lichen Planopilaris: A Randomized Placebo-Controlled Trial. *Int. Immunopharmacol.* **2025**, *162*, 115129, doi:10.1016/j.intimp.2025.115129.
115. Lin, X.; Li, X.; Zhai, Z.; Zhang, M. JAK-STAT Pathway, Type I/II Cytokines, and New Potential Therapeutic Strategy for Autoimmune Bullous Diseases: Update on Pemphigus Vulgaris and Bullous Pemphigoid. *Front. Immunol.* **2025**, *16*, 1563286, doi:10.3389/fimmu.2025.1563286.
116. Kooybaran, N.R.; Petzold, G.; Schön, M.P.; Mössner, R. Esophageal Lichen Planus Successfully Treated with the JAK1/3 Inhibitor Tofacitinib. *J. Dtsch. Dermatol. Ges. J. Ger. Soc. Dermatol. JDDG* **2022**, *20*, 858–860, doi:10.1111/ddg.14762.
117. Stein, P.; Brun, A.; Zaidi, H.; Sejpal, D.V.; Trindade, A.J. Successful Treatment of a Persistent Esophageal Lichen Planus Stricture With a Fully Covered Metal Stent. *ACG Case Rep. J.* **2016**, *3*, 98–100, doi:10.14309/crj.2016.12.
118. Sengupta, N.; Tapper, E.B.; Corban, C.; Sommers, T.; Leffler, D.A.; Lembo, A.J. The Clinical Predictors of Aetiology and Complications among 173 Patients Presenting to the Emergency Department with Oesophageal Food Bolus Impaction from 2004-2014. *Aliment. Pharmacol. Ther.* **2015**, *42*, 91–98, doi:10.1111/apt.13237.
119. Poincloux, L.; Rouquette, O.; Abergel, A. Endoscopic Treatment of Benign Esophageal Strictures: A Literature Review. *Expert Rev. Gastroenterol. Hepatol.* **2017**, *11*, 53–64, doi:10.1080/17474124.2017.1260002.
120. Fugazza, A.; Repici, A. Endoscopic Management of Refractory Benign Esophageal Strictures. *Dysphagia* **2021**, *36*, 504–516, doi:10.1007/s00455-021-10270-y.
121. Hoffman, R.S.; Burns, M.M.; Gosselin, S. Ingestion of Caustic Substances. *N. Engl. J. Med.* **2020**, *382*, 1739–1748, doi:10.1056/NEJMra1810769.
122. Halonen, P.; Jakobsson, M.; Heikinheimo, O.; Riska, A.; Gissler, M.; Pukkala, E. Cancer Risk of Lichen Planus: A Cohort Study of 13,100 Women in Finland. *Int. J. Cancer* **2018**, *142*, 18–22, doi:10.1002/ijc.31025.

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123. Halonen, P.; Jakobsson, M.; Heikinheimo, O.; Gissler, M.; Pukkala, E. Incidence of Lichen Planus and Subsequent Mortality in Finnish Women. *Acta Derm. Venereol.* **2020**, *100*, adv00303, doi:10.2340/00015555-3664.
124. Idrees, M.; Kujan, O.; Shearston, K.; Farah, C.S. Oral Lichen Planus Has a Very Low Malignant Transformation Rate: A Systematic Review and Meta-analysis Using Strict Diagnostic and Inclusion Criteria. *J. Oral Pathol. Med.* **2021**, *50*, 287–298, doi:10.1111/jop.12996.
125. Arduino, P.G.; Magliano, A.; Gambino, A.; Macciotta, A.; Carbone, M.; Conrotto, D.; Karimi, D.; Carrozzo, M.; Broccoletti, R. Risk of Malignant Transformation in 3173 Subjects with Histopathologically Confirmed Oral Lichen Planus: A 33-Year Cohort Study in Northern Italy. *Cancers* **2021**, *13*, 5740, doi:10.3390/cancers13225740.
126. Bombeccari, G.P.; Pallotti, F.; Guzzi, G.; Spadari, F. Oral-Esophageal Lichen Planus Associated with Oral Squamous Cell Carcinoma. *Indian J. Dermatol. Venereol. Leprol.* **2008**, *74*, 509, doi:10.4103/0378-6323.44323.
127. Chryssostalis, A.; Gaudric, M.; Terris, B.; Coriat, R.; Prat, F.; Chaussade, S. Esophageal Lichen Planus: A Series of Eight Cases Including a Patient with Esophageal Verrucous Carcinoma. A Case Series. *Endoscopy* **2008**, *40*, 764–768, doi:10.1055/s-2008-1077357.
