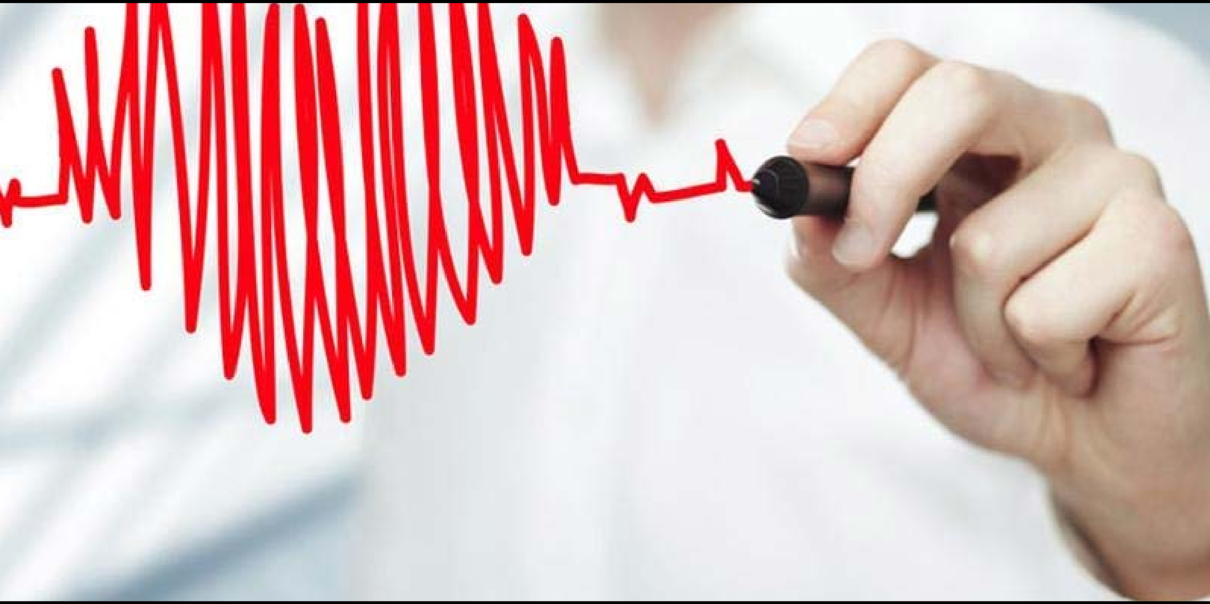
IMAGING IN DERMATOLOGIC NEOPLASMS

A Comprehensive Guide for Clinicians, Radiologists, and Oncologic Teams



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Assist. Prof. Dr. Betül TİRYAKİ BAŞTUĞ

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Imaging in Dermatologic Neoplasms: A Comprehensive Guide for Clinicians, Radiologists, and Oncologic Teams

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Imaging in Dermatologic Neoplasms: A Comprehensive Guide for Clinicians, Radiologists, and Oncologic Teams

Introduction

Betül Tiryaki Baştuğ

Dermatologic neoplasms represent a complex and heterogeneous group of tumors arising from the epidermal, dermal, adnexal, and subcutaneous tissues. Although many skin lesions are readily visible and accessible to clinical examination, their true biological behavior, depth of invasion, and extent of spread often cannot be accurately determined by inspection or palpation alone. As the global incidence of both benign and malignant skin tumors continues to increase—driven by rising ultraviolet exposure, aging populations, improved screening, and heightened public awareness—the role of radiologic imaging in dermatologic oncology has expanded dramatically. Today, imaging is no longer a secondary or optional tool but an essential component of comprehensive tumor evaluation, bridging the gap between clinical assessment and histopathologic diagnosis.

Historically, dermatologic diagnosis relied primarily on visual and dermoscopic examination, followed by biopsy when necessary. However, the evolution of imaging technologies has transformed the approach to skin tumors. High-frequency ultrasonography (HFUS) introduced the ability to visualize the epidermis, dermis, and subcutaneous fat layers with near-histologic resolution. Modern Doppler techniques further enabled the assessment of tumor vascularity—an important marker of malignancy. Cross-sectional imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI) have become invaluable for evaluating deeper extension into fascia, muscle, cartilage, or bone, and for identifying complications such as perineural spread, which markedly influences prognosis and treatment strategy. Functional imaging with positron emission tomography–computed tomography (PET-CT) revolutionized the staging of high-risk and aggressive malignancies, particularly melanoma, by enabling whole-body assessment of nodal and distant metastases.

The clinical significance of radiologic imaging becomes especially clear when considering the diverse biological behaviors of different dermatologic neoplasms. Basal cell carcinoma (BCC), the most common human malignancy, is usually locally invasive but can cause extensive destruction in high-risk locations such as the orbit, periorbital region, or scalp. Squamous cell carcinoma (SCC) demonstrates a much higher propensity for nodal metastatic spread, particularly in immunosuppressed patients, making imaging crucial for staging and treatment planning. Melanoma, although less common, carries the highest mortality among skin cancers due to its early and unpredictable dissemination through lymphatic and hematogenous routes. Rare tumors such as Merkel cell carcinoma, dermatofibrosarcoma protuberans (DFSP), and cutaneous angiosarcoma require early imaging-based identification of infiltration patterns and metastatic routes because delayed detection significantly worsens outcomes. In all these scenarios, radiologic modalities provide essential insights that clinical examination alone cannot offer.

Radiology serves not only in diagnosis and staging but also as a critical tool across the entire continuum of care. Preoperatively, imaging delineates tumor margins, identifies subclinical extension, and facilitates planning for Mohs micrographic surgery or wide local excision. Intra-therapeutically, it supports biopsy guidance and evaluates response to radiotherapy, targeted therapy, and immunotherapy—therapeutic domains that are rapidly advancing, particularly in melanoma and SCC. Post-treatment, imaging detects early recurrence and differentiates tumor regrowth from post-surgical or post-radiation changes. This continuous integration of radiology into dermatologic oncology underscores the importance of close collaboration between dermatologists, radiologists, surgeons, oncologists, and pathologists.

Recent technological advances have further transformed the landscape of dermatologic imaging. Ultra-high-frequency probes exceeding 30–70 MHz allow precise visualization of microscopic structures such as the dermal–epidermal junction. Contrast-enhanced ultrasonography provides real-time assessment of tumor perfusion, while elastography offers additional information about tissue stiffness, supporting differential diagnosis between benign and malignant masses. MRI advancements—including diffusion-weighted imaging, neurography, and dynamic contrast-enhanced sequences—significantly improve detection of subtle infiltration and perineural invasion. PET-CT and hybrid PET-MRI systems combine structural and metabolic imaging, enabling highly sensitive staging and treatment monitoring.

Parallel to these hardware developments, artificial intelligence (AI) and machine learning have emerged as powerful tools in dermatologic oncology. AI algorithms trained on imaging data—ranging from dermoscopic photographs to ultrasound and MRI datasets—have demonstrated potential in the automated detection, classification, and risk stratification of skin tumors. Radiomics, which extracts quantitative features from imaging, provides predictive biomarkers for tumor aggressiveness, treatment response, and survival, offering a pathway toward personalized oncologic management. Although still evolving, the integration of AI into radiology promises to enhance diagnostic accuracy and complement clinician expertise rather than replace it.

Given this rapidly evolving landscape, the need for a comprehensive understanding of radiologic imaging in dermatologic neoplasms is greater than ever. Imaging contributes critical information that affects surgical planning, therapeutic decision-making, and long-term patient outcomes. A multidisciplinary approach—uniting dermatology and radiology—ensures that patients receive precise, timely, and individualized care. This chapter aims to provide an in-depth overview of the imaging characteristics of benign and malignant skin tumors, highlighting practical radiologic strategies, modality-specific strengths, common diagnostic challenges, and the growing role of advanced technologies and artificial intelligence. By integrating clinical, pathologic, and radiologic perspectives, the chapter seeks to strengthen collaborative practice and improve diagnostic and therapeutic outcomes in dermatologic oncology.

Chapter 1

Imaging Modalities in Dermatologic Oncology

Mehmet Birinci

Radiologic imaging has become a fundamental component in the evaluation, staging, and management of dermatologic neoplasms. Each imaging modality contributes unique strengths, providing complementary anatomical, functional, and metabolic information. The choice of modality depends on lesion type, anatomical location, suspected depth of invasion, and clinical context. This section presents a comprehensive overview of the major imaging techniques used in dermatologic oncology, emphasizing their principles, technical considerations, strengths, limitations, and clinical applications.

High-Frequency Ultrasonography (HFUS)

High-frequency ultrasonography has revolutionized the imaging of cutaneous lesions by enabling real-time visualization of the skin with near-histologic detail. Probes with frequencies ranging from 15 to 22 MHz—and in some systems exceeding 50–70 MHz—allow precise assessment of the epidermis, dermis, and superficial subcutaneous fat.

Key Advantages

- Excellent spatial resolution for superficial tumors
- Distinguishes lesion layers, boundaries, and internal architecture
- Non-invasive, painless, radiation-free, and inexpensive
- Provides real-time Doppler evaluation
- Useful for preoperative mapping of margins
- Enables bedside assessment and point-of-care imaging

Sonographic Appearance of Skin Layers

- Epidermis: Thin, hyperechoic line
- Dermis: Moderately echogenic band
- Subcutaneous fat: Hypoechoic lobules separated by echogenic septa

Applications in Dermatologic Tumors

- BCC and SCC thickness measurement
- Melanoma thickness estimation (complementary to Breslow depth)
- DFSP depth and infiltration mapping
- Evaluation of cystic vs. solid lesions
- Differentiation between benign and malignant masses using Doppler features

Doppler Ultrasonography

Doppler imaging provides critical functional information regarding vascularity:

- Peak systolic velocity (PSV): often elevated in malignant tumors
- Resistive index (RI): malignant neovascularization tends to have low RI
- Vascular architecture: chaotic or central penetrating vessels suggest aggressive behavior

These markers support risk stratification, guide biopsy selection, and correlate with pathology.

