DERMIS

Review Article

Volume and Issue: 05, 02

Exploring Dermatological Manifestations in Gastroparesis and the Associated Link Between Delayed Gastric Emptying and Nutrient Deficiencies

Alyssa Forsyth[1], Jacquelyn Berman[2], Kelly Frasier[3*], Yazmin Williams[4], Reem Ayoub[5], Arielle Radparvar[6], Kaylahn Jones[7], Camile Delva[8]

[1]Texas College of Osteopathic Medicine, University of North Texas Health Science Center, Fort Worth, TX, USA

[2]A.T. Still University School of Osteopathic Medicine in Arizona (SOMA), Mesa, AZ, USA

[3]Department of Dermatology, Northwell Health, New Hyde Park, NY, USA

[4]Rowan-Virtua School of Osteopathic Medicine, Stratford, NJ, USA

[5]Texas College of Osteopathic Medicine, University of North Texas Health Science Center, Fort Worth, TX, USA

[6]California Health Sciences University College of Osteopathic Medicine, Clovis, CA, USA

[7]Kansas City University College of Osteopathic Medicine, Kansas City, MO, USA

[8]CUNY School of Medicine, New York, NY, USA

[*]Corresponding author:

Kelly Frasier, DO, MS,
Department of Dermatology, Northwell Health,
New Hyde Park, NY, USA, Phone: 3105956882,
Email: kellymariefrasier@gmail.com

Received : February 09, 2025
Published : March 18, 2025

ABSTRACT

Gastroparesis, characterized by delayed gastric emptying, significantly impacts nutrient absorption, leading to a spectrum of systemic and dermatological manifestations. Impaired gastric motility disrupts the breakdown and assimilation of essential vitamins and minerals, including zinc, vitamin C, and biotin, which are critical for maintaining skin health. Consequently, patients with gastroparesis frequently present with xerosis, delayed wound healing, and brittle nails, alongside more severe manifestations such as acrodermatitis enteropathica-like lesions and angular cheilitis. Delayed gastric emptying exacerbates these deficiencies by reducing gastric acid production and enzyme activity, impairing nutrient bioavailability, and increasing susceptibility to secondary skin infections. Furthermore, chronic inflammation and oxidative stress associated with gastroparesis contribute to skin barrier dysfunction, compounding dermatological complications. Therapeutic strategies, including tailored nutritional supplementation, prokinetic agents, and topical therapies, have shown potential in addressing these issues, yet treatment outcomes remain inconsistent due to the heterogeneity of nutrient deficiencies in this population. Understanding the interplay between delayed gastric emptying, malabsorption, and dermatological health is crucial for developing targeted interventions to mitigate skin-related morbidity in

DOI: https://doi.org/10.35702/Derm.10034

gastroparesis patients. A more integrated and personalized approach, combining precise nutritional repletion, innovative therapeutic modalities, and multidisciplinary care, holds the promise of transforming outcomes for individuals suffering from the systemic and dermatological burdens of this complex condition.

Keywords: Nutrient, Skin, Gastroparesis, Patients, Diabetes, Surgery.

INTRODUCTION

The term "gut-brain axis" is used in clinical academia to underscore the relationship between gastrointestinal and cutaneous health. Histopathologic findings and clinical presentation are key in diagnosing mineral and nutrient dermatoses and may demonstrate spongiosis, hyperkeratosis, parakeratosis, vacuolization, epidermal pallor, ballooning degeneration, and necrolysis [5]. Essential micronutrients such as zinc, copper, iron, and selenium are involved in skin morphogenesis, maintenance, repair, and gene expression. Their deficiencies illustrate their importance in maintaining cutaneous health. For example, deficiencies in zinc present with eczematous plaques and can progress to pustular, annular erosions in skin folds. Advanced cases may present with angular cheilitis and growth delay [6]. Deficiencies in copper, which functions as a cofactor for lysyl oxidase and is involved in crosslinking collagen and elastin, present with hypopigmented, brittle hairs, as well as poor wound healing and seborrheic dermatitis. Low levels of fat-soluble vitamins (A, D, E, and K) and B12 are also commonly seen in patients with gastroparesis, with manifestations ranging from phrynoderma to oral ulcers and coagulopathies [7]. Because these vitamins are involved in the expression of inflammatory cytokines and elimination of reactive oxygen species, patients are left susceptible to respiratory infections and certain forms of breast cancer [7]. These nutritional deficiencies highlight the systemic ramifications of malabsorption and rightfully demand our clinical attention. This paper explores the complex interplay between gastroparesis, nutrient malabsorption, and dermatological health, while examining current therapeutic approaches and the need for integrated care.