128. Singhi, A.D.; Arnold, C.A.; Crowder, C.D.; Lam-Himlin, D.M.; Voltaggio, L.; Montgomery, E.A. Esophageal Leukoplakia or Epidermoid Metaplasia: A Clinicopathological Study of 18 Patients. *Mod. Pathol.* **2014**, *27*, 38–43, doi:10.1038/modpathol.2013.100.
129. Singhi, A.D.; Arnold, C.A.; Lam-Himlin, D.M.; Nikiforova, M.N.; Voltaggio, L.; Canto, M.I.; McGrath, K.M.; Montgomery, E.A. Targeted Next-Generation Sequencing Supports Epidermoid Metaplasia of the Esophagus as a Precursor to Esophageal Squamous Neoplasia. *Mod. Pathol.* **2017**, *30*, 1613–1621, doi:10.1038/modpathol.2017.73.
130. Kamboj, A.K.; Graham, R.P.; Murray, J.A. Epidermoid Metaplasia of the Esophagus. *Mayo Clin. Proc.* **2020**, *95*, 1796, doi:10.1016/j.mayocp.2020.04.041.
131. Kamboj, A.K.; Gibbens, Y.Y.; Hagen, C.E.; Wang, K.K.; Iyer, P.G.; Katzka, D.A. Esophageal Epidermoid Metaplasia: Clinical Characteristics and Risk of Esophageal Squamous Neoplasia. *Am. J. Gastroenterol.* **2021**, *116*, 1533–1536, doi:10.14309/ajg.0000000000001225.
132. Dellon, E.S. No Maintenance, No Gain in Long-Term Treatment of Eosinophilic Esophagitis. *Clin. Gastroenterol. Hepatol. Off. Clin. Pract. J. Am. Gastroenterol. Assoc.* **2019**, *17*, 397–399, doi:10.1016/j.cgh.2018.07.038.
133. Blauvelt, A.; Chiricozzi, A. The Immunologic Role of IL-17 in Psoriasis and Psoriatic Arthritis Pathogenesis. *Clin. Rev. Allergy Immunol.* **2018**, *55*, 379–390, doi:10.1007/s12016-018-8702-3.
134. Boutet, M.-A.; Nerviani, A.; Gallo Afflitto, G.; Pitzalis, C. Role of the IL-23/IL-17 Axis in Psoriasis and Psoriatic Arthritis: The Clinical Importance of Its Divergence in Skin and Joints. *Int. J. Mol. Sci.* **2018**, *19*, doi:10.3390/ijms19020530.
135. Gueiros, L.; Arão, T.; Souza, T.; Vieira, C.; Gomez, R.; Almeida, O.; Lodi, G.; Leão, J. IL17A Polymorphism and Elevated IL17A Serum Levels Are Associated with Oral Lichen Planus. *Oral Dis.* **2018**, *24*, 377–383, doi:10.1111/odi.12718.
136. Abdul, N.; Shenoy, M. Role of Salivary and Serum IL17 and IL23 in the Pathogenesis of Oral Lichen Planus: A Systematic Review. *Jundishapur J. Microbiol.* **2022**, *15*, 11.
137. Holstein, J.; Solimani, F.; Baum, C.; Meier, K.; Pollmann, R.; Didona, D.; Tekath, T.; Dugas, M.; Casadei, N.; Hudemann, C.; et al. Immunophenotyping in Pemphigus Reveals a TH17/TFH17 Cell–Dominated Immune Response Promoting Desmoglein1/3-Specific Autoantibody Production. *J. Allergy Clin. Immunol.* **2021**, *147*, 2358–2369, doi:10.1016/j.jaci.2020.11.008.
138. Grossberg, L.B.; Papamichael, K.; Cheifetz, A.S. Review Article: Emerging Drug Therapies in Inflammatory Bowel Disease. *Aliment. Pharmacol. Ther.* **2022**, *55*, 789–804, doi:10.1111/apt.16785.
139. Turner, D.; Ricciuto, A.; Lewis, A.; D'Amico, F.; Dhaliwal, J.; Griffiths, A.M.; Bettenworth, D.; Sandborn, W.J.; Sands, B.E.; Reinisch, W.; et al. STRIDE-II: An Update on the Selecting Therapeutic Targets in Inflammatory Bowel Disease (STRIDE) Initiative of the International Organization for the Study of IBD (IOIBD): Determining Therapeutic Goals for Treat-to-Target Strategies in IBD. *Gastroenterology* **2021**, *160*, 1570–1583, doi:10.1053/j.gastro.2020.12.031.