Contrast-Enhanced Ultrasonography (CEUS)

CEUS uses microbubble contrast agents to enhance vascular detail, offering insights into microcirculation patterns not visible on conventional Doppler.

Advantages

- Evaluates tumor perfusion and angiogenesis
- Differentiates viable tissue from necrosis
- Helps identify aggressive lesions with rapid, heterogeneous enhancement

CEUS has shown promise in evaluating vascular tumors, recurrent malignancies, and nodal metastases, though its use in cutaneous oncology is still emerging.

Elastography

Elastography measures tissue stiffness and adds a valuable functional parameter to gray-scale US.

Principles

- Malignant tumors are generally stiffer due to desmoplastic reaction
- Benign lesions often demonstrate softer profiles

Clinical Uses

- Distinguishing malignancy from benign nodules
- Assessing fibrotic changes in DFSP
- Complementary evaluation in head and neck or facial tumors

Computed Tomography (CT)

CT remains indispensable for evaluating deep invasion, osseous involvement, and metastatic spread. While limited in assessing superficial dermal lesions, its value increases significantly in tumors affecting deep structures or high-risk anatomical locations.

Strengths

- Superior visualization of bone and calcification
- Fast and widely available
- Excellent for thoracic and abdominal staging

Applications

- Detecting bone erosion in aggressive BCC or SCC
- Mapping scalp tumors involving the calvarium
- Staging melanoma with lung, liver, or adrenal metastases
- Evaluating lymphadenopathy

Limitations

- Limited soft-tissue contrast for small or superficial lesions
- Radiation exposure
- Less sensitive in detecting perineural spread compared to MRI

Magnetic Resonance Imaging (MRI)

MRI provides unparalleled soft-tissue contrast and is the modality of choice for evaluating deep extension, perineural invasion, and involvement of critical anatomical structures.

Strengths

- Excellent soft-tissue differentiation
- Multiplanar capability
- Highly sensitive for muscle, fat, fascia, cartilage, and bone marrow involvement
- Superior in detecting perineural spread

Key MRI Techniques

- T1-weighted imaging: delineates fat-containing structures
- T2-weighted imaging: identifies edema and soft-tissue infiltration
- Fat-suppressed sequences: clarify lesion margins
- Diffusion-weighted imaging: highlights restricted diffusion in malignancies
- Dynamic contrast-enhanced MRI: evaluates vascularity and tumor perfusion

Clinical Utility

- Evaluating invasive SCC and BCC
- Mapping extent of DFSP
- Melanoma staging in extremities and head and neck
- Assessing tumors near the orbit, nose, scalp, and ears

Positron Emission Tomography–Computed Tomography (PET-CT)

PET-CT integrates metabolic and structural imaging, making it a cornerstone modality for staging aggressive cutaneous tumors.

Key Benefits

- Detects metabolically active nodal and distant metastases
- Assesses treatment response
- Identifies recurrence earlier than anatomic imaging

Clinical Indications

- Melanoma: essential for staging stages III–IV
- Aggressive SCC: detection of nodal and distant spread
- Merkel cell carcinoma: highly sensitive due to high metabolic activity
- Sarcomas: monitoring recurrence in DFSP and angiosarcoma

PET–MRI and Hybrid Imaging

PET–MRI combines the functional capabilities of PET with the superior soft-tissue contrast of MRI.

Advantages

- Better differentiation of soft-tissue infiltration
- Reduced radiation dose
- Improved assessment of lesions in the head and neck region
- Although not yet routine, PET–MRI holds significant promise in advanced dermatologic oncology.

Emerging Technologies and Artificial Intelligence Integration

AI and machine learning have gained rapid traction in dermatologic imaging. Applications include:

- Automated segmentation of tumors on ultrasound and MRI
- Radiomics-based prediction of tumor aggressiveness
- Early detection of recurrence through pattern recognition
- Machine-assisted Doppler analysis for vascularity assessment

AI tools are expected to augment diagnostic precision and support personalized management.

Chapter 2

Benign Dermatologic Neoplasms

Berkay Subaşı, Hatice Parlak Subaşı

Benign dermatologic neoplasms constitute a diverse group of non-aggressive tumors originating from epidermal, dermal, adnexal, or subcutaneous tissues. Although these lesions generally exhibit indolent behavior, they often present as palpable or visible abnormalities prompting radiologic evaluation for characterization, confirmation, and surgical planning. Imaging is particularly useful when clinical assessment is inconclusive, when the lesion is located in a complex anatomical region, or when differentiation from malignant counterparts is required. Among all modalities, high-frequency ultrasonography (HFUS) serves as the principal technique due to its excellent superficial resolution, real-time capability, and ability to differentiate cystic from solid components. MRI and CT may be used for deeper, atypical, or diagnostically challenging lesions.

A detailed understanding of the radiologic appearance of common benign skin tumors is essential to avoid unnecessary biopsies, guide management, and correctly identify lesions with atypical or aggressive features that merit further investigation.

Epidermal Inclusion Cysts

Epidermal inclusion cysts are among the most frequently encountered benign cutaneous lesions, arising from the proliferation of epidermal cells within the dermis, often due to follicular occlusion or trauma.

Ultrasound Characteristics

- Shape: Oval or round, well-defined
- Internal Content: Hypoechoic or heterogeneous with echogenic foci (keratin)
- Capsule: Hyperechoic rim representing the cyst wall
- Posterior enhancement: Common due to fluid/keratin content
- Rupture: Heterogeneous appearance with irregular margins and surrounding hyperechoic inflammatory changes
- Doppler typically shows absent or minimal vascularity unless infection or rupture is present.

MRI Features

- T1: Iso- to slightly hyperintense relative to muscle
- T2: Markedly hyperintense with variable internal patterns
- DWI: Restricted diffusion due to keratinaceous debris
- Post-contrast: Minimal or peripheral rim enhancement

These features help differentiate epidermal cysts from soft tissue tumors or abscesses.

Lipomas

Lipomas are benign tumors composed of mature adipocytes and are commonly located in the subcutaneous tissue.

Ultrasound Characteristics

- Appearance: Well-circumscribed, compressible, iso- to hyperechoic mass
- Internal architecture: Linear echogenic strands parallel to the skin
- Motion: Deformable with probe pressure
- Vascularity: Minimal or absent on Doppler

Although classic sonographic features are often diagnostic, atypical lipomas require further evaluation.

MRI Features

MRI is the gold standard for lipomatous tumors:

- T1: Homogeneous high signal identical to subcutaneous fat
- T2: High signal
- Fat suppression: Signal drops out completely
- Septations: Thin (<2 mm) in benign lipomas
- No nodular enhancements or thick septa (which would raise suspicion for liposarcoma)

MRI reliably distinguishes lipomas from well-differentiated liposarcomas.

Dermatofibromas

Dermatofibromas are common benign fibrohistiocytic lesions often arising after minor trauma.

Ultrasound Characteristics

- Location: Dermis, sometimes extending into superficial fat
- Echotexture: Hypoechoic solid nodule
- Margin: Well-defined with a peripheral hyperechoic halo representing fibrosisVascularity: Usually minimal
- The presence of a hyperechoic halo is a useful distinguishing feature.

MRI Features

- T1: Isointense to muscle
- T2: Low signal due to dense collagen
- Enhancement: Homogeneous or peripheral enhancement
- Blooming on gradient-echo: Possible due to hemosiderin
- MRI is used when deep extension or DFSP is suspected.

Neurofibromas

These benign peripheral nerve sheath tumors may be solitary or associated with neurofibromatosis type 1.

Ultrasound Characteristics

- Shape: Fusiform, continuous with the parent nerve
- Echotexture: Hypoechoic, homogeneous
- Target sign: Hyperechoic center with hypoechoic rim (classic)
- Vascularity: Minimal

MRI Features

- T1: Iso- to hypointense
- T2: Hyperintense with "target sign" (central low signal, peripheral high signal)
- Enhancement: Variable, often mild to moderate
- While benign, atypical features may require further evaluation to rule out malignant transformation.

Pilomatricoma

A benign adnexal tumor derived from hair matrix cells, commonly occurring in children and young adults.

Ultrasound Characteristics

- Echotexture: Heterogeneous, partially calcified mass
- Calcifications: Highly echogenic foci with posterior shadowing
- Location: Subcutaneous, firm on palpation
- Vascularity: Peripheral or internal vascular flow may be present

CT/MRI Features

- CT: Excellent for demonstrating calcifications
- MRI: Variable signal; often T2 heterogeneous due to calcific and cystic components
- Pilomatricomas may mimic malignancy if large or inflamed.

Hemangiomas

These benign vascular tumors are characterized by proliferating endothelial cells, commonly seen in infants but also in adults.

Ultrasound Characteristics

- Appearance: Lobulated, heterogeneous lesion
- Vascularity: Abundant internal Doppler flow
- Phleboliths: Hyperechoic foci with shadowing

MRI Features

- T1: Iso- to hyperintense depending on fat content
- T2: Markedly hyperintense
- Enhancement: Strong, homogeneous or nodular
- Flow voids: Seen in high-flow lesions
- Imaging differentiates hemangiomas from other soft-tissue vascular anomalies.

Angiolipomas

A variant of lipoma with prominent vascular channels.

Ultrasound

- Hyperechoic or mixed echogenicity
- Internal vascular flow may be prominent

MRI

- Fatty signal similar to lipoma
- Enhancing vascular septations
- These features help differentiate angiolipomas from liposarcoma or hemangioma.

Sebaceous Cysts and Adnexal Tumors

Other benign adnexal lesions—including trichilemmomas, syringomas, and hidradenomas—show variable imaging features.

Typical Sonographic Findings

- Well-circumscribed masses
- Cystic, solid, or mixed components
- Dermal or subdermal origin
- Minimal vascularity unless complicated

MRI is reserved for deep or atypical adnexal tumors.

