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Marjolin Ulcer: Pathogenesis, Clinical Features, and Management in Chronic Wounds- An Updated Review

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Abstract

Background: Marjolin ulcer is an aggressive cutaneous malignancy that develops within chronically injured, inflamed, or scarred tissue, most commonly arising from burn scars but also associated with chronic wounds, venous ulcers, osteomyelitis, pressure sores, and radiation-induced injury. These malignancies—predominantly squamous cell carcinoma—demonstrate high metastatic potential, recurrence rates, and poor overall prognosis.

Aim: This review aims to synthesize updated evidence on the etiology, epidemiology, pathophysiology, clinical features, diagnostic evaluation, management strategies, and prognosis of Marjolin ulcers to support improved recognition and management.

Methods: A comprehensive narrative review was conducted using current literature describing malignancies arising in chronic scars and wounds. Key themes include biological mechanisms, histopathology, diagnostic standards, and therapeutic approaches, including surgery, radiotherapy, and adjuvant therapies.

Results: Marjolin ulcers are most frequently squamous cell carcinomas (80–90%), followed by basal cell carcinoma and melanoma. They typically appear decades after the initial injury, exhibit rapid local invasion, and metastasize in up to 40% of cases. Prognosis is significantly worse than de novo cutaneous malignancies. Wide local excision with 2–3 cm margins remains the gold standard, while amputation is reserved for extensive or unresectable disease. Adjuvant radiotherapy and chemotherapy are indicated in high-risk or inoperable cases. Emerging immunotherapies show promise but require further evaluation.

Conclusion: Early detection, timely biopsy, and complete excision are critical to reducing morbidity, recurrence, and mortality. Management requires a multidisciplinary team and rigorous long-term follow-up due to high recurrence and metastatic potential.

Keywords: Marjolin ulcer; chronic wounds; squamous cell carcinoma; burn scars; malignant transformation; wide local excision; recurrence; metastasis.

Introduction

A Marjolin ulcer, historically described by French surgeon Jean Nicolas Marjolin, originally denoted a squamous cell carcinoma arising within a chronic burn scar. Over time, the concept has expanded to encompass all forms of malignancy that develop in previously injured, chronically inflamed, or otherwise compromised tissue. Although squamous cell carcinoma remains the predominant histological type, a spectrum of cutaneous malignancies, including basal cell carcinoma and melanoma, has been identified in the context of chronic wounds, trauma, osteomyelitis, and other long-standing ulcers [1][2]. Anatomically, Marjolin ulcers most frequently involve the lower extremities, followed by the head and neck region, upper limbs, and trunk, with infrequent manifestations on the face, foot, and digits [3]. These lesions are characterized by aggressive behavior, a tendency for local invasion, high rates of recurrence, and a comparatively poorer prognosis than primary cutaneous malignancies arising de novo. Marjolin ulcers may present decades after the initiating injury,

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reflecting the protracted latency between tissue insult and malignant transformation. Conversely, a subset termed "acute" Marjolin ulcers may develop within months of injury and is often associated with basal cell carcinoma histology. Effective prevention relies on meticulous burn wound management, diligent long-term surveillance of chronic scars, and timely identification of early malignant changes, thereby mitigating associated morbidity and mortality [4]. Recognizing the potential for malignant conversion in chronic wounds remains essential for clinicians across specialties, particularly in populations with long-standing cutaneous injuries or chronic inflammatory conditions.

Etiology

The majority of Marjolin ulcers originate from burn scars, with malignant transformation reported in 0.7% to 2.0% of burn injuries that have healed by secondary intention [5][6][7]. Beyond burns, numerous other conditions predispose to malignant degeneration. Chronic traumatic wounds, venous stasis ulcers, osteomyelitic lesions, pressure sores, and skin altered by radiation dermatitis, insect bites, stings, or hidradenitis suppurativa have all been implicated [2][6][7][8]. Immunocompromised individuals demonstrate an elevated risk, likely due to impaired immune surveillance that facilitates neoplastic transformation [8]. Malignancy may also arise in mucosal surfaces subjected to chronic inflammation, such as the oral cavity affected by lichen planus, graft-versus-host disease, discoid lupus, or syphilis-related lesions, as well as in chronic follicular disorders like scalp cellulitis, which feature persistent sinus tracts and sterile abscesses [9]. Repeated pressure, friction, and chronic irritation contribute to a pro-carcinogenic environment in the skin, promoting cellular dysplasia and eventual malignant conversion [10][11]. Collectively, these etiological factors underscore the role of chronic inflammation, tissue hypoxia, and persistent cellular turnover in predisposing damaged tissue to neoplastic transformation, establishing a pathophysiological basis for Marjolin ulcer development across diverse clinical contexts.