Gastroparesis, a condition defined by delayed gastric emptying in the absence of mechanical obstruction, profoundly impacts the body's ability to process and absorb nutrients. Gastroparesis has a largely idiopathic etiology, but is frequently associated with diabetes and surgery [1]. In diabetic patients, uncontrolled blood glucose can, over time, damage the vagus nerve, which is responsible for gastric and intestinal motility [1]. Post-surgical gastroparesis can occur due to surgical damage to the vagus nerve or other factors affecting gastric motility. This greatly delays the rate at which the stomach empties its contents, thereby causing early satiety, abdominal distension, bloating, diarrhea, and postprandial fullness. Notably, such malabsorption can also have deleterious consequences on the skin barrier, the body's largest organ with a high nutrient demand [2]. Gastroparesis disrupts the breakdown and assimilation of essential vitamins and minerals that are critical for maintaining overall health. The production of antioxidants, melanin, and tissue regeneration becomes compromised and hinders normal wound healing. Dermatological manifestations can range from xerosis (dry skin) to more severe conditions such as acrodermatitis enteropathica-like lesions and angular cheilitis [3]. This breach of cutaneous integrity also poses a systemic threat: increased susceptibility to viral and bacterial infections. Upon damage to the epidermis, key effectors of the innate immune system become activated along with epidermal keratinocytes, which release bactericidal antimicrobial proteins (AMPs). Their ability to then detect pathogen-associated molecular patterns (PAMPs) instigates the release of inflammatory cytokines, toll-like-receptors (TLRs), nucleotide-binding oligomerization domain-like receptors, and c-type lectin receptors (CLrs) [4]. These proteins are directly involved in defense against *Staphylococcus aureus,* herpesvirus, papillomaviruses, and *Candida albicans* [4].

METHODS

A comprehensive narrative review of the dermatologic manifestations associated with gastroparesis was conducted to evaluate the impact of impaired gastric motility on nutrient absorption and subsequent skin complications. The purpose of this review was to synthesize existing literature, providing a clearer understanding of the intersection between delayed gastric emptying, malabsorption, and dermatologic health to inform targeted therapeutic strategies. Sources were identified through a targeted search of databases such as PubMed and Google Scholar, focusing on peer-reviewed articles, clinical studies, and expert reviews discussing gastroparesis-related nutrient deficiencies, skin manifestations, and treatment approaches. The dermatologic sequelae of these deficiencies, including xerosis, delayed wound healing, brittle nails, acrodermatitis enteropathica-like lesions, and angular

DOI: https://doi.org/10.35702/Derm.10034

cheilitis, were analyzed in relation to underlying metabolic disruptions. The role of chronic inflammation and oxidative stress in skin barrier dysfunction was explored to highlight their contribution to dermatologic morbidity. Therapeutic interventions, including targeted nutritional supplementation, prokinetic agents, and topical treatments, were assessed, with particular attention to the challenges posed by variability in nutrient deficiencies among patients. Emerging treatment modalities were examined to identify advancements in disease management.

Review

Gastroparesis and Nutrient Absorption

Gastroparesis impairs the stomach's ability to coordinate contractions that propel food into the small intestine. This delayed transit time disrupts the digestion and breakdown of macronutrients and micronutrients. Adequate gastric acid production and enzyme activity, which are crucial for nutrient solubilization and absorption, are often reduced in gastroparesis, particularly in diabetic patients [8]. The reduction in gastric acid, or hypochlorhydria, also disrupts the activation of enzymes like pepsin, which are essential for protein digestion. Pepsin activation requires a highly acidic environment, and when this process is impaired, the breakdown of dietary proteins into amino acids becomes incomplete. The compromised ability of the stomach to produce sufficient gastric acid and enzymes affects not only nutrient absorption but also the mechanical and chemical digestion of food.

Gastric acid plays a central role in nutrient assimilation by aiding the digestion of proteins and the solubilization of micronutrients. In gastroparesis, the hypochlorhydria (low stomach acid) commonly observed significantly impairs the bioavailability of essential minerals such as iron, magnesium, and calcium [9-11]. Reduced enzyme activity, particularly pepsin, further compromises protein breakdown, leading to systemic deficiencies that manifest as brittle nails, hair thinning, and other skin-related issues [12]. These deficiencies not only affect protein metabolism but also interfere with the absorption of other critical nutrients, exacerbating the consequences of malnutrition.

Since gastric acid is also integral to the absorption of certain vitamins, this disruption leads to deficiencies in zinc, vitamin C, and biotin, further compounding the effects of nutritional insufficiency. Zinc, a trace mineral essential for numerous biochemical processes, is particularly vulnerable to malabsorption due to its dependence on an acidic gastric environment. The implications of zinc deficiency extend beyond dermatological health, as it is also vital for immune function and enzymatic activity. Parkman et al. emphasize that a deficiency in zinc can manifest in systemic symptoms, such as fatigue and increased susceptibility to infections, thereby underscoring the broader impact of impaired nutrient absorption in gastroparesis [13]. Zinc also plays a central role in tissue repair by promoting cellular proliferation and inflammation regulation during the wound-healing process. Deficiency in zinc can lead to impaired wound healing and diminished skin barrier integrity [14]. This leaves the skin more vulnerable to delayed closure and secondary infections, further complicating the patient's health. Similarly, vitamin C, essential for collagen synthesis, becomes deficient, exacerbating skin fragility and delaying repair processes [15]. Collagen, a structural protein, is critical for maintaining the tensile strength and elasticity of skin and connective tissues. Mohammed et al. describe how a lack of vitamin C undermines these structural components, leading to skin that is more prone to tearing and bruising [15]. The deficiency also hinders fibroblast activity, which is essential for the formation of new connective tissue during healing.

