



# The Dermatologist's Role in Long-Term Surveillance of Burn Scars for Malignancy

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## Article Info

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## Abstract

Chronic burn scars represent a unique dermatologic substrate characterized by persistent inflammation, altered immune surveillance, and long-term structural skin changes that may predispose patients to cutaneous malignancy. Squamous cell carcinoma arising in burn scars, often referred to as Marjolin's ulcer, is a well-documented but frequently delayed diagnosis associated with aggressive behavior and poor outcomes. While acute burn management is typically overseen by burn specialists and reconstructive surgeons, long-term surveillance of healed burn scars often falls outside structured care pathways. Dermatologists are uniquely positioned to identify early malignant transformation within burn scars due to their expertise in skin cancer recognition and longitudinal outpatient follow-up. This mini-review summarizes the epidemiology and pathophysiology of burn scar-associated malignancy, highlights clinical features suggestive of malignant transformation, and proposes a dermatology-centered framework for surveillance and early intervention. Increased awareness of burn scars as oncogenic risk sites may improve diagnostic timeliness and patient outcomes.

## Introduction

Burn injuries affect millions of individuals worldwide and frequently result in permanent scarring.<sup>1</sup> While the acute management of burns is well-established within specialized burn centers, long-term follow-up after wound closure is inconsistent and often fragmented.<sup>2</sup> Many patients transition out of burn-specific care and subsequently rely on primary care physicians or dermatologists for management of post-burn sequelae, including pruritus, dyspigmentation, hypertrophic scarring, and cosmetic concerns.<sup>3</sup> Dermatologists therefore frequently encounter burn scars years after the initial injury, often outside of formal burn care pathways.<sup>4</sup>

Burn scars are not inert tissue. Instead, they represent chronically altered skin with ongoing inflammatory signaling, disrupted lymphatic drainage, reduced immune surveillance, and repeated mechanical or traumatic stress.<sup>5,6</sup> These factors contribute to a recognized, though underappreciated, risk of malignant transformation, most commonly squamous cell carcinoma (SCC).<sup>7,8</sup> Despite this risk, burn scars are not routinely conceptualized as high-risk oncologic sites in dermatologic practice, and no standardized surveillance recommendations currently exist.<sup>9</sup>

Unlike ultraviolet-driven cutaneous malignancies, cancers arising in burn scars develop within previously injured skin characterized by fibrosis and chronic inflammation.<sup>8</sup> The prolonged

latency between burn injury and malignant transformation further contributes to under-recognition, as both patients and clinicians may incorrectly assume that risk diminishes once the acute injury has healed.<sup>10</sup> As a result, burn scars often fall outside established skin cancer surveillance paradigms despite mounting evidence supporting their classification as high-risk cutaneous sites.<sup>11</sup>

While prior reviews of burn scar-associated malignancy have primarily emphasized surgical management, oncologic outcomes, or wound biology, fewer have addressed the role of dermatologists in long-term, outpatient surveillance after patients transition out of burn-centered care. This mini review reframes burn scars as persistent oncologic risk sites within routine dermatologic practice and focuses on the dermatologist's unique position to provide longitudinal monitoring, early recognition of malignant transformation, and timely referral. By centering surveillance within standard dermatologic workflows rather than episodic detection, this review offers a complementary, practice-oriented perspective to the existing literature.

### Literature Search Strategy

This narrative mini review synthesizes findings from previously published reviews, observational studies, and case series identified through targeted searches of PubMed and Google Scholar within the dermatologic and burn literature, with primary focus on clinically relevant patterns rather than systematic evidence synthesis.

### Epidemiology of Burn Scar-Associated Malignancy

The most commonly reported malignancy arising in burn scars is cutaneous SCC, though basal cell carcinoma, melanoma, and sarcoma have also been described.<sup>7,9,12,13</sup> The incidence of malignant transformation within burn scars has been estimated at approximately 1–2%, with SCC accounting for the majority of reported cases.<sup>8</sup> Although relatively uncommon, these malignancies are clinically significant due to their aggressive behavior and tendency toward delayed diagnosis.<sup>14</sup>

Latency periods for burn scar-associated malignancy are highly variable, with reported intervals ranging from 10 to over 40 years following the initial injury.<sup>10,15,16</sup> This prolonged latency poses a significant diagnostic challenge, as malignant transformation may occur decades after patients have disengaged from specialized burn care.<sup>17</sup> Lesions arising within burn scars are frequently diagnosed at advanced stages, with higher rates of local invasion and regional lymph node metastasis compared to conventional cutaneous SCC.<sup>12,15</sup>

Delayed diagnosis is often attributed to clinical overlap between malignant lesions and benign scar-related changes, including chronic ulceration, hypertrophy, intermittent breakdown, and secondary infection.<sup>18–20</sup>

Consequently, malignant transformation within burn scars may go unrecognized until invasive disease develops.