Epidemiology

Marjolin ulcers predominantly affect individuals in the fifth decade of life, with men affected two to three times more frequently than women, a disparity attributed to the higher incidence of burns and traumatic injuries in males [3][12]. The condition shows no specific ethnic predilection, though cultural practices that predispose to burns or chronic injury influence regional prevalence. For instance, habitual use of heating pads correlates with a 6.8% prevalence of Marjolin ulcers in affected populations [3][12]. Latency between the initial injury and malignant transformation varies widely, ranging from five to fifty-one years, with a mean latency of approximately twenty-nine years. Older individuals tend to exhibit shorter latency periods, whereas younger patients may present decades after the inciting trauma [13][14][15]. Histologically, the majority of Marjolin ulcers are squamous cell carcinomas, though basal cell carcinomas and melanomas are also documented. Approximately 2.5% of all squamous cell carcinomas, representing 0.05% of lower extremity cutaneous squamous malignancies, arise in burn scars, while basal cell carcinoma accounts for 0.3% [5][16]. Chronic osteomyelitic lesions demonstrate a malignant transformation rate between 0.2% and 1.7%. Among chronic leg ulcers, one in three hundred harbors malignancy, with epidermoid carcinoma accounting for 0.21% to 0.34% of neoplasms originating in this context. Venous leg ulcers exhibit a 5.8% relative risk for transformation to nonmelanoma skin cancer compared to the general population [5][16]. Clinically, Marjolin ulcers demonstrate higher metastatic potential and recurrence rates than de novo cutaneous malignancies. Approximately 30% to 40% of squamous cell Marjolin ulcers metastasize, contrasting with 0.5% to 3% of non-Marjolin squamous cell carcinomas. Recurrence significantly elevates mortality risk relative to non-Marjolin cutaneous malignancies, emphasizing the aggressive nature of these lesions and the necessity for vigilant surveillance and timely surgical management [17].

Pathophysiology

The aggressive behavior of Marjolin ulcers is rooted in complex and multifactorial pathophysiologic mechanisms. Central to their development is the interplay between chronic inflammation, tissue hypoxia, and repeated cycles of injury and repair, which collectively foster a pro-oncogenic environment. Chronic inflammation stimulates persistent cellular proliferation and secretion of growth factors while simultaneously inhibiting apoptosis, thereby allowing abnormal cells to survive and accumulate genetic mutations over time [18]. Impaired immune surveillance within scarred tissue exacerbates this risk. Damage to local immune mechanisms, including reduced activity of Langerhans cells and natural killer cells, diminishes the ability to detect and eliminate transformed cells. Additionally, obliteration of local lymphatic vessels and poor perfusion further shield malignant cells from immune recognition, creating an immunologically privileged niche that promotes tumor survival and expansion [2][3]. Molecular dysregulation also plays a pivotal role. Alterations in cell adhesion molecules and upregulation of growth factors facilitate fibroblast-mediated epithelial-mesenchymal transition, a key process in tumor invasiveness and metastasis [19]. Mutations in tumor suppressor genes, such as TP53, and associations with HLA-DR4 contribute to a genetic predisposition for malignant transformation, as seen in syndromes like Li-Fraumeni [20]. Mutations affecting apoptotic pathways, including Fas receptor

(FasR) abnormalities, lead to decreased programmed cell death and uncontrolled cellular proliferation. Rapid cellular turnover during wound healing, particularly at ulcer margins, renders tissue highly susceptible to mutation accumulation. External factors such as ultraviolet radiation and repeated trauma further exacerbate this procarcinogenic milieu [3][16]. The histological and anatomical characteristics of chronic scars influence tumor behavior and spread. Malignant transformation is most common in full-thickness burns, likely due to extensive tissue destruction and prolonged inflammatory exposure [3][13]. Wounds spanning joint surfaces demonstrate increased susceptibility, attributed to persistent friction and mechanical stress that exacerbate cellular injury [21]. Metastatic dissemination primarily occurs through lymphatic channels rather than hematogenous routes, although the dense fibrous tissue surrounding ulcers may initially act as a mechanical or immunological barrier. Paradoxically, surgical excision may disrupt these barriers, potentially facilitating lymphatic spread [16]. Collectively, these mechanisms underline the unique aggressiveness, high recurrence, and metastatic potential of Marjolin ulcers, emphasizing the necessity for early recognition, rigorous surveillance, and definitive surgical management to mitigate morbidity and mortality.