Beyond the direct impact on nutrient absorption, the impaired activation of digestive enzymes also fosters an environment conducive to bacterial overgrowth. This further exacerbates inflammation and nutrient malabsorption, creating a cycle of worsening deficiencies and systemic complications [16]. The overgrowth of bacteria in the stomach and small intestine can lead to additional digestive disturbances, including bloating, gas, and diarrhea, further impairing nutrient uptake. These disruptions underscore the critical need for effective management of gastric acid levels to optimize nutrient absorption and mitigate the dermatological and systemic consequences of gastroparesis.

Dermatological Manifestations of Nutrient Deficiencies in Gastroparesis

The dermatological manifestations of gastroparesis are diverse and directly linked to specific nutrient deficiencies. Xerosis, or dry skin, is one of the most common complaints and stems from the lack of essential fatty acids and vitamins required for maintaining the skin's lipid barrier [17].

Delayed wound healing, another hallmark feature, is closely associated with deficiencies in zinc and vitamin C [14,15]. Severe manifestations such as acrodermatitis enteropathica-like lesions, characterized by erythematous plaques and pustules, mimic the symptoms of zinc deficiency commonly observed in gastroparesis patients [18]. Angular cheilitis, presenting as painful fissures and inflammation at the corners of the mouth, often results from deficiencies in riboflavin and biotin, further illustrating the nutritional impact of the disorder [19]. Riboflavin deficiency may also be linked to the development of seborrheic dermatitis [20]. Biotin deficiency further compounds zinc deficiency, as it is necessary for cutaneous zinc homeostasis [21]. These dermatological concerns highlight the broad impact of nutrient deficiencies in gastroparesis, with hair loss emerging as another important manifestation that reflects the systemic effects of impaired nutrient absorption.

Hair loss is another important dermatological concern associated with gastroparesis. Silver et al. reported that 45.5% of patients with gastroparesis experienced hair loss [22]. The connection between hair loss and gastroparesis is largely attributed to the systemic nutritional deficiencies associated with the disorder, particularly those affecting vitamins and minerals essential for hair follicle health. The study found that hair loss was frequently linked to more severe gastroparesis symptoms, such as substantial weight loss, and was exacerbated by the impaired nutrient absorption inherent to the condition [22]. Furthermore, many patients with hair loss exhibited abnormal bloodwork, revealing deficiencies in key nutrients such as ferritin, zinc, and biotin, which are critical for hair growth and maintenance. Importantly, supplementation with daily multivitamins led to a 41% improvement in hair loss after eight weeks, underscoring the potential for correcting these deficiencies to yield significant dermatological benefits [22]. This finding reinforces the need for a comprehensive approach to managing gastroparesis, emphasizing the correction of nutritional deficiencies not only to address hair loss but also to mitigate other integumentary and systemic complications commonly seen in affected individuals.

Dermatological Manifestations of Chronic Inflammation in Gastroparesis

Chronic inflammation has been increasingly recognized as a crucial contributor to both nutrient malabsorption and the manifestation of various dermatological complications seen in gastroparesis. These symptoms arise from the complex relationship between gastrointestinal dysfunction, the corresponding immune response, systemic inflammation and the resulting nutrient deficiencies. Previous research has highlighted the role of systemic inflammation in promoting skin barrier dysfunction, suggesting that elevated levels of pro-inflammatory markers seen in patients with gastroparesis may correlate with the presence of xerosis. Pro-inflammatory cytokines that are commonly elevated in gastroparesis like interleukin-4 (IL-4) and interleukin-13 (IL-13) are known to reduce key proteins involved in keratinocyte differentiation including filaggrin, loricrin, and involucrin [23]. These alterations lead to impaired skin barrier integrity and increasing transepidermal water loss (TEWL) which facilitates the entry of allergens and pathogens through the skin barrier. Dry skin seen in gastroparesis due to inflammation is exacerbated even further in the presence of vitamin A deficiency. Due to this dysregulation in the skin barrier, patients with gastroparesis become more susceptible to infections. Similarly, interleukin-6 (IL-6), promotes keratinocyte proliferation while also inhibiting ceramide synthesis, causing further damage to the lipid envelope of the skin [23]. This decrease in ceramide synthesis is also compounded by the nutritional decrease in saturated fatty acids.

Proinflammatory cytokines also play a role in the disruption of normal gastric motility by altering the interstitial cells of Cajal (ICC), which are important in the regulation of peristaltic movements [24]. In gastroparesis, elevated levels of these inflammatory mediators may inhibit ICC functionality, resulting in prolonged gastric retention and secondary malnutrition as well as gastrointestinal discomfort [25]. The underlying mechanism involves classical activation of macrophages (M1), leading to the secretion of IL-1β, IL-6 and tumor necrosis factor-alpha (TNF-α) [26]. Side effects of this delayed gastric emptying include accumulation of toxins, vitamin deficiency, and increased inflammation, which can all result in the increased prevalence of inflammatory skin conditions like atopic dermatitis.