Clinical Importance of Radiologic Evaluation in Benign Tumors

Although benign lesions are non-aggressive, imaging offers several important benefits:

- Differentiation from malignancy, especially when lesions are firm, vascular, or rapidly growing
- Assessment of size and depth, critical for surgical planning in facial or functional areas
- Detection of atypical features that may prompt biopsy
- Avoidance of unnecessary interventions when imaging strongly supports benignity
- Evaluation of complications, such as rupture, infection, or hemorrhage

Thus, imaging plays a substantial role in the safe and effective management of benign dermatologic neoplasms.

Chapter 3

Malignant Dermatologic Neoplasms

Berkay Subaşı, Hatice Parlak Subaşı

Malignant dermatologic neoplasms encompass a diverse group of tumors that vary widely in their biological behavior, metastatic potential, and clinical outcomes. While some malignancies, such as basal cell carcinoma, exhibit slow growth and limited metastatic risk, others, including squamous cell carcinoma, melanoma, Merkel cell carcinoma, and cutaneous sarcomas, may demonstrate aggressive invasion and early dissemination. Radiologic imaging plays an essential role in the evaluation of these tumors—from initial diagnosis and staging to surgical planning, treatment monitoring, and longitudinal follow-up. High-frequency ultrasonography (HFUS), Doppler imaging, computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography–computed tomography (PET-CT), and hybrid modalities each contribute unique diagnostic insights that complement clinical and histopathologic findings.

This section provides a comprehensive overview of the major malignant skin tumors, emphasizing their imaging characteristics, typical patterns of spread, and modality-specific diagnostic features.

Basal Cell Carcinoma (BCC)

Basal cell carcinoma is the most common human malignancy, accounting for the majority of non-melanoma skin cancers. Although metastasis is exceedingly rare, BCC can cause significant local destruction, particularly when located near critical structures such as the orbit, nose, and scalp.

Ultrasound Appearance

- Morphology: Hypoechoic, heterogeneous mass with irregular or lobulated margins
- Depth: May infiltrate dermis and extend into subcutaneous fat
- Vascularity: Increased peripheral or internal Doppler flow in aggressive subtypes
- Margins: Ill-defined in infiltrative or morpheaform BCC
- Calcifications: Occasional punctate echogenic foci

HFUS is particularly valuable for preoperative tumor thickness assessment and margin mapping.

MRI Features

- T1: Intermediate signal intensity
- T2: High signal with surrounding edema
- Post-contrast: Strong enhancement with irregular borders
- Perineural spread: Visible as nerve thickening or enhancement, especially in head and neck lesions

MRI is recommended for large, recurrent, or infiltrative BCC and for tumors at high-risk anatomical sites.

CT Findings

Useful for:

- Bone erosion
- Orbital invasion
- Involvement of nasal cartilage or calvarium

Squamous Cell Carcinoma (SCC)

Squamous cell carcinoma shows a higher propensity for local invasion and nodal metastasis compared with BCC. Imaging is crucial in evaluating depth of invasion, perineural involvement, and metastatic spread—especially in immunosuppressed patients.

Ultrasound Characteristics

- Appearance: Solid, hypoechoic, irregular lesion
- Borders: Poorly defined in aggressive or invasive tumors
- Vascularity: Marked internal Doppler flow, often with low resistive index
- Keratin debris: Possible internal echogenic foci

Ultrasound is particularly effective in assessing tumor thickness and guiding biopsy.

CT/MRI

CT: Identifies cortical bone erosion, cartilage destruction, or deep extension

MRI:

Superior for perineural invasion

Displays deep tissue infiltration

Enhancing soft-tissue masses surrounding nerves, muscles, or fascia

Nodal Metastasis

Ultrasound and CT can detect:

- Rounded, hypoechoic lymph nodes
- Loss of fatty hilum
- Peripheral or mixed vascularity on Doppler

PET-CT is valuable for staging advanced SCC.

Cutaneous Melanoma

Melanoma is the most lethal primary skin cancer due to its early hematogenous and lymphatic spread. Radiologic evaluation depends on tumor staging and suspected involvement of nodal or distant sites.

Ultrasound for Primary Lesions

Although histopathology remains the gold standard, HFUS aids in:

- Measuring tumor thickness (useful when biopsy is delayed or for recurrent lesions)
- Assessing ulceration or deeper infiltration
- Detecting satellite or in-transit metastases

Ultrasound of Lymph Nodes

Features suggestive of metastasis include:

- Hypoechoic enlarged nodes
- Rounded morphology (loss of reniform shape)
- Absence of fatty hilum
- Peripheral or chaotic vascularity

MRI Features

- T1 hyperintensity: Due to melanin or hemorrhage
- T2 variable signal: Often intermediate
- DWI restriction: High signal indicating cellular metastasis

MRI is essential for evaluating:

- Brain metastasis
- Deep soft-tissue involvement
- Subcutaneous nodules
- Acral and mucosal melanoma

CT and PET-CT

- CT: Lung, liver, adrenal, and bone metastases
- PET-CT: Highest sensitivity for detecting distant metastatic disease
- PET-MRI: Superior for soft tissues and brain

Given melanoma's unpredictable metastatic pathways, PET-CT is recommended for high-risk disease.

Merkel Cell Carcinoma (MCC)

Merkel cell carcinoma is an aggressive neuroendocrine tumor with high rates of recurrence and metastasis. Early imaging is essential for staging.

Ultrasound Findings

- Hypoechoic, hypervascular nodule
- Irregular margins
- Rapid growth patterns

CT/MRI

- Soft-tissue masses with strong enhancement
- Common nodal and distant metastases
- MRI shows muscle and fascia involvement

PET-CT

- Highly sensitive due to strong metabolic activity
- Detects occult metastases early

Dermatofibrosarcoma Protuberans (DFSP)

DFSP is a low- to intermediate-grade soft-tissue sarcoma known for local aggressiveness and high recurrence rates.

Ultrasound

- Hypoechoic, infiltrative mass with irregular deep margins
- Extends along septa and fascia
- Minimal Doppler flow

MRI

- T1: Low to intermediate signal
- T2: High signal
- "Tail-like" projections: Classic sign of infiltrative growth
- Enhancement: Intense and homogeneous

MRI is the imaging modality of choice to guide surgical margins and assess recurrence.

Cutaneous Angiosarcoma

Angiosarcoma is a highly aggressive vascular malignancy often presenting in the scalp and face of elderly patients.

Ultrasound

- Ill-defined, heterogeneous, vascular mass
- Prominent chaotic Doppler flow

MRI

- T2-hyperintense infiltrative plaque or mass
- Strong heterogeneous enhancement
- Multifocal involvement is common

CT and PET-CT

- Detect metastatic spread to lung, liver, and lymph nodes
- PET-CT frequently shows intense FDG uptake

Angiosarcoma requires early imaging due to its rapid dissemination.

Cutaneous Metastases

Secondary involvement of the skin from primary internal malignancies may mimic benign lesions.

Ultrasound

- Hypoechoic nodules
- Increased vascularity
- Lobulated or infiltrative patterns

MRI/CT

- Variable signal depending on primary tumor
- Often multiple lesions
- Important for staging systemic disease
- Common primary sources include breast, lung, melanoma, and gastrointestinal cancers.

Role of Radiology in Treatment Planning and Follow-up

Radiology provides essential information across all stages of management:

Preoperative

- Tumor thickness and depth
- Margin delineation
- Evaluation of critical structure involvement

During Treatment

- Response to chemotherapy, immunotherapy, radiation
- Early detection of therapeutic complications

Post-treatment

- Identification of recurrence (local or nodal)
- Differentiation of scar tissue from viable tumor
- Monitoring satellite or in-transit metastases

PET-CT is highly effective for assessing response to immunotherapies in melanoma and advanced SCC.

Malignant dermatologic neoplasms present diverse imaging profiles influenced by their histologic origin, biological aggressiveness, and anatomical location. Radiologic evaluation enhances diagnostic certainty, guides therapy, and improves patient outcomes. High-frequency ultrasound and Doppler serve as initial modalities for primary lesion assessment, whereas MRI and CT are crucial for evaluating deep invasion. PET-CT remains indispensable for staging and monitoring metastatic disease, especially in melanoma, SCC, Merkel cell carcinoma, and angiosarcoma. Recognizing the characteristic radiologic patterns of these malignancies is essential for effective multidisciplinary management.

Chapter 4

Vascular Dermatologic Neoplasms

Mehmet Birinci

Vascular dermatologic neoplasms represent a broad spectrum of benign and malignant tumors derived from endothelial cells, perivascular smooth muscle, or vascular-associated mesenchymal tissues. Their clinical presentation varies widely—from soft, compressible lesions detected in infancy to rapidly aggressive malignancies associated with high morbidity and mortality. Radiologic imaging plays a central role in characterizing these lesions, determining their flow dynamics, assessing their extent, identifying complications, and differentiating them from other soft tissue tumors.

High-frequency ultrasonography (HFUS) with Doppler evaluation is the cornerstone for initial assessment. MRI provides advanced soft-tissue characterization and delineates deep tissue involvement, whereas CT may be useful in identifying calcifications or staging malignant vascular neoplasms. Understanding the radiologic patterns of vascular tumors is essential, given their diverse behaviors and treatment strategies.

Hemangiomas

Hemangiomas are the most common benign vascular tumors of the skin and subcutaneous tissues. Although often associated with infancy, they can occur in adults as well. Hemangiomas are traditionally classified into infantile hemangiomas, congenital hemangiomas, and adult hemangiomas, each with distinct radiologic patterns.

Ultrasound Characteristics

- Appearance: Lobulated, well-defined or infiltrative heterogeneous mass
- Echogenicity: Mixed hyper- and hypoechoic areas
- Vascularity: Prominent internal Doppler flow, sometimes with high-velocity channels
- Phleboliths: Hyperechoic nodules with posterior acoustic shadowing
- Compressibility: Present but variable
- Color and power Doppler demonstrate rich vascularity, which helps distinguish hemangiomas from other soft-tissue masses.

MRI Features

- T1: Isointense to slightly hyperintense
- T2: Markedly hyperintense, reflecting slow-flow vascular spaces
- Contrast enhancement: Intense, often nodular or homogeneous
- Flow voids: Seen in high-flow hemangiomas

- MRI is particularly useful in determining lesion boundaries and identifying involvement of deeper structures.