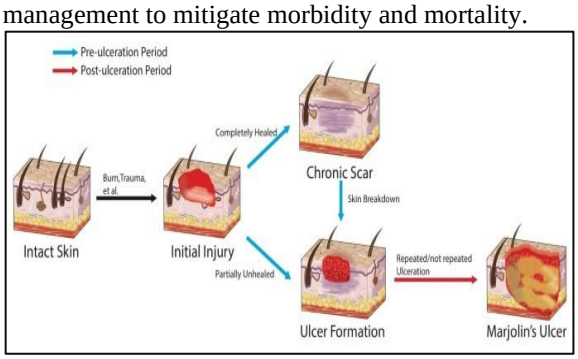

Fig. 1: Marjolin Ulcer.

Histopathology

Histopathologic evaluation of Marjolin ulcers demonstrates a predominance of squamous cell carcinoma, accounting for 80% to 90% of cases, with basal cell carcinoma comprising approximately 9.6% and melanoma around 2.45% of specimens [5][22]. Rarely, other malignancies such as sarcomas—including dermatofibrosarcoma, fibrosarcoma, angiosarcoma, osteosarcoma, malignant fibrous histiocytoma, liposarcoma, leiomyosarcoma, and malignant schwannoma—have been documented, highlighting the diverse oncologic potential of chronically injured or scarred tissue [5][22]. The lesions exhibit a spectrum of differentiation from well-differentiated to poorly-differentiated tumors, with squamous cell carcinoma presenting as irregular squamous cells demonstrating increased mitotic activity. Grading of squamous cell carcinoma follows a scale from I to III based on the proportion of well-differentiated cells, where grade I comprises 75% well-differentiated cells, grade II ranges from 25% to 75%, and grade III contains less than 25% well-differentiated cells [13]. Well and moderately-differentiated squamous carcinomas often display pseudo-epitheliomatous hyperplasia with increased epidermal thickness and irregular proliferation, minimal cytologic atypia, and variable monocyte infiltration, which may mimic benign reparative changes in chronic scars but should raise suspicion for early malignant transformation. The underlying scar tissue is characterized by dense, irregular collagen, providing a unique stromal environment for malignant proliferation. In lesions arising secondary to radiation dermatitis, basal cell carcinoma is more frequently observed, with histology demonstrating dermal islands of basaloid cells embedded within a mucinous stroma. The basaloid tumor cells are typically round with hyperchromatic nuclei and elevated mitotic activity, while adjacent adnexal structures such as hair follicles and sweat glands often remain preserved [16]. Basosquamous carcinoma represents a hybrid form with both basal and squamous histologic features and is associated with a high metastatic potential. Cytologically, these lesions resemble squamous carcinoma, complicating differentiation and underscoring the aggressive behavior of such tumors. Distinctions between Marjolin-associated squamous cell carcinoma and de novo cutaneous squamous malignancies are clinically and therapeutically significant. De novo cutaneous squamous cell carcinomas commonly arise in sun-exposed areas, exhibit solar elastosis, and demonstrate favorable responsiveness to immunotherapeutic interventions such as programmed cell death protein 1 (PD-1) blockade. In contrast, Marjolin ulcers develop within chronically scarred or inflamed tissue, often lacking prior solar damage, and generally show poor responsiveness to PD-1-directed therapy [23]. This histopathologic and molecular divergence emphasizes the importance of accurate tumor characterization in guiding treatment decisions and prognostication in patients with chronic wound-associated malignancies.

History and Physical

Patients presenting with a Marjolin ulcer typically report a chronic wound, burn scar, traumatic lesion, or other area of prior tissue injury that has failed to heal over an extended period. A hallmark feature is the observation of new changes within the lesion, which may include ulceration, pain, spontaneous bleeding, serous or purulent drainage, or an increase in size and exophytic growth [20]. The lower extremities are the most commonly affected sites, followed by the scalp, upper extremities, torso, and, less frequently, the face [6][22]. Clinicians should maintain a high index of suspicion for malignant transformation when a longstanding scar or chronic wound develops a nonhealing, indurated, or ulcerative lesion [5][15]. Marjolin ulcers can manifest as two primary forms: an exophytic variant, often milder and more localized, and the classic ulcerative type, which is more common, poorly differentiated histologically,