Dermatological symptoms, particularly pruritus, are common in gastroparesis patients and are primarily driven by nutrient malabsorption and systemic inflammation. Research indicates that inflammation can, in some cases, heighten the sensitivity of cutaneous nerve endings [27]. When combined with deficiencies in essential vitamins such as B12 and D, this increased sensitivity can amplify pruritic

DOI: https://doi.org/10.35702/Derm.10034

sensations. This underscores how cutaneous manifestations may indicate ongoing nutrient deficiencies and systemic inflammation in individuals with gastrointestinal disorders [28]. Such symptoms can significantly affect patients' quality of life, presenting unique challenges in the management of gastroparesis.

Heightened Susceptibility to Secondary Skin Infections in Gastroparesis

The susceptibility to secondary skin infections is heightened in gastroparesis due to impaired immune function and disrupted skin barriers. Poor oral intake in severe cases of gastroparesis can lead to malnutrition and deficiencies in essential vitamins and minerals, further exacerbating overall health and immune function [29]. Nutritional deficiencies, particularly in zinc and vitamin A, impair the skin's innate immune response, reducing its ability to fend off bacterial and fungal pathogens. In gastroparesis, low zinc levels can impair the skin's healing ability, leading to prolonged wound healing and increased susceptibility to infections. Due to its regulatory effects on macrophage and neutrophil activity, zinc directly enhances chemotactic activity in polymorphonuclear (PMN) leukocytes, while its deficiency is associated with a reduction in granulocyte levels [30,31]. Decreased granulocyte levels can lead to chronic inflammation causing even higher susceptibility to infections. Similarly, vitamin A, which regulates immune responses through its metabolite, retinoic acid (RA), is essential for maintaining skin integrity and mucosal barriers. RA supports the normal differentiation of keratinocytes, and its deficiency results in improper keratinization of the skin, causing xerosis (dry, rough, thickened skin) [32]. This, in turn, makes the skin more susceptible to infection and inflammation, highlighting the critical role of vitamin A in supporting the skin's immune defense.

The combination of immune dysfunction and skin barrier impairment in gastroparesis creates an environment conducive to recurrent skin infections, such as folliculitis and candidiasis. Folliculitis, an infection of hair follicles, is most commonly caused by the bacteria *Staphylococcus aureus* but can also result from fungi such as *Malassezia furfur*, typically found in adolescence secondary to increased activity of sebaceous glands. This condition manifests as red, inflamed papules or pustules, primarily in areas prone to friction or occlusion and can progress to deeper abscesses if left untreated [33]. Candidiasis is an opportunistic infection that arises from overgrowth of *Candida* species, often due to disrupted epithelial barriers and reduced immune surveillance. The most frequent route by which *Candida* reaches the bloodstream is via the gastrointestinal mucosal barrier. Candidiasis commonly affects intertriginous areas, such as the axillae, groin, or under the breasts, presenting with erythematous plaques, satellite pustules, and a characteristic moist appearance. If progression to *Candida* sepsis occurs, the individual's own gastrointestinal tract is the source of infection. Skin invasion from macerated intertriginous regions and intravenous (IV) lines are potential sources [34,35]. The chronic nutrient deficiencies in gastroparesis create an environment conducive to such infections, as impaired immunity and skin barrier dysfunction allow pathogens to proliferate. These infections further complicate the clinical picture, requiring targeted antimicrobial treatments in addition to addressing the underlying nutrient deficiencies.

Management of Dermatological Complications in Gastroparesis

Effective management of dermatological complications in gastroparesis involves a combination of nutritional support, pharmacological interventions, and supportive skin therapies. Current dietary recommendations emphasize low-fat, low-fiber foods to minimize delayed gastric emptying. Patients are advised to maintain caloric intake through small, frequent meals. Due to delayed gastric emptying, gastroparesis patients often have impaired nutrient absorption and higher rates of vitamin A, vitamin C, iron, and zinc deficiencies compared to the general population [13]. Nutritional supplementation targeting these deficiencies, such as oral or intravenous zinc and vitamin C, has been shown to improve skin symptoms significantly. Vitamin C, a potent antioxidant, supports collagen synthesis and wound healing, while zinc plays a crucial role in inflammatory response and epidermal growth factor production [30,36]. Supplementation enhances skin health, improving resistance to damage and promoting faster recovery from wounds. Prokinetic agents, like metoclopramide and domperidone, enhance gastric motility, improving nutrient absorption and reducing systemic inflammation [37]. Topical therapies, including emollients and barrier repair creams, provide symptomatic relief for xerosis and other skin conditions, while advanced wound care techniques address delayed healing [38]. A multifaceted approach, addressing both systemic and localized factors, improves dermatological symptoms and the overall quality of life for patients with gastroparesis.

DOI: https://doi.org/10.35702/Derm.10034

Despite potential benefits, treatment outcomes remain inconsistent due to variations in nutrient deficiencies, disease severity, comorbid conditions, and individual absorption capacities. This variability complicates the development of standardized treatment protocols [39]. Oral supplementation may be insufficient for patients with severe gastric motility issues, requiring parenteral routes of administration, which carry risks such as catheter-related infections and electrolyte imbalances [40]. The lack of comprehensive management guidelines underscores the need for a multidisciplinary approach involving gastroenterologists, dietitians, endocrinologists, and mental health professionals [41]. Future research should focus on identifying specific nutritional interventions and developing evidence-based protocols for gastroparesis management. Enhanced patient education could also improve adherence and long-term outcomes.