### Pathophysiologic Mechanisms of Malignant Transformation

Several mechanisms have been proposed to explain the oncogenic potential of burn scars. Chronic inflammation plays a central role, promoting sustained cytokine release, oxidative stress, and repeated cycles of tissue injury and repair.<sup>7,21</sup> Persistent inflammatory signaling may induce DNA damage via oxidative stress and genomic instability within keratinocytes, facilitating malignant transformation over time.<sup>22–24</sup> At the molecular level, chronic oxidative stress within burn scars may promote mutagenesis through sustained reactive oxygen species exposure, impaired DNA repair mechanisms, and accumulation of oncogenic mutations over time.<sup>25–27</sup> Persistent cytokine signaling and fibro-inflammatory remodeling further alter the local microenvironment, facilitating epithelial dysregulation and malignant progression.<sup>23</sup> Concurrent disruption of lymphatic architecture and antigen presentation diminishes immune-mediated tumor surveillance, allowing dysplastic keratinocytes to evade clearance.<sup>28,29</sup>

Burn scars also demonstrate altered local immune function characterized by diminished antigen presentation and impaired lymphatic drainage.<sup>21,30</sup> Fibrotic remodeling following burn injury disrupts normal dermal architecture, reducing immune cell trafficking and surveillance within scar tissue.<sup>31</sup> These changes may allow dysplastic cells to evade immune-mediated elimination.

Additionally, the avascular and fibrotic nature of scar tissue may facilitate unchecked tumor growth by limiting immune access and delaying clinical detection.<sup>12</sup> Repetitive mechanical trauma, friction, and ulceration of scarred skin further perpetuate epithelial instability and ongoing cycles of injury and repair.<sup>32,33</sup> Collectively, these factors create a permissive microenvironment for malignant transformation, distinguishing burn scars from other chronic inflammatory dermatoses and underscoring their unique oncogenic risk.

### Clinical Features Suggestive of Malignant Transformation

Dermatologists should maintain a higher index of suspicion when evaluating long-standing burn scars, particularly those demonstrating new or evolving features. Concerning clinical signs include non-healing ulceration, progressive induration or nodularity, rapid enlargement of a previously stable lesion, spontaneous bleeding, foul-smelling discharge, and new or worsening pain within scar tissue.<sup>8,12,18</sup>

Because burn scars often exhibit baseline irregularity and textural change, malignant transformation may

present subtly. Persistent ulceration or focal change within a stable scar should prompt further evaluation. A low threshold for biopsy is essential, as early malignant lesions may be clinically indistinguishable from benign scar-related breakdown;<sup>12</sup> however, biopsy decisions should be individualized and guided by clinical concern. Although biopsy of scar tissue may contribute to additional scarring, the risk of delayed diagnosis and progression of invasive malignancy generally outweighs procedural morbidity when malignant transformation is suspected.

### The Dermatologist's Role in Surveillance

Dermatologists are uniquely positioned to provide longitudinal surveillance of burn scars due to their expertise in skin cancer detection and accessibility within outpatient care settings. Patients frequently present to dermatologists years after burn injury for cosmetic or symptomatic concerns, offering an opportunity for incidental surveillance that may otherwise be missed.<sup>4,34</sup>

Incorporating burn scar assessment into routine full-body skin examinations may facilitate earlier diagnosis of malignant transformation.<sup>35</sup> This role aligns with dermatology's established responsibilities in monitoring other high-risk populations, including patients with chronic ulcers, immunosuppression, and extensive actinic damage.<sup>36,37</sup>

### Proposed Dermatologic Surveillance Approach for Burn Scars

In the absence of formal surveillance guidelines, dermatologists may adopt a pragmatic, risk-informed approach to burn scar monitoring. Extensive scars, scars with a history of chronic ulceration, and scars located in areas subject to repeated friction or trauma may warrant closer observation.<sup>8,10</sup>

In practice, annual inspection of mature burn scars

during full-body skin examinations may be reasonable for most patients, with shorter follow-up intervals considered for extensive scars, scars with prior ulceration, or those subject to repeated trauma. Escalation of evaluation should be prompted by focal change, persistent ulceration, new induration, or pain, with biopsy or referral pursued based on clinical judgment. These considerations are intended to support risk-informed surveillance rather than establish prescriptive guidelines.