and associated with a worse prognosis due to early tissue invasion at diagnosis. During physical examination, careful attention should be directed toward all scars and chronic wounds, noting any changes from prior evaluations and assessing for regional or systemic lymphadenopathy [24]. In some cases, superimposed infection may be the first clinical indication of malignant transformation, particularly in burn scars that are raised above surrounding skin and prone to chronic irritation [3]. Lesions often present as ulcerative, irregularly shaped, foul-smelling areas with surrounding induration and rolled, elevated margins [15]. Additional clinical features that may suggest Marjolin ulcer development include exophytic granulation tissue, persistent bleeding, poor response to standard wound care measures, and palpable regional lymph nodes, which occur in approximately one-third of patients [3][6][7][22]. Recognition of these historical and physical findings is critical for early diagnosis, as delayed detection is strongly associated with poor outcomes, including aggressive local invasion and a higher likelihood of metastasis. Clinicians should maintain vigilance in patients with chronic scars or nonhealing wounds, particularly those arising from burns or traumatic injuries, to ensure timely biopsy, histopathologic evaluation, and initiation of definitive management. Early detection and monitoring of changes in chronic lesions can significantly impact prognosis and reduce the morbidity and mortality associated with Marjolin ulcer.

Evaluation

The evaluation of suspected Marjolin ulcers begins with a high degree of clinical suspicion in any chronic, nonhealing, ulcerative, or irregular lesion arising within or adjacent to a scar. Definitive diagnosis requires histopathological confirmation, typically obtained through excisional, incisional, or punch biopsy. When incisional or punch biopsies are performed, sampling should be comprehensive, often including multiple sites across a four-quadrant distribution to capture potential heterogeneity within the lesion and avoid underdiagnosis [6][25]. Assessment of local and regional lymph nodes is essential, as Marjolin ulcers have a higher metastatic potential compared with primary cutaneous malignancies. Ultrasound and lymphatic mapping are commonly employed to evaluate nodal involvement. In certain cases, a sentinel lymph node biopsy may be indicated prior to excisional or incisional biopsy to guide staging, detect occult metastasis, and inform surgical planning [6][25]. Imaging studies serve a complementary role in defining the extent of disease and detecting potential metastases. Plain radiography can help identify bony involvement, whereas computed tomography (CT) and magnetic resonance imaging (MRI) provide detailed information on soft tissue invasion, depth of the lesion, and anatomical relationships critical for surgical planning. Positron emission tomography (PET) may be used in select cases to detect distant metastatic disease and evaluate for occult lesions, particularly in patients with aggressive or recurrent disease [20][26]. A comprehensive evaluation integrates biopsy, nodal assessment, and imaging to determine both local and systemic involvement. Early and thorough diagnostic work-up is essential, as delayed recognition can result in more extensive tissue invasion, higher rates of regional metastasis, and poorer overall prognosis. This multidisciplinary diagnostic approach ensures that appropriate staging, surgical planning, and adjuvant therapies are implemented to optimize patient outcomes.

Treatment / Management

The management of Marjolin ulcers emphasizes prevention and early recognition as primary strategies for reducing morbidity and improving outcomes. Chronic wounds, burn scars, and other tissue injuries that have a prolonged healing course should undergo regular surveillance, including routine clinical examination, patient education regarding warning signs, and, when appropriate, prophylactic excision with reconstruction to eliminate tissue at risk for malignant transformation [3]. Despite the recognition of these preventive measures, there is currently no universally accepted, standardized protocol for the treatment of Marjolin ulcers, reflecting both the rarity of the condition and the variability in presentation [5]. For localized, nonmetastatic disease, the mainstay of treatment is wide local excision. Surgical margins are typically 2 cm to 3 cm, with many clinicians recommending a 3 cm margin to reduce recurrence risk. Intraoperative frozen section analysis is often employed to confirm negative margins and ensure complete resection. Lesions confined to the subcutaneous tissue are excised down to the fascia, whereas those infiltrating fascia or muscle require excision to the periosteum. Amputation is generally reserved for cases involving extensive bony invasion or when wide local excision is not feasible due to anatomical or functional limitations [27]. While amputation can sometimes reduce recurrence rates, studies have reported mixed results, with some showing no difference or even higher recurrence compared with wide local excision [13]. Lymph node involvement, identified through clinical or imaging assessment, is managed with lymphadenectomy, either alone or combined with adjuvant radiation therapy, though prophylactic lymph node dissection remains controversial [6][16][25][28].