Micronutrient management is essential for individuals with gastroparesis, not only to alleviate gastrointestinal symptoms but also to improve skin-related manifestations of deficiencies. Many individuals with gastroparesis lack appropriate nutritional planning, have multiple vitamin deficiencies, and consume calorically deficient diets. The NIH Gastroparesis Consortium found that only one-third of 305 patients took vitamin supplements, 32% had nutritional consultations, and 2% followed a modified gastroparesis diet [42]. Early intervention and correction of deficiencies are crucial.

Specialized meal plans tailored to gastroparesis patients can improve nutritional status and mitigate symptoms. Diets consisting of small meals with low fat and non-digestible fiber content improve gastric emptying [44]. Nasoduodenal tubes and pureed or liquid foods ensure proper weight gain and nutrient absorption. For diabetic gastroparesis patients, maintaining glycemic control is vital, as blood glucose deviations inhibit gastric emptying and exacerbate nutrient deficiencies. Prokinetic and antiemetic therapies, including metoclopramide and motilin agonists, can also improve symptoms [43]. A holistic approach can better address both gastrointestinal and dermatological symptoms.

Currently, routine testing for micronutrient deficiencies in gastroparesis is not part of standard management. This limits understanding of specific deficiencies and their clinical implications. Dermatological manifestations can indicate disease severity. For example, patients with hair loss had significantly more abdominal symptoms, weight loss, and were more frequently on soft or liquid diets [22]. These patients often have deficiencies in riboflavin, biotin, folate, and vitamin B12, and correcting these with a multivitamin supplement for eight weeks reduced hair loss by 40% [44]. Although the study had limitations, it highlights the potential of multivitamins as a safe, low-cost therapy for gastroparesis management.

Research into microbiota-targeted interventions, including probiotics and prebiotics, shows promise in reducing inflammation and improving gut health. *Lactobacillus* and *Bifidobacterium* species have been shown to modulate immune mechanisms and reduce inflammatory markers like C-reactive protein (CRP) and tumor necrosis factor-alpha (TNF-α) [45]. Prebiotics, such as inulin and fructooligosaccharides, support beneficial gut bacteria and provide anti-inflammatory benefits [46]. Developing slow-release, highly bioavailable nutrient formulations could also improve supplementation strategies, reducing deficiencies and enhancing outcomes.

The link between gastroparesis and skin health highlights the interconnectedness of systemic and dermatological conditions. Skin manifestations serve as visible indicators of internal dysfunction, offering a unique window into the systemic impact of delayed gastric emptying. Addressing these manifestations not only improves quality of life but also provides an opportunity to manage the broader systemic implications of the disease.

Future Directions

Gastroparesis requires an integrated care model that combines gastroenterological expertise with dermatological and nutritional support. Collaboration among healthcare providers can help identify nutrient deficiencies early and implement personalized treatment plans. Dermatological assessments should be a routine part of gastroparesis management. Current American College of Gastroenterology guidelines also support monitoring the nutritional state of gastroparesis patients through dietary modifications and, if necessary, enteral or parenteral nutrition [47]. Applying a comprehensive approach to monitoring helps prevent severe complications, such as infections or chronic skin conditions, by ensuring early identification and intervention.

Emerging therapies, such as gastric electrical stimulation and advanced prokinetic agents, offer hope for improving gastric motility and nutrient absorption. The FDA currently approves gastric electrical stimulation (GES) for nausea and vomiting

DOI: https://doi.org/10.35702/Derm.10034

associated with gastroparesis and has shown promising results in improving symptoms for these patients. Recent studies have shown that GES does not accelerate gastric emptying but does work to modulate gastric pacemaker and sensory afferent pathways to improve glycemic control, nutritional status, and total symptom scores [48]. Clinical trials have also shown promise in using advanced prokinetic agents, such as Motilin, 5-HT4, and Ghrelin agonists, in enhancing gastric motility and lowering total symptom scores. One drug, Relamorelin, a ghrelin agonist, has demonstrated efficacy and shown significantly reduced frequencies in vomiting and improved gastric emptying in patients with gastroparesis [49]. While both GES and advanced prokinetic agents represent promising therapeutic options for managing gastroparesis, ongoing research is needed to further validate their efficacy and safety.

Further exploration into the molecular mechanisms underlying nutrient malabsorption and dermatological manifestations in gastroparesis is crucial for advancing care. Acrodermatitis enteropathica (AE), a rare skin disorder associated with mutations of the zinc transporter, ZIP4, demonstrates how defects in absorption pathways can result in significant dermatological complications [50]. Zinc deficiencies in gastroparesis can mimic the dermatological manifestations seen in AE, such as periorificial and acral dermatitis, alopecia, and diarrhea [51]. Studying the pathophysiology of vitamin deficiencies in conditions such as AE can provide a framework to understand the gut-skin axis, leading to the development of targeted interventions.