Vascular Malformations (Although Not True Neoplasms)

Although vascular malformations are not neoplasms, they often mimic vascular tumors clinically and radiologically. Their inclusion is important due to overlapping imaging features.

Types and Key Imaging Findings

Venous malformations:

- Compressible, hypoechoic serpiginous structures
- Phleboliths common (MRI/CT)
- T2 hyperintensity with slow filling on post-contrast imaging

Arteriovenous malformations (AVMs):

- High-flow Doppler signals
- Enlarged feeding arteries and draining veins
- "Flow voids" on MRI

Lymphatic malformations:

- Multicystic appearance
- No internal vascularity
- Fluid–fluid levels on MRI

Although not tumors, differentiating malformations from vascular neoplasms is vital for management.

Angiolipoma

Angiolipomas are benign tumors composed of mature adipose tissue interspersed with numerous vascular channels.

Ultrasound Features

- Iso- to hyperechoic mass
- Multiple internal vascular channels visible on Doppler
- Soft and mildly compressible

MRI Characteristics

- T1/T2: Fat signal identical to lipoma
- Enhancing vascular septa after contrast
- Absence of thick septa or non-fatty nodules (which would suggest liposarcoma)

Pyogenic Granuloma (Lobular Capillary Hemangioma)

Despite its name, pyogenic granuloma is a benign vascular tumor characterized by rapid growth and a tendency to bleed.

Ultrasound

- Well-circumscribed, hypoechoic or isoechoic nodule
- Marked internal vascularity
- Pedicle or stalk sometimes visible

MRI

- Strong enhancement
- T2 hyperintense lesion
- Imaging helps differentiate it from amelanotic melanoma or nodular BCC.

Kaposi Sarcoma

Kaposi sarcoma is a low-grade vascular malignancy associated with HHV-8 infection, frequently seen in immunosuppressed patients.

Ultrasound

- Hypoechoic cutaneous or subcutaneous nodules
- Prominent internal vascularity

MRI

- T2 hyperintense nodules
- Nodular or plaque-like thickening
- Strong contrast enhancement
- PET-CT may reveal multiorgan involvement (lymph nodes, visceral organs).

Angiosarcoma

Angiosarcoma is one of the most aggressive malignant vascular tumors, commonly arising on the scalp and face of elderly patients or in areas of chronic lymphedema (Stewart–Treves syndrome).

Ultrasound

- Ill-defined, infiltrative, heterogeneous mass
- Marked chaotic vascularity on Doppler
- Often multifocal

MRI

- T1: Iso- to hypointense
- T2: Markedly hyperintense infiltrative pattern
- Enhancement: Strong, heterogeneous, sometimes nodular
- Margins: Poorly defined, reflecting aggressive infiltration
- MRI is critical for assessing disease extent and surgical planning.

CT/PET-CT

- CT evaluates pulmonary or hepatic metastases
- PET-CT shows intense metabolic activity
- Early metastasis detection is essential due to poor prognosis

Hemangioendothelioma

An intermediate-grade vascular tumor, behavior between hemangioma and angiosarcoma.

Imaging Features

- Ultrasound: Solid vascular mass
- MRI: T2 hyperintense, strong enhancement
- May mimic hemangioma or low-grade sarcoma
- Radiology helps in identifying aggressive patterns warranting biopsy.

Glomus Tumor

A benign but highly vascular perivascular tumor often presenting in the subungual region.

Ultrasound

- Small, hypoechoic nodule
- Prominent internal vascular flow

MRI

- T1: Low signal
- T2: Very high signal
- Contrast: Intense enhancement

Imaging is essential for localization prior to surgery, especially in subungual lesions.

Clinical Importance of Radiologic Assessment in Vascular Tumors

Radiologic imaging plays a critical role in vascular dermatologic neoplasms by enabling:

- Differentiation of high-flow vs. low-flow lesions
- Identification of malignant vascular tumors (angiosarcoma, Kaposi sarcoma)
- Delineation of lesion extent for surgical planning
- Detection of multifocal involvement
- Assessment of nodal and visceral metastasis
- Avoidance of misdiagnosis with benign masses

Doppler ultrasonography remains foundational, while MRI provides deeper insight into infiltrative behavior. PET-CT is indispensable in aggressive malignancies for staging and treatment monitoring.

Chapter 5

Doppler Ultrasonography in Tumor Assessment

Betül Tiryaki Baştuğ

Doppler ultrasonography is a powerful non-invasive imaging tool that provides real-time evaluation of tissue perfusion, vascular architecture, and hemodynamic characteristics of dermatologic neoplasms. When combined with high-frequency gray-scale ultrasonography, Doppler imaging significantly enhances diagnostic accuracy by helping differentiate benign from malignant lesions, guiding biopsies, predicting tumor aggressiveness, and monitoring therapeutic response. Because angiogenesis is a hallmark of tumor growth and malignant transformation, Doppler parameters frequently correlate with histologic vascular density and tumor biology.

Doppler ultrasonography encompasses several techniques—including color Doppler, power Doppler, spectral Doppler, and advanced methods such as superb microvascular imaging (SMI)—each offering different advantages in visualizing tumor vascularity. This section provides a comprehensive examination of Doppler principles, measurable parameters, characteristic patterns in benign and malignant lesions, and their clinical utility in dermatologic oncology.

Principles of Doppler Ultrasonography

Doppler imaging relies on the frequency shift produced when ultrasound waves encounter moving red blood cells. This shift enables quantification of blood flow velocity and direction, allowing detailed analysis of vascular structures within and surrounding cutaneous tumors.

Common Doppler Techniques

- Color Doppler: Displays flow direction and velocity; useful for mapping larger vessels.
- Power Doppler: More sensitive to low-flow states; valuable for superficial tumors.
- Spectral Doppler: Quantifies flow velocity and resistance; provides PSV (peak systolic velocity) and RI (resistive index).
- Superb Microvascular Imaging (SMI): Detects microvascular flow beyond the sensitivity of conventional Doppler; excellent for low-flow lesions and early angiogenesis evaluation.

Quantitative Doppler Parameters

1. Peak Systolic Velocity (PSV)

- PSV reflects the maximum blood flow velocity within the vessel.
- Malignant tumors often exhibit higher PSV values due to increased neovascularity and arteriovenous shunting.
- Benign lesions usually demonstrate lower PSV with more uniform flow.

2. Resistive Index (RI)

- RI = (PSV – EDV) / PSV
- RI provides insight into vascular resistance downstream.
- Malignancies typically have lower RI, reflecting low-resistance neovascular beds.
- Benign lesions often show higher RI, attributed to mature vasculature.

3. Pulsatility Index (PI)

- PI offers additional evaluation of vascular impedance, especially in larger lesions.

4. Vessel Density and Distribution

- Patterns of vessel arrangement are highly informative:
- Chaotic or penetrating central vessels → Suggest malignancy
- Peripheral curvilinear vessels → Often benign or inflammatory
- Avascular lesions → Cysts or lipid-rich lesions

Doppler Characteristics of Benign Tumors

Benign lesions typically exhibit minimal or organized vascularity:

Epidermal Inclusion Cysts

- Usually avascular unless ruptured or infected
- Peripheral hyperemia may appear during inflammation

Lipomas

- Minimal or absent vascularity
- Thin, regular septal vessels if present

Dermatofibromas

- Scant peripheral flow
- Central avascularity common

Hemangiomas

- Exception among benign tumors
- Rich Doppler flow, often high in vascular density
- Low-resistance spectra

Pilomatricomas

- May show peripheral or mild internal vascularity
- Shadowing from calcifications may limit Doppler evaluation

Benign tumors often show lower PSV, higher RI, and organized flow patterns compared with malignant tumors.

Doppler Characteristics of Malignant Tumors

Malignant dermatologic tumors demonstrate neovascular changes driven by tumor angiogenesis, resulting in distinct Doppler signatures.

Key Doppler Features of Malignancy

- Increased internal vascularity
- Chaotic, disorganized flow patterns
- Low-resistance arterial waveforms (low RI)
- Elevated PSV due to proliferative vessels
- Penetrating vessels entering from deep tissue planes
- Irregular vascular networks

These features are observed in a variety of malignant tumors.

Basal Cell Carcinoma (BCC)

- Increased peripheral and sometimes central vascularity
- Low RI in aggressive subtypes
- Helps assess infiltrative/morpheaform patterns

Squamous Cell Carcinoma (SCC)

- Marked internal Doppler flow
- Chaotic branching vessels
- Higher PSV, correlating with tumor aggressiveness
- Useful for identifying peritumoral invasion

Melanoma

- Vascularity varies with depth and stage
- Doppler particularly useful for nodal metastases
- Nodes show peripheral or mixed vascularity with high PSV

Merkel Cell Carcinoma

- Hypervascular with high-flow signals
- Early detection of nodal involvement with Doppler US

Angiosarcoma

- Extremely vascular malignant tumor
- Chaotic high-flow signals
- Multiple irregular neovascular channels

Doppler Ultrasound in Lymph Node Assessment

Nodal evaluation is crucial in malignant dermatologic neoplasms, especially in melanoma and SCC.

Malignant Nodal Features

- Loss of fatty hilum
- Rounded shape
- Cortical thickening
- Peripheral or mixed vascularity
- High PSV and low RI patterns

Doppler effectively differentiates reactive from malignant adenopathy in many cases.

Clinical Applications of Doppler Ultrasonography

1. Differentiation Between Benign and Malignant Lesions

- Doppler parameters enhance diagnostic confidence when morphology alone is insufficient.

2. Biopsy Targeting

- Areas of highest vascularity correlate with viable aggressive tissue.

3. Preoperative Evaluation

- Identifies deep feeding vessels, tumor depth, and potential invasion.

4. Monitoring Treatment Response

- Reduced vascularity indicates therapeutic success
- Particularly useful during immunotherapy or radiotherapy

5. Early Recurrence Detection

- Subclinical neovascularity may appear before visible recurrence.