Nonexcisional interventions, including curettage, cryotherapy, or limited debridement, are generally discouraged because Marjolin ulcers frequently extend into deep tissue and such approaches do not achieve oncologic clearance. Mohs micrographic surgery can be considered in anatomically sensitive regions, such as the face, scalp, hands, feet, or areolae, to maximize tissue preservation

while achieving margin control [29][30]. Following any intervention, strict surveillance is necessary due to the high propensity for recurrence. Recommended follow-up includes clinical evaluation every two weeks for the initial two months, every two months for six months, and every six months for up to five years, with imaging or laboratory evaluation performed if there is any suspicion of recurrent disease [3][16]. Adjuvant and neoadjuvant therapies lack robust evidence from randomized controlled trials, but they are indicated in select high-risk scenarios, including lesions greater than 10 cm, tumors of the head and neck with nodal involvement, or cases where surgery is not feasible. Chemotherapeutic strategies include systemic or topical agents such as 5-fluorouracil, cisplatin, methotrexate, bleomycin, l-phenylalanine, and other platinum-based therapies [5][25]. Radiotherapy is typically reserved for recurrent disease, high-grade or poorly differentiated tumors, lesions not amenable to surgery, or patient refusal of surgical intervention [16]. Hyperthermic intraarterial limb perfusion with methotrexate is an option in selected extremity lesions. Surgical excision effectively addresses lymphatic spread in 40% to 45% of patients, but adjuvant radiotherapy remains critical for controlling disease progression in the remaining cohort [6]. Emerging immunotherapies, particularly immune checkpoint inhibitors such as cemiplimab and pembrolizumab, have demonstrated preliminary efficacy in metastatic squamous cell Marjolin ulcers. These therapies exploit the immunogenic nature of the tumor, though further studies are needed to validate long-term efficacy, determine optimal regimens, and address cost considerations [17]. In conclusion, management of Marjolin ulcers requires a tailored, multidisciplinary approach incorporating surgical excision, adjuvant therapy for high-risk cases, and rigorous follow-up to address the lesion's aggressive nature, minimize recurrence, and improve patient survival outcomes.

Differential Diagnosis

The evaluation of a suspected Marjolin ulcer requires careful consideration of a broad range of differential diagnoses, as many chronic or ulcerative lesions of the skin can mimic malignant transformation. Chronic pressure ulcers, particularly those arising in immobile or debilitated patients, may present with induration, necrotic tissue, or secondary infection, closely resembling the ulcerative phenotype of a Marjolin lesion. Similarly, abscesses and other localized infections can produce erythema, tenderness, and purulent drainage, complicating early recognition of malignant degeneration within a scar or chronic wound [29]. Vascular pathologies such as arterial or venous insufficiency should also be considered, as ischemic ulcers may persist for extended periods and display slow healing, hyperkeratotic borders, or necrotic tissue, potentially overlapping with the clinical presentation of a Marjolin ulcer. Inflammatory and autoimmune conditions are additional considerations. Vasculitis can produce ulcerative lesions with irregular borders, necrotic tissue, or regional pain, and may coexist with systemic manifestations that can guide diagnosis. Contact dermatitis and chronic inflammatory dermatological disorders may also mimic Marjolin ulcers, particularly in patients with repeated irritation or chemical exposure, producing erythema, ulceration, or hyperpigmentation over scarred tissue. Precancerous or malignant lesions, including actinic keratosis, Bowen disease (in situ squamous cell carcinoma), atypical fibroxanthoma, and other skin cancers, can present as persistent nonhealing lesions with irregular margins, raised edges, or friable tissue, underscoring the need for histopathologic confirmation. Trauma-induced lesions, including chemical burns, thermal injuries, or mechanical disruption of skin and subcutaneous tissues, may simulate early Marjolin ulcer features, particularly if healing is delayed or complicated by infection. Benign growths such as dermatofibromas, epidermal inclusion cysts, and hypertrophic scars may also present with induration or focal ulceration, requiring careful differentiation. Accurate diagnosis relies on a combination of patient history, including the chronicity of the wound, progression of symptoms, and predisposing factors, alongside targeted histological and imaging studies to distinguish malignant transformation from other chronic or reactive skin pathologies [31].