Additionally, identifying biomarkers for early detection of deficiencies and tailoring interventions based on individual absorption profiles could significantly improve outcomes. Serum methylmalonic acid and homocysteine levels are commonly used in identifying malabsorption of vitamin B12. Although these levels are frequently used in diagnosing pernicious anemia, gastroparesis can decrease intrinsic factor production, leading to reduced absorption of vitamin B12 [52,53]. Incorporating biomarkers in diagnostic tests for patients with gastroparesis could facilitate earlier detection of nutrient deficiencies.

Research into dietary modifications tailored to individual patients' motility patterns and nutrient deficiencies also shows promise. A review found that diets composed of small-particles, isoflavones, and low fat improved gastric emptying time in patients with gastroparesis [54]. Nutritional interventions can help patients enhance nutrient absorption and reduce symptoms of bloating and discomfort. Future studies should address how these dietary interventions can be tailored to individual patients based on their gastric motility patterns, nutrient deficiencies, and comorbid conditions.

Probiotics and their role in regulating the gut-skin axis are another emerging area of interest. Both topical and internal probiotics have shown potential in improving nutrient absorption, reducing systemic inflammation, and enhancing skin barrier function [55]. Probiotics can potentially alleviate symptoms of xerosis and delayed wound healing, which patients with gastroparesis and nutritional deficits commonly experience.

Finally, addressing the psychosocial aspects of gastroparesis is crucial. Woodhouse et al. reported that gastroparesis symptoms are adversely associated with increased anxiety, depression, and impaired quality of life [56]. Integrating mental health resources and psychosocial support into gastroparesis management could improve both emotional well-being and physical outcomes.

By combining precise nutritional repletion, advanced therapeutic modalities, and proactive dermatological management, clinicians can significantly mitigate the systemic and cutaneous burdens of gastroparesis. Through innovative strategies and integrated care, there is immense potential to transform outcomes for individuals affected by this complex condition.

CONCLUSION

Gastroparesis exerts a multifaceted impact on systemic and dermatological health, with delayed gastric emptying disrupting critical pathways of nutrient absorption and metabolic regulation. The resultant deficiencies in zinc, vitamin C, biotin, and other micronutrients highlight the essential role of gastric motility in maintaining cellular and structural integrity across organ systems. Dermatological manifestations, including xerosis, delayed wound healing, acrodermatitis enteropathica-like lesions, and angular cheilitis, are not merely superficial consequences but rather outward markers of profound systemic dysfunction. Cutaneous complications are further exacerbated by the chronic inflammation, oxidative stress, and immune dysregulation inherent in gastroparesis, creating a biologically interconnected cascade

DOI: https://doi.org/10.35702/Derm.10034

of impaired barrier function and increased susceptibility to secondary infections. Current therapeutic approaches, while partially effective, are limited by the complexity of nutrient malabsorption and the variability in clinical presentation, necessitating a paradigm shift toward precision medicine. Advances in targeted prokinetic agents, nutrient formulations with optimized bioavailability, and microbiota-based therapies hold significant promise for restoring metabolic and immune homeostasis. Addressing the dermatological sequelae of gastroparesis requires not only direct treatment of skin manifestations but also a broader integration of gastroenterological, nutritional, and dermatological expertise. A comprehensive, systems-based approach is essential for mitigating the cascading effects of delayed gastric emptying, advancing patient care, and ultimately improving both systemic and cutaneous outcomes in this complex patient population.

ACKNOWLEDGEMENTS

None.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

REFERENCES

1. Vavricka SR, Greuter T. (2019). Gastroparesis and Dumping Syndrome: Current Concepts and Management. J Clin Med. 8(8):1127.
2. Abenavoli L, Proietti I, Vonghia L, Leggio L, Ferrulli A, Capizzi R, et al. (2008). Intestinal malabsorption and skin diseases. Dig Dis. 26(2):167-174.
3. Boh EE, al-Smadi RM. (2002). Cutaneous manifestations of gastrointestinal diseases. Dermatol Clin. 20(3):533-546.
4. Coates M, Blanchard S, MacLeod AS. (2018). Innate antimicrobial immunity in the skin: A protective barrier against bacteria, viruses, and fungi. PLoS Pathog. 14(12):e1007353.
5. Nosewicz J, Spaccarelli N, Roberts KM, Hart PA, Kaffenberger JA, Trinidad JC, et al. (2022). The epidemiology, impact, and diagnosis of micronutrient nutritional dermatoses part 1: Zinc, selenium, copper, vitamin A, and vitamin C. J Am Acad Dermatol. 86(2):267-278.
6. Maverakis E, Fung MA, Lynch PJ, Draznin M, Michael DJ, Ruben B, et al. (2007). Acrodermatitis enteropathica and an overview of zinc metabolism. J Am Acad Dermatol. 56(1):116-124.
7. Albahrani AA, Greaves RF. (2016). Fat-Soluble Vitamins: Clinical Indications and Current Challenges for Chromatographic Measurement. Clin Biochem Rev. 37(1):27-47.
8. Hasler WL, Coleski R, Chey WD, Koch KL, McCallum RW, Wo JM, et al. (2008). Differences in intragastric pH in diabetic vs. idiopathic gastroparesis: relation to degree of gastric retention. Am J Physiol Gastrointest Liver Physiol. 294(6):G1384-G1391.
9. Betesh AL, Santa Ana CA, Cole JA, Fordtran JS. (2015). Is achlorhydria a cause of iron deficiency anemia? Am J Clin Nutr. 102(1):9-19.
10. Sipponen P, Härkönen M. (2010). Hypochlorhydric stomach: a risk condition for calcium malabsorption and osteoporosis? Scand J Gastroenterol. 45(2):133-138.
11. Suksridechacin N, Kulwong P, Chamniansawat S, Thongon N. (2020). Effect of prolonged omeprazole administration on segmental intestinal Mg2+ absorption in male Sprague-Dawley rats. World J Gastroenterol. 26(11):1142-1155.
12. Rivera Del Rio A, Keppler JK, Boom RM, Janssen AEM. (2021). Protein acidification and hydrolysis by pepsin ensure efficient trypsin-catalyzed hydrolysis. Food Funct. 12(10):4570-4581.
13. Parkman HP, Yates KP, Hasler WL, Nguyan L, Pasricha PJ, Snape WJ, et al. (2011). Dietary intake and nutritional deficiencies in patients with diabetic or idiopathic gastroparesis. Gastroenterology. 141(2):486-498, 498.e1-7.
14. Henderson LM, Brewer GJ, Dressman JB, Swidan SZ, DuRoss DJ, Adair CH, et al. (1995). Effect of intragastric pH on the absorption of oral zinc acetate and zinc oxide in young healthy volunteers. JPEN J Parenter Enteral Nutr. 19(5):393-397.
15. Mohammed BM, Fisher BJ, Kraskauskas D, Ward S, Wayne JS, Brophy DF, et al. (2016). Vitamin C promotes wound healing through novel pleiotropic mechanisms. Int Wound J. 13(4):572-584.