6. Research Applications (Radiomics & AI)

- Machine learning models increasingly incorporate Doppler-derived vascular biomarkers, offering potential predictive indices for tumor aggressiveness and treatment response.

Advantages and Limitations of Doppler Ultrasonography

Advantages

- Real-time, dynamic imaging
- Excellent for superficial lesions
- No radiation exposure
- Affordable and widely available
- Superior for characterizing neovascularity
- Ideal adjunct to HFUS

Limitations

- User-dependent
- Limited by calcifications or shadowing
- Difficulty in deeply located tumors
- May underestimate microvascular flow compared with MRI or SMI

Doppler ultrasonography is a vital component of dermatologic tumor assessment, offering dynamic vascular information that complements structural imaging. Its ability to detect angiogenesis, quantify vascular flow, and distinguish benign from malignant patterns makes it indispensable in modern dermatologic oncology. As AI-driven quantitative Doppler analysis continues to evolve, Doppler imaging is expected to play an even more central role in personalized tumor evaluation and treatment planning.

Chapter 6

Nodal and Distant Metastatic Evaluation

Betül Tiryaki Baştuğ

The evaluation of nodal and distant metastases represents one of the most important components of radiologic assessment in dermatologic oncology. While many skin cancers remain localized, several malignancies—including melanoma, squamous cell carcinoma (SCC), Merkel cell carcinoma (MCC), and angiosarcoma—carry a significant risk of regional lymphatic spread and systemic dissemination. Early detection of metastasis profoundly influences staging, treatment planning, prognosis, and patient survival.

Radiologic imaging plays an essential role in identifying metastatic disease, characterizing nodal involvement, differentiating malignant from reactive lymphadenopathy, and mapping distant organ spread. A multimodality approach is often required, combining high-resolution ultrasonography with cross-sectional imaging such as CT and MRI, and functional metabolic imaging such as PET-CT.

Pathways of Metastatic Spread in Dermatologic Tumors

Understanding the metastatic behavior of skin cancers provides the foundation for targeted imaging.

Lymphatic Spread

Common in:

- Melanoma
- SCC
- Merkel cell carcinoma
- Angiosarcoma
- Cutaneous adnexal carcinomas

Typical nodal basins:

- Cervical
- Axillary
- Inguinal / femoral
- Parotid and intraparotid nodes (in head and neck lesions)

Hematogenous Spread

Typical in aggressive tumors:

- Melanoma → lung, liver, brain, bone
- Angiosarcoma → lung, liver
- Merkel cell carcinoma → lung, liver, bone
- SCC (high-risk) → lung, bone

These pathways guide imaging selection and interpretation.

Ultrasound Assessment of Regional Lymph Nodes

Ultrasound is the first-line modality for evaluating superficial nodal basins due to its high spatial resolution, availability, and real-time capability.

Ultrasound Features of Malignant Nodes

Shape

- Round morphology
- Loss of normal reniform appearance

Hilum

- Absence of fatty hilum
- Displacement or compression by tumor

Cortex

- Thickened, hypoechoic cortex (>3 mm)
- Focal bulges indicating tumor infiltration

Echotexture

- Globally hypoechoic
- Heterogeneous in necrotic or advanced disease

Doppler Patterns

- Peripheral or mixed vascularity
- Hypervascularity
- Chaotic intranodal flow
- High PSV and low RI

These findings strongly suggest malignant infiltration and prompt biopsy or FNAC.

Sentinel Lymph Node Evaluation

Ultrasound is increasingly used to:

- Identify metastatic involvement
- Guide preoperative sampling
- Monitor nodes in patients undergoing surveillance (e.g., post-melanoma excision)

Cross-sectional Imaging for Nodal Staging

Computed Tomography (CT)

CT is valuable for evaluating:

- Deep lymph nodes (retroperitoneal, mediastinal, intrathoracic)
- Nodal necrosis
- Extranodal extension
- Subtle lung or liver metastases

CT criteria for nodal metastasis include:

- Short-axis diameter >1 cm
- Loss of fatty hilum
- Round shape
- Heterogeneous enhancement
- Necrotic or cystic changes

Although size-based criteria have limitations, CT remains essential for systemic staging.

Magnetic Resonance Imaging (MRI)

MRI is superior for:

- Assessing perinodal soft tissue infiltration
- Parotid and cervical nodes in head and neck tumors
- Distinguishing cystic vs. solid nodes
- Detecting extracapsular nodal spread
- Diffusion-weighted imaging (DWI) increases sensitivity by demonstrating restricted diffusion in metastatic nodes.

PET-CT in Metastatic Evaluation

PET-CT combines anatomical and metabolic imaging, making it the most sensitive modality for detecting nodal and distant metastases in many dermatologic malignancies.

Advantages of PET-CT

- Detects small metastases missed by CT/MRI
- Provides whole-body evaluation
- Identifies occult metastases
- Assesses treatment response
- Differentiates active tumor from scar tissue
- Highly accurate for melanoma, MCC, and aggressive SCC

Nodal Metastasis on PET-CT

- Increased FDG uptake in pathological nodes
- Useful for identifying metastatic drainages beyond expected basins
- Clarifies indeterminate CT/MRI findings
- Distant Metastasis on PET-CT

Common metastatic patterns:

- Melanoma: Lung, liver, brain, bone, soft tissues
- SCC: Lung, mediastinum, liver
- MCC: Lung, liver, skeleton
- Angiosarcoma: Lung, soft tissues, liver

PET-CT is frequently pivotal in staging high-risk or recurrent disease.

MRI for Detection of Distant Metastasis

MRI is particularly useful for:

- Brain metastases (melanoma)
- Bone marrow infiltration
- Soft tissue metastases
- Orbital or skull base involvement

Melanoma brain metastases often show:

- T1 hyperintensity (melanin/hemorrhage)
- Perilesional edema
- Ring or nodular enhancement

MRI remains the modality of choice for CNS staging.

Evaluation of In-Transit and Satellite Metastases

These metastatic deposits occur between the primary tumor and the regional lymph node basin, especially in melanoma.

Ultrasound

- Hypoechoic or heterogeneous subcutaneous nodules
- Increased internal vascularity
- Easily detected even when small

MRI

- Multiple enhancing nodules in subcutaneous tissue
- Better for deeper or anatomically complex areas

PET-CT

- Highly sensitive for metabolically active deposits
- Detects multifocal or subclinical involvement
- Imaging helps distinguish metastases from benign nodules or postoperative changes.

Patterns of Distant Metastasis in Major Dermatologic Malignancies

Melanoma

- Lung (most common)
- Liver
- Brain (high prevalence)
- Bone
- Subcutaneous and soft tissues

Squamous Cell Carcinoma

- Lung
- Mediastinal nodes
- Bone
- Liver
- Adrenal glands

Merkel Cell Carcinoma

- Lung
- Liver
- Bone
- Multiple nodal basins

Angiosarcoma

- Early lung metastasis
- Liver
- Soft-tissue deposits
- Multifocal disease common

Recognition of these patterns supports targeted imaging and early detection.

7.8. Role of Imaging in Follow-Up and Surveillance

The frequency and modality of follow-up depend on tumor type, stage, and risk level.

Ultrasound

- Ideal for regional lymph node surveillance
- Early detection of recurrences or new nodal metastases

CT/MRI

- Used for intermediate-high risk patients
- Particularly important after treatment for SCC, DFSP, MCC

PET-CT

- Best for evaluating systemic recurrence
- Detects metabolically active lesions before they become morphologic
- Surveillance imaging is essential to ensure early intervention and improve outcomes.

Nodal and distant metastatic evaluation is a cornerstone of staging and monitoring in dermatologic oncology. Ultrasound remains the first-line modality for superficial lymph nodes, while CT and MRI offer detailed assessment of deep nodal groups and visceral spread. PET-CT provides unparalleled sensitivity for detecting metastatic disease, especially in melanoma, Merkel cell carcinoma, and aggressive SCC. Recognizing the typical metastatic patterns and imaging features of malignant skin tumors is essential for accurate staging, treatment planning, and survivorship management

Chapter 7

Treatment Planning and Follow-Up

Betül Tiryaki Baştuğ

Treatment planning and follow-up in dermatologic oncology rely heavily on radiologic imaging to determine disease extent, guide surgical and non-surgical interventions, evaluate therapeutic response, and detect recurrence at the earliest possible stage. While histopathology remains the diagnostic gold standard, imaging provides indispensable complementary information about tumor depth, infiltration patterns, nodal involvement, and distant spread—factors that profoundly influence treatment decisions and long-term prognosis. As multimodal therapies continue to evolve, radiology plays an increasingly central role in personalized care, enabling clinicians to tailor management strategies to each patient's tumor biology and risk profile.

Role of Imaging in Preoperative Assessment

Preoperative imaging is essential for determining the full extent of disease before surgical intervention, particularly for high-risk tumors or lesions in anatomically complex regions.

Tumor Depth and Margins

High-frequency ultrasonography (HFUS) provides highly accurate, real-time assessment of:

- Tumor thickness
- Vertical and lateral extension
- Involvement of dermis, subcutaneous fat, fascia, and muscle

MRI offers superior evaluation for:

- Perineural invasion
- Orbital and nasal extension
- Deep involvement of scalp, face, and extremities

These findings guide decisions regarding:

- Surgical margin width
- Need for Mohs micrographic surgery
- Complexity of reconstruction
- Choice between surgery and radiation

Critical Structure Involvement

Imaging identifies invasion into:

- Bone (CT)
- Cartilage (CT/MRI)
- Muscles and tendons (MRI)
- Nerves (MR neurography)
- Parotid gland and cervical compartments (MRI/CT)

These details influence oncologic and reconstructive planning.

Radiologic Guidance for Minimally Invasive Interventions

Radiology assists in planning and guiding various interventions:

Image-Guided Biopsy

Ultrasound-guided biopsy ensures:

- Accurate sampling of suspicious regions
- Targeting highly vascular or aggressive tumor components
- Avoidance of necrotic areas

CT-guided biopsy may be required for deep or visceral lesions.