Radiation Oncology

Radiation therapy is an important adjunctive modality in the management of Marjolin ulcers, particularly for cases where surgical excision is not feasible, the tumor demonstrates aggressive or high-grade histology, or lymph node involvement is present. The suggested therapeutic dose for cutaneous lesions exceeding 2 cm ranges from 5000 to 6000 cGy, delivered in daily fractions of approximately 250 cGy [16]. This fractionation allows for maximal tumoricidal effects while minimizing damage to surrounding healthy tissues, an important consideration given the frequent proximity of Marjolin ulcers to underlying fascia, muscle, or bone. Radiation therapy can also serve as an adjuvant following surgical excision to reduce the risk of local recurrence, particularly in poorly differentiated lesions or those with positive or close margins on histopathology. In situations of advanced disease or inoperable tumors, radiotherapy may provide both local control and symptomatic relief, particularly when the lesion is ulcerative or prone to bleeding, exudation, or secondary infection. Hypofractionated or higher-dose regimens are occasionally considered for palliation, depending on tumor size, location, and patient comorbidities. The precise planning of radiation fields is critical to protect adjacent vital structures, especially in lesions of the head, neck, or distal extremities, where functional and cosmetic outcomes are paramount. Modern techniques such as intensity-modulated radiation therapy (IMRT) and image-

guided radiation therapy (IGRT) enable precise targeting of the lesion while sparing surrounding normal tissues, reducing the risk of radiation-induced complications such as fibrosis, ulceration, or secondary malignancy. Multidisciplinary coordination between surgical, medical, and radiation oncology teams is essential to ensure optimal timing and integration of radiotherapy with other interventions, including surgical excision and lymph node management. Continuous follow-up with imaging and clinical assessment is recommended to monitor for recurrence or radiation-related adverse effects, providing an integrated strategy for controlling both primary tumor progression and potential metastatic spread [16].

Staging

Marjolin ulcers lack a disease-specific TNM staging system, and therefore, the staging of these malignancies is generally guided by the histopathologic diagnosis of the lesion. When biopsy confirms squamous cell carcinoma, clinicians typically apply the staging criteria outlined by the American Joint Committee on Cancer (AJCC) for cutaneous squamous cell carcinoma. This approach allows the tumor to be classified according to size, depth of invasion, involvement of regional lymph nodes, and the presence of distant metastases, providing a standardized framework for prognostication and management. Tumor thickness, perineural invasion, and differentiation grade are particularly relevant, as higher-grade lesions correlate with increased aggressiveness and metastatic potential. Although basal cell carcinomas and melanomas arising in Marjolin ulcers can also be staged using existing AJCC criteria, squamous cell carcinoma remains the most common histologic subtype, accounting for the majority of cases. In the absence of a dedicated staging system for Marjolin ulcers, utilizing established cutaneous malignancy criteria facilitates consistent reporting, guides surgical planning, and informs the need for adjunctive therapies such as lymphadenectomy, radiation, or systemic treatment. This histopathology-based approach remains the cornerstone for stratifying risk and tailoring individualized management in patients with Marjolin ulcers [5].

Prognosis

The clinical outcomes of Marjolin ulcers are generally unfavorable compared with de novo cutaneous malignancies, reflecting their aggressive biological behavior and delayed diagnosis. Patients with well-differentiated Marjolin ulcers demonstrate a 3-year survival rate ranging from 65% to 75%, while the 5-year survival decreases to 43% to 58% [29]. The presence of metastases at diagnosis significantly worsens prognosis, with a 3-year survival rate between 35% and 50%. Long-term survival data indicate an overall 20-year survival of approximately 52%, which declines to 23% among those presenting with metastatic disease. The histopathologic differentiation of the tumor remains a critical determinant of outcome, as poorly differentiated lesions are associated with higher rates of metastatic progression and mortality [17]. Tumor size and depth are also recognized as important prognostic indicators. European guidelines, including those from the European Dermatology Forum, European Association of Dermato-Oncology, and European Organisation for Research and Treatment of Cancer, emphasize that tumors exceeding 2 cm in diameter or demonstrating invasion greater than 6 mm are correlated with poorer outcomes [17]. The risk of metastatic disease varies according to the underlying etiology, being highest for Marjolin ulcers arising from pressure sores, followed by burn-related lesions. Overall, metastatic spread occurs in 27.5% to 40% of cases, with squamous cell carcinoma accounting for up to 27% of metastases in Marjolin ulcers compared to only 3% in non-Marjolin squamous cell carcinomas [6][15][22]. The overall reported mortality of Marjolin ulcers is 21%, highlighting the aggressive nature of these lesions. Specific anatomic locations, such as head and neck Marjolin ulcers, carry a particularly poor prognosis due to their aggressiveness, limited response to chemoradiation, and high recurrence risk [13]. Clinical cases illustrate these challenges, such as a 20-year-old patient who developed a scalp Marjolin ulcer from a burn sustained at age three. Despite extensive interventions including surgical excision, brachytherapy, chemoradiation, metastectomy, and neck dissection, the patient experienced locoregional and systemic metastases [17]. Recurrence rates after surgical resection are reported to approach 50%, with 5-year survival among patients with recurrence ranging from 20% to 50% and 10-year survival approximately 34%. Postoperative lymphatic invasion further portends a poor prognosis, with a 3-year survival rate of 35% to 50% and rapid clinical deterioration [3][16]. These data underscore the importance of early detection, complete excision, and vigilant follow-up in managing Marjolin ulcers.