Annual full-body skin examinations should include deliberate inspection and palpation of burn scars, with particular attention to areas of induration, nodularity, or surface change.<sup>38</sup> A low threshold for biopsy is warranted, as early malignant transformation may present subtly within fibrotic tissue.<sup>12</sup> Patient education is equally critical; individuals with burn scars should be counseled to report new pain, non-healing ulcers, bleeding, or rapid changes in scar appearance. Key clinical features and surveillance considerations are summarized in **Table 1**.

This table summarizes commonly reported risk characteristics, concerning clinical changes, and practical surveillance considerations relevant to dermatologic evaluation of long-standing burn scars. The information is derived from previously published literature and is intended to support clinical awareness rather than to establish formal surveillance guidelines.

### Barriers to Effective Surveillance

Several barriers limit effective dermatologic surveillance of burn scars, including limited provider awareness, perceived rarity of malignant transformation, and lack of standardized follow-up pathways after burn center discharge.<sup>30,39</sup> Geographic disparities in burn care access further compound these challenges, particularly in rural or underserved regions where dermatologists may be the primary specialists available.<sup>40</sup>

**Table 1.** Clinical Features and Surveillance Considerations for Malignant Transformation in Burn Scars

Category	Key Features	Clinical Pearl for the Dermatologist
High-risk burn scar characteristics	Extensive surface area; long-standing scars; history of chronic ulceration; scars exposed to repeated friction or trauma. <sup>7,8,10,42</sup>	May warrant closer clinical monitoring and prompt evaluation for biopsy if focal change develops
Concerning clinical changes	Non-healing ulceration; new nodularity or induration; rapid lesion growth; spontaneous bleeding; foul-smelling discharge; new or worsening pain. <sup>12,18,20,29</sup>	Should prompt urgent dermatologic evaluation with low threshold for biopsy
Latency considerations	Malignant transformation may occur decades after initial burn injury. <sup>10,15,43,44</sup>	Long-term surveillance remains important even many years post-burn
Common malignancies	Squamous cell carcinoma (most common); less commonly basal cell carcinoma, melanoma, or sarcoma. <sup>7,12,13,35,45</sup>	Awareness of aggressive behavior and higher metastatic potential is essential
Role of dermatologic surveillance	Routine inspection during full-body skin exams; patient education on warning signs. <sup>4,34</sup>	Early detection may reduce diagnostic delay and improve outcomes
Referral considerations	Suspicion for invasive disease; rapidly progressive lesions; biopsy-confirmed malignancy. <sup>10,30</sup>	Prompt referral to surgical oncology or reconstructive surgery is recommended once malignancy is suspected or confirmed

Educational gaps within dermatology training may also contribute to inconsistent surveillance practices. Burn-related content is inconsistently represented in graduate and continuing medical education,<sup>39,41</sup> leading to variability in provider confidence and recognition of burn scars as oncologic risk sites.<sup>39,41</sup>

### Future Directions

Future research should prioritize longitudinal studies assessing malignancy incidence within burn scars and identifying injury-specific risk factors that may warrant intensified surveillance. Registry-based analyses and prospective cohort studies may inform evidence-based surveillance recommendations. Educational initiatives targeting dermatologists and trainees may further enhance early recognition and referral patterns.

### Conclusion

Burn scars represent an underrecognized oncologic risk site within dermatologic practice. Given the prolonged latency of malignant transformation and the aggressive behavior of burn scar-associated SCC, dermatologists play a critical role in early detection and surveillance. Integrating burn scar assessment into routine dermatologic care may improve diagnostic timeliness and reduce morbidity associated with delayed cancer diagnosis. Recognizing burn scars as persistent oncologic risk sites and integrating their assessment into routine dermatologic care may facilitate earlier detection, reduce diagnostic delay, and improve outcomes for this under-recognized patient population.

### Conflicts of Interest

Richard Moraga has no conflicts of interest to disclose.

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### Declaration of Generative AI and AI-Assisted Technologies

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### Reprint requests

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### Author Contributions

Author R.M. is solely responsible for this study's conception, design, and analysis, as well as for all versions of the manuscript.

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