Sentinel Lymph Node Localization

Ultrasound is increasingly used to:

- Identify abnormal morphology
- Guide preoperative fine-needle aspiration
- Facilitate postoperative surveillance

Ablative and Non-Surgical Therapies

Radiology supports:

- Laser and cryotherapy planning
- Intralesional therapy targeting
- Image-guided injection of chemotherapeutic agents

Emerging modalities include focused ultrasound and photodynamic therapy monitoring.

Imaging in Radiation Therapy Planning

Many dermatologic malignancies—especially SCC, MCC, and angiosarcoma—require radiation therapy. Imaging contributes to:

- Tumor volume delineation (MRI/CT)
- Identifying perineural spread requiring expanded fields
- Evaluating nearby radiosensitive structures
- Monitoring radiation-induced changes in soft tissue

MRI offers the most accurate mapping for head and neck lesions, while CT is standard for radiation dose planning.

Imaging in Systemic Therapy Monitoring

Systemic therapy has expanded dramatically with the development of:

- Immunotherapy (checkpoint inhibitors)
- Targeted therapy (BRAF/MEK inhibitors in melanoma)
- Chemotherapy (MCC, advanced SCC)
- Anti-angiogenic agents (angiosarcoma)

Response Patterns on Imaging

Unlike cytotoxic therapy, immunotherapy may produce atypical responses such as:

- Pseudoprogression (transient lesion enlargement)
- Delayed response
- Mixed response patterns

PET-CT is particularly useful to differentiate true progression from immune-related changes.

MRI and CT for Treatment Monitoring

These modalities help evaluate:

- Tumor shrinkage
- Resolution of perineural invasion
- Bone and soft tissue remodeling
- Necrosis vs. viable tumor

Advanced MRI sequences (DWI, perfusion imaging) improve assessment sensitivity.

Post-treatment Surveillance

Surveillance imaging aims to detect recurrence, nodal involvement, and distant metastasis early, especially in high-risk tumors such as melanoma, SCC, MCC, and DFSP.

Local Recurrence

Ultrasound:

- Identifies subtle nodules within scar tissue
- Detects increased vascularity suggestive of tumor regrowth

MRI:

- Differentiates post-surgical fibrosis from recurrent tumor
- Particularly useful in head and neck or post-radiation settings

Nodal Surveillance

Ultrasound is the modality of choice for:

- Melanoma nodal basins
- SCC cervical nodes
- Merkel cell carcinoma monitoring

PET-CT may be used for intermediate-high risk patients.

Distant Metastasis Monitoring

PET-CT and CT/MRI are used based on tumor type:

- Melanoma: PET-CT and brain MRI
- SCC: Chest CT or PET-CT
- MCC: PET-CT for early detection
- Angiosarcoma: Chest CT due to early lung metastasis

The frequency of surveillance varies with tumor staging guidelines.

Evaluating Treatment-Related Complications

Imaging also helps identify complications such as:

- Radiation dermatitis and fibrosis
- Osteoradionecrosis
- Infection or abscess formation
- Lymphedema
- Immunotherapy-related pseudoprogression
- Treatment-induced vascular changes

MRI and ultrasound are particularly efficient in differentiating complications from tumor recurrence.

Emerging Trends in Imaging-Guided Oncology Care

Artificial Intelligence and Radiomics

AI-driven analysis of imaging data enables:

- Prediction of treatment response
- Early detection of recurrence

- Automated segmentation of complex lesions
- Quantitative biomarkers for tumor aggressiveness

Functional and Hybrid Imaging

- PET-MRI: integrates metabolic and high-resolution soft-tissue imaging
- Contrast-enhanced ultrasound: evaluates microvasculature in real time
- Elastography: monitors tissue stiffness changes post-treatment

These innovations promote precision oncology and tailored follow-up.

Radiologic imaging is integral to the comprehensive management of dermatologic malignancies. From preoperative planning and minimally invasive interventions to radiation therapy mapping, systemic treatment monitoring, and long-term surveillance, imaging informs clinical decision-making at every stage. The combination of HFUS, CT, MRI, and PET-CT—enhanced by evolving techniques such as elastography, CEUS, DWI, and AI—offers a powerful toolkit for optimizing patient outcomes. Effective treatment planning and follow-up rely on a deep understanding of radiologic patterns and interdisciplinary collaboration between dermatology, radiology, surgical oncology, and pathology.

Chapter 8

Dermatologists' Perspective: Comprehensive Clinical Integration, Diagnostic Expectations, and the Expanding Multidisciplinary Role of Dermatology in Cutaneous Oncology

Hatice Gencer Başol

From the standpoint of the dermatologist, the evaluation and management of dermatologic neoplasms represent a dynamic and multifaceted clinical responsibility that extends far beyond the traditional paradigm of lesion recognition and biopsy. As the clinicians who most frequently encounter cutaneous tumors at their earliest stages, dermatologists carry the critical responsibility of distinguishing benign from malignant lesions, determining which tumors require urgent intervention, and orchestrating the sequence of diagnostic tests, imaging studies, surgeries, systemic therapies, and follow-up strategies. This role requires not only an expert understanding of skin morphology, dermoscopic patterns, and tumor biology but also an ability to integrate radiologic, pathologic, surgical, and oncologic insights into a unified, patient-centered plan of care.

Dermatologists rely heavily on high-frequency ultrasonography (HFUS) as an extension of their clinical and dermoscopic examination. While dermoscopy provides unparalleled resolution of the epidermal surface and superficial vascular structures, it cannot assess tumor depth, fascial invasion, or subclinical lateral extension. HFUS fills this gap by enabling dermatologists to visualize the deeper architecture of the skin in vivo—capturing dermal penetration, subcutaneous infiltration, involvement of adnexal structures, proximity to neurovascular bundles, and the presence of deeper nodules or satellite lesions that may not be clinically apparent. Dermatologists expect HFUS reports to include precise measurements of tumor thickness, clear delineation of lesion margins, and anatomic descriptions of adjacent structures, all of which are essential for selecting the appropriate surgical technique and margin width. The dermatologist's decision to perform standard excision, Mohs micrographic surgery, curettage, electrosurgery, or topical therapy hinges upon this level of detail.

Beyond HFUS, Doppler ultrasonography provides dermatologists with functional vascular information that carries profound diagnostic and prognostic implications. Dermatologists place significant emphasis on Doppler-detected vascular patterns—such as chaotic internal flow, penetrating vessels, or low-resistance arterial signals—which often correlate with malignancy, high-grade biological behavior, or aggressive angiogenesis. Conversely, benign lesions frequently exhibit predictable vascular architectures or no vascularity at all. These Doppler characteristics allow dermatologists to refine their differential diagnosis, prioritize biopsy sites, and determine the urgency of intervention. In inflammatory or reactive conditions where vascularity may mimic neoplasia, Doppler findings facilitate differentiation by correlating vascular distribution with clinical morphology.

hen clinical or ultrasonographic findings suggest deep extension or involvement of critical structures, dermatologists depend on MRI to characterize the lesion with superior soft-tissue contrast. MRI provides critical information about perineural invasion, muscle infiltration, bone marrow involvement, and extension into parotid, orbital, or skull base regions—findings that dermatologists cannot obtain through surface examination alone. Dermatologists expect MRI reports to not only confirm or exclude these features but also to specify the exact anatomic trajectory of perineural spread, the thickness and enhancement pattern of involved nerves, and the relation of the tumor to surgical landmarks. These insights guide dermatologists in referring patients to appropriate surgical subspecialties, involving neurosurgery or head and neck oncology when necessary, and counseling patients accurately about prognosis and treatment pathways.

For high-risk neoplasms such as melanoma, Merkel cell carcinoma, advanced squamous cell carcinoma, and angiosarcoma, dermatologists rely on cross-sectional imaging (CT, PET-CT) for regional and distant staging. Dermatologists must determine whether sentinel lymph node biopsy is indicated; whether systemic therapy should precede surgery; whether surgery is feasible or whether the disease is too widespread for operative management; and whether the patient should be triaged to oncology for immunotherapy or targeted therapy. PET-CT is especially important in melanoma and MCC, where dermatologists anticipate early metastasis and rely on metabolic activity patterns to guide treatment. Dermatologists expect imaging to clearly identify nodal abnormalities, suspicious pulmonary nodules, hepatic lesions, bone involvement, or soft-tissue metastases that may alter the therapeutic plan dramatically.

Dermatologists also play a pivotal role in coordinating biopsy strategy, and in this regard, imaging is indispensable. In large, heterogeneous, or infiltrative tumors, dermatologists rely on imaging to identify the most diagnostically valuable area to biopsy—whether the deepest portion, the most vascular region, or the area showing atypical borders. Accurate biopsy site selection avoids underdiagnosis, prevents erroneous benign interpretations in aggressive tumors, and reduces the need for repeated procedures. Dermatologists expect radiologists to identify the most suspicious components so that pathology yields maximally informative results.

Beyond diagnosis and initial staging, dermatologists oversee long-term surveillance, often for years or decades. In this extended phase of care, dermatologists depend on radiologic imaging to monitor recurrence, detect new primary tumors, evaluate nodal basins, and assess treatment response. Dermatologists expect radiologic reports to provide comparative measurements over time, differentiate between scar tissue and recurrence, and identify residual subclinical disease. This is especially vital in patients with a history of melanoma, high-risk SCC, atypical fibroxanthomas, DFSP, or complex adnexal tumors. Dermatologists frequently synthesize radiologic and clinical data to determine whether a new nodule represents post-surgical fibrosis, radiation changes, local recurrence, or a metastasis. The precision of radiologic monitoring thus directly influences the timing and accuracy of dermatologist-led clinical decisions.

Dermatologists also rely on imaging as a powerful patient-education and counseling tool. Many patients struggle to comprehend the depth, invasiveness, or seriousness of their tumors based solely on surface appearance. Radiologic images—ultrasound slices, MRI sequences, PET-CT maps—enable dermatologists to visually explain disease extent, the rationale for treatment, and the expected outcomes. This transparency strengthens trust, improves adherence, and fosters joint decision-making between the patient and the care team.