Complications

Marjolin ulcer represents a serious long-term complication arising from chronic scars, burn sites, or areas subject to repeated trauma and inflammation. The malignancy often develops insidiously in tissue that has undergone incomplete healing or chronic irritation, which can complicate the clinical course. One of the primary complications is infection, which may arise due to ulceration, necrotic tissue, or repeated trauma to the lesion. Secondary infections increase morbidity, delay healing, and may obscure early recognition of malignant changes, leading to further diagnostic delays [32]. Functional compromise is another critical issue, particularly when the ulcer affects weight-bearing areas, joints, or regions involved in mobility or dexterity. Lesions on the extremities may interfere with ambulation or hand

function, while those on the face or scalp may compromise sensory or motor function, depending on proximity to neural structures. Cosmetic disfigurement is also a significant concern, as the lesions are often ulcerative, exophytic, and irregular, creating aesthetic challenges that may impact social and psychological well-being. In addition, Marjolin ulcers exhibit a high propensity for local tissue invasion and metastasis, particularly to regional lymph nodes, which further complicates clinical management and worsens prognosis [32]. Recurrence after surgical excision remains a notable complication, with reported rates approaching 50%, underscoring the importance of comprehensive surgical margins and ongoing surveillance. Other complications include delayed wound healing due to chronic inflammation and tissue fibrosis, as well as potential for amputation in cases of extensive or deep invasion. The combination of functional, cosmetic, infectious, and metastatic risks emphasizes the importance of early recognition and aggressive management to mitigate long-term morbidity [32].

Consultations

Management of a patient with a Marjolin ulcer requires coordinated consultation across multiple specialties to optimize outcomes. Dermatology and dermatopathology play central roles, providing expertise in lesion assessment, biopsy interpretation, and identification of atypical or early malignant changes. Dermatopathologists are particularly critical for distinguishing between benign scar-related changes and early malignant transformation, ensuring accurate histopathologic diagnosis [3]. Surgical consultations are often essential, with general, orthopedic, and plastic surgeons collaborating on excision strategies, reconstructive planning, and optimization of functional and cosmetic outcomes. Plastic surgery may be required for complex closures, skin grafting, or flap reconstruction, particularly for large defects or lesions in anatomically sensitive regions. Orthopedic input is necessary when lesions involve extremities, joints, or bony structures, as Marjolin ulcers may invade deep tissues requiring amputation or extensive resection [6][25]. Oncology consultations, including medical and radiation oncology, are important in the context of nodal involvement, high-grade tumors, or metastatic disease, providing guidance on adjuvant therapy, chemoradiation, or systemic management. Coordination with radiology is critical for imaging evaluation to assess tumor extent, lymphatic spread, or distant metastases, while pathology teams guide both staging and margin assessment during surgical intervention. A multidisciplinary approach ensures that patients receive individualized care that addresses oncologic control, functional preservation, and aesthetic considerations, improving both short-term outcomes and long-term survival [3][6][25].

Patient Education

Patient education and preventive measures are central to reducing the incidence of Marjolin ulcer in individuals with chronic wounds, burn scars, or sites of repetitive trauma. Patients should be counseled to monitor scars and chronic wounds vigilantly, paying attention to any alterations in size, texture, pain, discharge, or bleeding, as these may indicate malignant transformation [24]. Education should emphasize that early recognition significantly improves prognosis, enabling timely intervention before deep tissue invasion or metastasis occurs. Scalp wounds and scars require particular attention due to the potential for rapid malignant progression and involvement of adjacent neural and vascular structures [1]. Patients should be advised to seek immediate evaluation for any nonhealing lesion or sudden change within a chronic scar. In addition to clinical vigilance, patients may benefit from guidance on general wound care, including the avoidance of repeated trauma, friction, or pressure that may exacerbate chronic inflammation. Reinforcing the importance of regular follow-up appointments, adherence to imaging protocols, and prompt reporting of suspicious symptoms is essential. Comprehensive education not only promotes early detection but also empowers patients to actively participate in their care, ultimately reducing morbidity and mortality associated with Marjolin ulcers [24].