16. George NS, Sankineni A, Parkman HP. (2014). Small intestinal bacterial overgrowth in gastroparesis. Dig Dis Sci. 59(3):645-652.

17. Jeppesen PB, Høy CE, Mortensen PB. (2000). Deficiencies of essential fatty acids, vitamin A and E and changes in plasma lipoproteins in patients with reduced fat absorption or intestinal failure. Eur J Clin Nutr. 54(8):632-642.

18. Glutsch V, Hamm H, Goebeler M. (2019). Zinc and skin: an update. J Dtsch Dermatol Ges. 17(6):589-596.

19. DiBaise M, Tarleton SM. (2019). Hair, Nails, and Skin: Differentiating Cutaneous Manifestations of Micronutrient Deficiency. Nutr Clin Pract. 34(4):490-503.

20. McNulty H, Pentieva K, Ward M. (2023). Causes and Clinical Sequelae of Riboflavin Deficiency. Annu Rev Nutr. 43:101-122.

21. Ogawa Y, Kinoshita M, Sato T, Shimada S, Kawamura T. (2019). Biotin Is Required for the Zinc Homeostasis in the Skin. Nutrients. 11(4):919.

22. Silver PJ, Coles MJ, Heath CR, Parkman HP. (2023). Hair Loss in Patients with Gastroparesis: A Sign of Nutritional Deficiency in Gastroparesis? Dig Dis Sci. 68(4):1397-1402.

23. Hänel KH, Cornelissen C, Lüscher B, Baron JM. (2013). Cytokines and the skin barrier. Int J Mol Sci. 14(4):6720-6745.

24. Akiho H, Ihara E, Motomura Y, Nakamura K. (2011). Cytokine-induced alterations of gastrointestinal motility in gastrointestinal disorders. World J Gastrointest Pathophysiol. 2(5):72-81.

25. Wu Y, Xie N, Yu Y, Li B. (2023). Pathogenesis and endoscopic treatment of gastroparesis. Gastroenterology & Endoscopy. 1(2):110-117.

26. Mikkelsen HB. (2010). Interstitial cells of Cajal, macrophages and mast cells in the gut musculature: morphology, distribution, spatial and possible functional interactions. J Cell Mol Med. 14(4):818-832.

27. Szöllősi AG, Oláh A, Lisztes E, Griger Z, Tóth BI. (2022). Pruritus: A Sensory Symptom Generated in Cutaneous Immuno-Neuronal Crosstalk. Front Pharmacol. 13:745658.

28. Leal JM, de Souza GH, Marsillac PF, Gripp AC. (2021). Skin manifestations associated with systemic diseases - Part II. An Bras Dermatol. 96(6):672-687.

29. Amjad W, Qureshi W, Singh RR, Richter S. (2021). Nutritional deficiencies and predictors of mortality in diabetic and nondiabetic gastroparesis. Ann Gastroenterol. 34(6):788-795.

30. Hassan A, Sada KK, Ketheeswaran S, Dubey AK, Bhat MS. (2020). Role of Zinc in Mucosal Health and Disease: A Review of Physiological, Biochemical, and Molecular Processes. Cureus. 12(5):e8197.

31. Gupta M, Mahajan VK, Mehta KS, Chauhan PS. (2014). Zinc therapy in dermatology: a review. Dermatol Res Pract. 2014:709152.

32. Roche FC, Harris-Tryon TA. (2021). Illuminating the Role of Vitamin A in Skin Innate Immunity and the Skin Microbiome: A Narrative Review. Nutrients. 13(2):302.