Finally, dermatologists serve as the central coordinators of multidisciplinary management. They are often responsible for initiating collaboration with surgeons, radiologists, pathologists, medical oncologists, radiation oncologists, nuclear medicine specialists, reconstructive surgeons, and, when necessary, ophthalmologists, neurologists, or other subspecialists. Dermatologists expect imaging reports to be clear, clinically oriented, and aligned with dermatologic anatomy and terminology. This alignment ensures that communication among specialties remains consistent and that all clinicians interpret the imaging findings in a manner that supports a unified treatment strategy.

In sum, dermatologists view radiologic imaging as an essential extension of their clinical capabilities—necessary for refined diagnosis, precise staging, optimal treatment planning, accurate patient counseling, and comprehensive long-term surveillance. More than a diagnostic supplement, imaging serves as an integral component of dermatologic oncology, empowering dermatologists to lead multidisciplinary teams with clarity, confidence, and a deepened understanding of each patient’s disease.

Chapter 9

Surgical Expectations from Preoperative Radiologic Evaluation

Buket Dursun Çoban

For surgeons managing dermatologic neoplasms, preoperative radiologic evaluation serves as a critical bridge between clinical examination and operative execution, directly shaping the surgical approach, extent of resection, reconstruction planning, and intraoperative decision-making. Modern surgical oncology no longer views imaging as a supportive tool; instead, imaging is recognized as an indispensable pillar that defines the therapeutic trajectory. As dermatologic tumors range widely in biological behavior—from superficial, slow-growing lesions to deeply infiltrative or rapidly metastasizing malignancies—surgeons require imaging that is accurate, anatomically explicit, and tailored to the unique demands of each case. Their expectations have evolved significantly as imaging modalities themselves have advanced, now encompassing detailed structural mapping, functional assessment, and early detection of subtle or occult disease.

High-frequency ultrasonography (HFUS) is frequently the surgeon's first and most essential imaging tool for superficial and intermediate-depth tumors. Surgeons expect HFUS to provide precise measurements of tumor thickness, to identify the deepest plane of invasion, and to quantify the distance from the lesion to critical anatomic barriers such as deep fascia, periosteum, cartilage, and neurovascular bundles. This information is indispensable when determining the width of surgical margins, planning Mohs micrographic surgery, or deciding whether standard excision is appropriate. In addition, surgeons place great value on HFUS for its ability to visualize subclinical lateral spread that cannot be appreciated on physical examination. Detecting small peripheral tumor islands or subtle infiltrative extensions can dramatically alter the operative plan, ensuring complete tumor clearance while avoiding excessive tissue removal. This is particularly crucial in cosmetically or functionally sensitive areas—such as the periorbital region, nose, lips, scalp, ears, and hands—where inadequate margins risk recurrence and excessive margins risk disfigurement or functional impairment.

Doppler ultrasonography further enhances surgical planning by revealing the vascular architecture within and around the tumor. Surgeons expect Doppler studies to identify major feeding vessels, quantify tumor vascularity, and characterize flow dynamics that may correlate with aggressive tumor biology. High peak systolic velocities and low resistive indices provide early warning signs of malignancy or high-grade neovascularization, prompting more extensive preoperative preparation. Knowledge of tumor vascularity helps surgeons minimize intraoperative bleeding, anticipate potential operative challenges, and select appropriate surgical techniques—particularly when performing flap-based reconstructions or when excising vascular-rich tumors such as angiosarcomas or hemangiomas.

Magnetic resonance imaging (MRI) is increasingly regarded as the surgeon's most powerful tool for evaluating complex, infiltrative, or anatomically challenging tumors. Surgeons rely on MRI for its exquisite soft-tissue contrast and multiplanar capability, enabling detailed visualization of muscle involvement, perineural spread, cartilage infiltration, and early marrow changes. In head and neck skin cancers—where facial nerve branches, parotid ducts, extraocular muscles, and orbital structures lie in close proximity—MRI provides critical preoperative intelligence that cannot be replaced by clinical examination alone. Identifying perineural invasion, for example, may completely alter surgical strategy, converting a standard excision into a more extensive oncologic resection, prompting involvement of head and neck surgeons or neurosurgeons, or necessitating adjuvant radiotherapy. Surgeons expect MRI reports to clearly describe the precise course, caliber, and enhancement characteristics of involved nerves, as these details influence surgical access, nerve preservation attempts, and postoperative counseling.

Computed tomography (CT) continues to play an essential role, particularly for tumors with suspected bone or cartilage involvement. Surgeons expect CT to accurately identify cortical breaches, permeative osseous changes, or erosive defects caused by locally aggressive tumors such as SCC, BCC, and angiosarcoma. For scalp lesions, CT helps determine whether the outer or inner table of the skull is involved, information that dictates whether a multidisciplinary craniofacial approach is required. In addition, CT is invaluable for thoracic and visceral staging in melanoma, advanced SCC, and Merkel cell carcinoma, ensuring that operative plans are grounded in a comprehensive understanding of the patient's systemic disease status.

PET-CT has become indispensable in the preoperative evaluation of high-risk malignant tumors. Surgeons rely on PET-CT not only for the detection of nodal and distant metastases but also for identifying metabolically active subclinical disease that may go unnoticed on anatomic imaging. PET-CT informs surgeons whether sentinel lymph node biopsy is adequate or whether a more extensive nodal dissection is warranted. In melanoma and Merkel cell carcinoma—where early metastasis is common—PET-CT allows surgeons to avoid futile operations by ensuring that surgical intervention remains appropriate within the broader context of metastatic burden. Surgeons expect PET-CT to provide accurate mapping of disease distribution, which directly influences decisions regarding operative aggressiveness, timing, and coordination with medical oncology.

Broader reconstructive planning also depends on precise preoperative imaging. Surgeons must anticipate tissue deficits and vascular pedicle availability, particularly when performing advancement flaps, rotation flaps, free flaps, or skin grafts. Radiologic identification of vascular territories, perforator vessels, and tissue integrity plays an increasingly recognized role in determining reconstructive feasibility. In the scalp, for instance, MRI and CT help assess the thickness and vascularity of galea and pericranium—information essential for flap survival. Similarly, Doppler ultrasonography of perforators may guide reconstructive surgeons in selecting flap designs that minimize morbidity and optimize cosmetic outcomes.

Lastly, surgeons expect radiology to serve as an early-warning system—flagging subtle signs of recurrence, incomplete excision, or metastatic disease that may alter follow-up protocols or prompt timely reintervention. A radiologist's ability to differentiate scar tissue from residual tumor, to detect in-transit metastases in melanoma, or to identify early lymphatic involvement can prevent delays in treatment and significantly improve long-term survival.

In summary, surgeons rely on preoperative radiologic evaluation to provide clarity, predictability, and anatomic precision. They expect imaging to define the true extent of disease, reveal hidden complexities, prevent intraoperative surprises, and support the selection of the safest and most effective operative strategy. This collaborative synergy between surgeon and radiologist is fundamental to achieving optimal oncologic control, minimizing morbidity, and ensuring the best possible outcome for patients with dermatologic neoplasms.

Chapter 10

Critical Points in Surgeon–Radiologist Communication and an Ideal Preoperative Imaging Report Format

Sinan Topuz

Critical Points in Surgeon–Radiologist Communication

Effective communication between surgeons and radiologists is a cornerstone of successful oncologic management. Dermatologic neoplasms often lie at the intersection of superficial anatomy and complex deep-structure involvement, making clear, precise, and clinically meaningful dialogue essential. Below are the critical elements that ensure optimal interdisciplinary collaboration:

Clear Definition of the Clinical Question

Radiologists frequently receive imaging requests with limited clinical context. Surgeons should communicate:

- The suspected diagnosis or differential
- Prior procedures (biopsy, excision, radiation)
- Specific concerns (e.g., perineural invasion, depth of infiltration, bone/cartilage involvement)
- Planned surgical approach (standard excision vs. Mohs vs. wide local excision)

A well-defined question allows the radiologist to tailor the protocol, imaging planes, and level of detail in the report.

Precise Anatomic Localization

Dermatologic lesions often present as small structures in complex regions. Surgeons should provide:

- Exact location (e.g., "left nasal sidewall, 1 cm inferior to medial canthus")
- Orientation (cephalad, caudal, medial, lateral landmarks)
- Surface mapping or photos when applicable

Accurate localization ensures the radiologist images the correct region and correlates findings with physical exam.

Communicating Surgical Intent

The radiologist should understand:

- Desired clearance margins
- Whether reconstruction is planned
- The need for mapping of vascular perforators
- Whether imaging will guide sentinel node biopsy

This information influences the radiologic emphasis and detail.

Highlighting High-Risk Features

Surgeons should alert radiologists if the patient has:

- Rapid tumor growth
- Recurrence after prior excision
- Immunosuppression
- High-risk locations (periorbital, scalp, ear, lips)
- Symptoms of nerve involvement (paresthesia, numbness, pain)

These influence imaging modality selection (MRI vs. US vs. CT).

Bidirectional Feedback Loop

Communication should not end with the report. Surgeons should:

- Clarify unclear points
- Request re-review of ambiguous structures
- Provide postoperative histopathology to radiology for correlation
- Share recurrence outcomes to enhance future accuracy

This fosters a culture of continuous improvement.

Agreement on Thresholds for Action

Both specialties must agree on:

- When perineural invasion is “radiologically significant”
- Which nodal abnormalities require biopsy

- When the deep fascia is considered breached

Imaging triggers for altering surgical margins. Such consensus avoids unnecessary procedures and prevents under-treatment.

Idealized Preoperative Radiology Report Format

A well-structured radiology report is essential for surgeon-friendly communication. An ideal report for dermatologic neoplasms should include the following standardized sections:

Administrative Header

- Patient name, age, ID
- Imaging modality and technical parameters
- Date of examination
- Referring physician and stated clinical question

Clinical Context (Concise but Essential)

- Suspected or confirmed diagnosis
- Biopsy-proven features
- Prior surgeries or treatments
- Symptoms (pain, numbness, bleeding, rapid growth)

This section ensures alignment between radiologist and surgeon.