Other Issues

Preventive surgical management of chronic wounds and scars remains a key strategy in reducing Marjolin ulcer formation. Thorough excision of burn wounds, chronic scars, and areas of incomplete healing, followed by grafting or reconstruction, has been shown to decrease the risk of malignant transformation [16]. In contrast, unreconstructed or poorly managed scars demonstrate a higher incidence of Marjolin ulcer, emphasizing the need for proactive intervention. Clinicians should maintain a high index of suspicion for any scar or wound that demonstrates persistent changes, including ulceration, induration, or exophytic growth, and biopsy should be performed systematically in a four-quadrant approach to minimize sampling error [9][24]. Because Marjolin ulcers carry a high risk of recurrence, routine post-treatment surveillance is critical. Current guidelines from the NCCN recommend clinical evaluation every 2 to 3 months in the first year, every 2 to 4 months in the second year, every 4 to 6 months in the third year, and every 6 to 12 months thereafter [17]. Amputation sites are particularly susceptible to malignant development due to friction, compression from prostheses, and chronic irritation, with multiple tumor types—including squamous, basal, lymphangiosarcoma, and melanoma—documented in such scars [18]. The overarching principle is that early identification, complete excision, and vigilant follow-up are paramount to minimizing morbidity, preventing metastasis, and improving long-term outcomes. Clinicians must remain alert to subtle changes in

chronic wounds and scars, recognizing that delay in diagnosis can significantly worsen prognosis [9][16][24].

Enhancing Healthcare Team Outcomes

Optimal management of Marjolin ulcer necessitates a coordinated, interprofessional team approach. Burn care specialists, plastic surgeons, orthopedic surgeons, dermatologists, and general surgeons collaborate to ensure complete excision, functional preservation, and effective reconstruction [29]. Radiation and medical oncologists provide guidance on adjuvant or palliative therapies in cases of nodal involvement or metastatic disease, while radiologists and pathologists ensure accurate staging, margin assessment, and histopathologic evaluation. Primary care providers maintain long-term follow-up and reinforce education regarding early warning signs. Effective communication and collaboration among these specialties allow for timely intervention, prevention of malignant transformation in chronic wounds, and ongoing surveillance post-treatment. Patient education is central to this model, emphasizing recognition of early changes in scars and chronic wounds, adherence to follow-up protocols, and avoidance of activities that may provoke recurrent trauma [29]. By integrating clinical expertise across disciplines, the interprofessional team ensures that management strategies address oncologic control, functional preservation, and psychosocial support, thereby improving overall patient outcomes and survival [3][29].

Conclusion:

Marjolin ulcer represents one of the most serious long-term complications of chronic wounds and scar tissue, characterized by delayed malignant transformation and aggressive biological behavior. Its development is driven by chronic inflammation, impaired immune surveillance, tissue hypoxia, and repeated cycles of injury and repair, creating an environment conducive to oncogenesis. Because clinical presentation often overlaps with benign chronic wound pathology, diagnosis is frequently delayed, contributing to the high rates of local invasion, metastasis, and recurrence. Early recognition remains the most important factor influencing patient outcomes. Any chronic wound or scar showing changes such as ulceration, increased size, bleeding, or induration should prompt immediate biopsy. Wide local excision remains the cornerstone of treatment, with reconstruction tailored to preserve function and aesthetics. High-risk cases benefit from adjuvant radiotherapy or systemic therapy, while emerging immunotherapies offer potential options for advanced disease. Given recurrence rates approaching 50% and significantly reduced survival in cases of nodal or distant spread, long-term surveillance is essential. A coordinated multidisciplinary approach—integrating dermatology, surgery, oncology, pathology, and radiology—optimizes diagnostic accuracy, therapeutic planning, and follow-up. Ultimately, increased awareness among clinicians and patients, coupled with proactive management of chronic wounds, is key to reducing the morbidity and mortality associated with Marjolin ulcers.

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