33. Winters RD, Mitchell M. (2023). Folliculitis. In: StatPearls [Internet]. StatPearls Publishing. Available at: https://www.ncbi.nlm.nih.gov/books/NBK547754/

34. Song P, Burgin S, Prasad P. (2024). Disseminated candidiasis in adult. In: Goldsmith L, (Ed.), VisualDx. Available at: https://www.visualdx.com/visualdx/diagnosis/?moduleId=101&diagnosisId=51244

35. Arya NR, Rafiq NB. (2023). Candidiasis. In: StatPearls [Internet]. StatPearls Publishing. Available at: https://www.ncbi.nlm.nih.gov/books/NBK560624/

36. Moores J. (2013). Vitamin C: a wound healing perspective. Br J Community Nurs. (Suppl:S6):S8-S11.

37. Camilleri M, Atieh J. (2021). New Developments in Prokinetic Therapy for Gastric Motility Disorders. Front Pharmacol. 12:711500.

38. Nankervis H, Thomas KS, Delamere FM, et al. (2016). Scoping systematic review of treatments for eczema. NIHR Journals Library. Chapter 5: Emollients and other topical treatments. (Programme Grants for Applied Research, No. 4.7). Southampton, UK. Available at: https://www.ncbi.nlm.nih.gov/books/NBK363123/

39. Camilleri M, Parkman HP, Shafi MA, Abell TL, Gerson L; American College of Gastroenterology. (2013). Clinical guideline: management of gastroparesis. Am J Gastroenterol. 108(1):18-37.

40. Worthington PH, Gilbert KA. (2012). Parenteral nutrition: risks, complications, and management. J Infus Nurs. 35(1):52-64.

41. Waseem S, Moshiree B, Draganov PV. (2009). Gastroparesis: current diagnostic challenges and management considerations. World J Gastroenterol. 15(1):25-37.

42. Zheng T, Camilleri M. (2021). Management of Gastroparesis. Gastroenterol Hepatol (N Y). 17(11):515-525.

43. Usai-Satta P, Bellini M, Morelli O, Geri F, Lai M, Bassotti G. (2020). Gastroparesis: New insights into an old disease. World J Gastroenterol. 26(19):2333-2348.

44. Flanagan RF, Cai JX. (2023). Untangling the Link Between Gastroparesis, Micronutrient Deficiency, and Hair Loss. Dig Dis Sci. 68(4):1086-1088.

45. Cristofori F, Dargenio VN, Dargenio C, Miniello VL, Barone M, Francavilla R. (2021). Anti-Inflammatory and Immunomodulatory Effects of Probiotics in Gut Inflammation: A Door to the Body. Front Immunol. 12:578386.

46. Sanders ME, Merenstein DJ, Reid G, Gibson GR, Rastall RA. (2019). Probiotics and prebiotics in intestinal health and disease: from biology to the clinic. Nat Rev Gastroenterol Hepatol. 16(10):605-616.

47. Camilleri M, Kuo B, Nguyen L, Vaughn VM, Petrey J, Greer K, et al. (2022). ACG Clinical Guideline: Gastroparesis. Am J Gastroenterol. 117(8):1197-1220.

48. Lacy BE, Tack J, Gyawali CP. (2022). AGA Clinical Practice Update on Management of Medically Refractory Gastroparesis: Expert Review. Clin Gastroenterol Hepatol. 20(3):491-500.

49. Camilleri M. (2016). Novel Diet, Drugs, and Gastric Interventions for Gastroparesis. Clin Gastroenterol Hepatol. 14(8):1072-1080.

50. Bin BH, Bhin J, Kim NH, Lee SH, Jung HS, Seo J, et al. (2017). An Acrodermatitis Enteropathica-Associated Zn Transporter, ZIP4, Regulates Human Epidermal Homeostasis. J Invest Dermatol. 137(4):874-883.

51. Saritha M, Gupta D, Chandrashekar L, Thappa DM, Rajesh NG. (2012). Acquired zinc deficiency in an adult female. Indian J Dermatol. 57(6):492-494.

52. Ahmed SS, El-Hafez HAA, Mohsen M, El-Baiomy AA, Elkhamisy ET, El-Eshmawy MM. (2023). Is vitamin B12 deficiency a risk factor for gastroparesis in patients with type 2 diabetes? Diabetol Metab Syndr. 15(1):33.

53. Al-Awami HM, Raja A, Soos MP. (2023). Physiology, gastric intrinsic factor. In: StatPearls [Internet]. StatPearls Publishing. Available at: https://www.ncbi.nlm.nih.gov/books/NBK546655/

54. Eseonu D, Su T, Lee K, Chumpitazi BP, Shulman RJ, Hernaez R. (2022). Dietary Interventions for Gastroparesis: A Systematic Review. Adv Nutr. 13(5):1715-1724.

55. Gao T, Wang X, Li Y, Ren F. (2023). The Role of Probiotics in Skin Health and Related Gut-Skin Axis: A Review. Nutrients. 15(14):3123.

56. Woodhouse S, Hebbard G, Knowles SR. Psychological controversies in gastroparesis: A systematic review. World J Gastroenterol. 2017 Feb 21;23(7):1298-1309.