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140. Fanizzi, F.; D'Amico, F.; Peyrin-Biroulet, L.; Danese, S.; Dignass, A. Treatment Targets in IBD: Is It Time for New Strategies? *Best Pract. Res. Clin. Gastroenterol.* **2025**, *77*, 101990, doi:10.1016/j.bpg.2025.101990.
141. Centanni, L.; Cicerone, C.; Fanizzi, F.; D'Amico, F.; Furfaro, F.; Zilli, A.; Parigi, T.L.; Peyrin-Biroulet, L.; Danese, S.; Allocca, M. Advancing Therapeutic Targets in IBD: Emerging Goals and Precision Medicine Approaches. *Pharm. Basel Switz.* **2025**, *18*, 78, doi:10.3390/ph18010078.
142. Sandborn, W.J.; Feagan, B.G.; D'Haens, G.; Wolf, D.C.; Jovanovic, I.; Hanauer, S.B.; Ghosh, S.; Petersen, A.; Hua, S.Y.; Lee, J.H.; et al. Ozanimod as Induction and Maintenance Therapy for Ulcerative Colitis. *N. Engl. J. Med.* **2021**, *385*, 1280–1291, doi:10.1056/NEJMoa2033617.
143. Wang, J.; Goren, I.; Yang, B.; Lin, S.; Li, J.; Elias, M.; Fiocchi, C.; Rieder, F. The Sphingosine 1 Phosphate / Sphingosine 1 Phosphate Receptor Axis: A Unique Therapeutic Target in Inflammatory Bowel Disease. *Aliment. Pharmacol. Ther.* **2022**, *55*, 277–291, doi:10.1111/apt.16741.
144. Wils, P.; Peyrin-Biroulet, L. Etrasimod for the Treatment of Ulcerative Colitis. *Immunotherapy* **2023**, *15*, 311–321, doi:10.2217/imt-2022-0255.
145. Martinez-Molina, C.; González-Suárez, B. Etrasimod: Modulating Sphingosine-1-Phosphate Receptors to Treat Ulcerative Colitis. *J. Clin. Med.* **2025**, *14*, 3890, doi:10.3390/jcm14113890.
146. Gonzalez Lopez de Turiso, F.; Guckian, K. Selective TYK2 Inhibitors as Potential Therapeutic Agents: A Patent Review (2019-2021). *Expert Opin. Ther. Pat.* **2022**, *32*, 365–379, doi:10.1080/13543776.2022.2026927.
147. Bellinato, F.; Gisondi, P.; Girolomoni, G. Latest Advances for the Treatment of Chronic Plaque Psoriasis with Biologics and Oral Small Molecules. *Biol. Targets Ther.* **2021**, *15*, 247–253, doi:10.2147/BTT.S290309.
148. Gonciarz, M.; Pawlak-Buś, K.; Leszczyński, P.; Owczarek, W. TYK2 as a Therapeutic Target in the Treatment of Autoimmune and Inflammatory Diseases. *Immunotherapy* **2021**, *13*, 1135–1150, doi:10.2217/imt-2021-0096.
149. Danese, S.; Peyrin-Biroulet, L. Selective Tyrosine Kinase 2 Inhibition for Treatment of Inflammatory Bowel Disease: New Hope on the Rise. *Inflamm. Bowel Dis.* **2021**, *27*, 2023–2030, doi:10.1093/ibd/izab135.
150. Jo, C.E.; Gooderham, M.; Beecker, J. TYK 2 Inhibitors for the Treatment of Dermatologic Conditions: The Evolution of JAK Inhibitors. *Int. J. Dermatol.* **2022**, *61*, 139–147, doi:10.1111/ijd.15605.
151. Mohan, R.P.S.; Gupta, A.; Kamarthi, N.; Malik, S.; Goel, S.; Gupta, S. Incidence of Oral Lichen Planus in Perimenopausal Women: A Cross-Sectional Study in Western Uttar Pradesh Population. *J. -Life Health* **2017**, *8*, 70–74, doi:10.4103/jmh.JMH_34_17.
152. Lavaee, F.; Bazrafkan, N.; Zarei, F.; Sardo, M.S. Follicular-Stimulating Hormone, Luteinizing Hormone, and Prolactin Serum Level in Patients with Oral Lichen Planus in Comparison to Healthy Population. *BioMed Res. Int.* **2021**, *2021*, 8679505, doi:10.1155/2021/8679505.
153. Han, A.; Kim, J.Y.; Kwak-Kim, J.; Lee, S.K. Menopause Is an Inflection Point of Age-Related Immune Changes in Women. *J. Reprod. Immunol.* **2021**, *146*, 103346, doi:10.1016/j.jri.2021.103346.

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