Tumor Localization

A precise description including:

- Exact anatomic site
- Orientation with respect to surface landmarks
- Measurement from nearby fixed structures

Example:

"A well-defined lesion is located on the right infraorbital region, 8 mm inferior to the medial canthus and 5 mm lateral to the nasal sidewall junction."

Tumor Measurements

Should include:

- Maximum transverse diameter
- Maximum craniocaudal and anteroposterior dimensions
- Tumor thickness
- Depth of invasion
- Distance to deep fascia, periosteum, cartilage

Example:

"Lesion thickness: 3.8 mm; distance to the orbicularis oculi muscle: 0.9 mm."

Tumor Margins and Behavior

- Well-defined vs. infiltrative borders
- Subclinical extensions
- Discrete nodules vs. plaque-like pattern

- Presence of satellite lesions
- US and MRI should explicitly state whether infiltration is smooth, lobulated, or spiculated.

Tissue Layer Involvement

Detailed description for each layer:

- Epidermis
- Dermis
- Subcutaneous fat
- Superficial fascia
- Deep fascia
- Muscle
- Cartilage
- Bone

Surgeons rely heavily on this section for margin planning.

Vascularity (Doppler Section)

Include:

- Peak systolic velocity (PSV)
- Resistive index (RI)
- Vascular pattern (peripheral, central, chaotic, avascular)

State whether vascularity suggests benign or malignant behavior.

Perineural and Perivascular Extension

- Nerve enlargement
- Enhancement (MRI)
- Trackable nerve involvement
- Vascular encasement

This is a critical surgical determinant.

Lymph Node Assessment

For each nodal basin:

- Size
- Shape (round vs. reniform)
- Hilum status
- Cortex thickness
- Vascularity patterns
- Suspicious vs. reactive features
- State whether biopsy or follow-up is advised.

Evaluation of Distant Structures (When Applicable)

- Thoracic, abdominal organs (CT/PET-CT)
- Brain metastasis (MRI)
- Soft-tissue deposits

Impression (Surgical Action-Oriented Summary)

A concise, structured conclusion answering the surgeon's core questions:

- Is the lesion likely malignant?
- What is the true anatomic extent?
- Are critical structures involved?
- Are the margins achievable surgically?
- Is nodal biopsy recommended?
- Is systemic staging warranted?

Surgeons prefer a final 3–5 line bullet summary explicitly stating recommended next steps.

Chapter 11

Preoperative Evaluation by Other Clinical Specialties in Dermatologic Neoplasms

Selma Aktaş

The preoperative evaluation of patients with dermatologic neoplasms demands collaboration across a broad spectrum of clinical specialties, each contributing critical insights that refine diagnostic accuracy, clarify systemic involvement, optimize treatment safety, and shape the overall therapeutic plan. As cutaneous malignancies increasingly present with complex biological behavior and potential for locoregional or distant spread, the participation of non-dermatologic, non-surgical disciplines becomes indispensable in ensuring that patients are appropriately staged, comorbidities are stabilized, and treatment decisions are grounded in comprehensive medical assessment.

Medical oncologists play a pivotal role in preoperative decision-making for high-risk malignancies such as melanoma, Merkel cell carcinoma, advanced squamous cell carcinoma, and aggressive adnexal tumors. Their interpretation of preoperative imaging—CT, PET-CT, MRI—helps determine whether systemic therapy should precede surgery, whether sentinel lymph node biopsy is warranted, or whether metastatic disease precludes operative intervention. Oncologists also evaluate molecular biomarkers that influence systemic treatment planning and provide prognostic information relevant to surgical timing.

Radiation oncologists provide early input for tumors in difficult anatomical areas or for patients whose clinical presentation suggests that surgery may not achieve adequate margins. Preoperative imaging reviewed jointly with radiation oncology assists in determining whether neoadjuvant radiotherapy could improve resectability or reduce tumor burden. Their evaluation of nerve pathway involvement, deep fascial extension, or proximity to radiosensitive structures contributes to multidisciplinary planning.

Nuclear medicine specialists are essential in the staging process. PET-CT and PET-MRI identify regional or distant metastases that dramatically influence operative decisions. Sentinel lymph node mapping, particularly in melanoma and Merkel cell carcinoma, is guided by nuclear medicine teams who ensure accurate identification of lymphatic drainage pathways and aid surgeons and dermatologists in selecting biopsy targets.

Pulmonologists and thoracic medicine specialists contribute to the preoperative evaluation when imaging reveals pulmonary nodules, mediastinal adenopathy, or thoracic abnormalities. They differentiate metastatic lesions from benign entities such as infections or granulomatous disease. Pulmonologists also assess respiratory reserve, manage chronic lung disease, and determine preoperative operability for patients undergoing general anesthesia.

Endocrinologists assist in optimizing metabolic derangements that may complicate surgery or systemic therapy. Thyroid dysfunction, adrenal disorders, diabetes, and calcium metabolism abnormalities—particularly in patients receiving targeted therapy or immunotherapy—require endocrine evaluation. Endocrine neoplasia syndromes with cutaneous manifestations also necessitate coordinated preoperative assessment.

Internal medicine specialists, including cardiologists, nephrologists, hepatologists, and immunologists, evaluate comorbidities that influence operative risk and postoperative outcomes. Cardiac and renal optimization is particularly important for older or medically fragile patients. Immunologists also contribute to risk assessment in patients with autoimmune disease or immunosuppression, especially those who may require immunotherapy.

Anesthesiologists and preoperative assessment units evaluate airway status, anesthesia risk, anticoagulation management, and perioperative medication adjustments. Their input is essential in determining suitability for general anesthesia versus local or regional techniques.

Finally, psychiatry, psychology, and social work teams contribute to preoperative planning for patients with anxiety, depression, body image concerns, or psychosocial stressors related to cancer diagnosis or impending surgery.

Collectively, these specialties ensure that preoperative evaluation is not limited to tumor characteristics alone, but instead reflects the broader medical, systemic, and psychosocial context necessary for safe and effective surgical care.

Chapter 12

Pathologists' Perspective: Expectations, Diagnostic Integration, and the Essential Role of Imaging in Dermatologic Neoplasms

Özlem Türelik

From the viewpoint of the pathologist, preoperative radiologic evaluation provides indispensable contextual information that enhances diagnostic accuracy, guides histologic sampling strategy, and strengthens the multidisciplinary decision-making process. Although histopathology unquestionably remains the definitive method for the diagnosis and classification of dermatologic neoplasms, the increasingly complex biological behavior of these tumors has made the integration of imaging data fundamental to modern pathology practice. Pathologists now rely on high-quality imaging not only to corroborate microscopic findings but also to identify subtle patterns of tumor spread, anticipate challenging differential diagnoses, and understand the three-dimensional architecture of lesions that may otherwise be incompletely represented in core or punch biopsies.

One of the most significant expectations of the pathologist is that imaging—particularly high-frequency ultrasonography and MRI—clearly communicates the true extent of disease, including its depth, lateral spread, and relationship to key anatomical structures. Many dermatologic tumors exhibit heterogeneous histologic patterns, meaning that the biologically most active or diagnostically decisive area may not be captured in a superficial or limited biopsy. When imaging demonstrates deeper fascial involvement, infiltrative growth patterns, perineural tracking, or satellitosis, the pathologist is alerted to the possibility that an initial biopsy may underrepresent the disease. This insight encourages deeper sampling, oriented grossing, the submission of additional levels, or the use of immunohistochemical markers targeting nerve, vascular, or adnexal structures. Thus, radiologic mapping ensures that histopathologic evaluation aligns with true tumor biology.

Preoperative ultrasonography, particularly when combined with Doppler techniques, provides valuable information regarding vascular architecture and perfusion, which often mirrors histologic patterns. Increased vascular density, chaotic flow patterns, or high-velocity Doppler signals suggest angiogenic activity consistent with malignancy. When the radiologic impression indicates aggressive vascular behavior, the pathologist anticipates increased mitotic activity, irregular vascular channels, and possibly lymphovascular invasion. Conversely, when imaging suggests a well-defined, hypovascular lesion with smooth borders, the pathologist may consider adnexal or benign mesenchymal tumors even in histologically ambiguous regions. This reciprocal reinforcement between imaging and pathology helps avoid diagnostic errors in borderline neoplasms, such as atypical adnexal proliferations, low-grade sarcomas, or unusual variants of basal and squamous cell carcinomas.

MRI plays an especially critical role in detecting perineural invasion, a feature with major prognostic and therapeutic implications. Perineural invasion may be subtle or focal on histology, particularly if the initial biopsy does not capture the involved nerve. When MRI reports nerve enlargement, abnormal enhancement, or perineural tracking, the pathologist intensifies the microscopic search for this feature, examines additional neurovascular bundles, and applies S100, SOX10, or epithelial markers to identify minute perineural tumor deposits. This synergy significantly reduces the risk of missing clinically significant perineural involvement, which could otherwise lead to undertreatment.

Radiology also shapes the pathologist's approach to margin assessment. Tumors with radiologically noted subclinical extension, infiltrative margins, or "tail-like" projections—such as dermatofibrosarcoma protuberans (DFSP) or infiltrative BCC—prompt the pathologist to examine peripheral and deep margins meticulously, often requiring step sections or Mohs micrographic correlation. Knowledge of imaging-detected satellite lesions or in-transit metastases ensures that the pathologist surveys surgical specimens more comprehensively and correlates cutaneous findings with possible lymphatic or intradermal spread.

Furthermore, imaging guides the selection of the most diagnostically meaningful biopsy site, particularly in cases involving large, heterogeneous, or multifocal lesions. Pathologists expect radiologists to identify:

- the area of greatest depth,
- the region with the most suspicious vascular flow,
- the part exhibiting irregular borders or deep infiltration, and
- any nodules that differ from the primary tumor.

This prevents sampling errors, ensures that the biopsy is representative, and reduces the likelihood of inconclusive or misleading pathology reports.

Radiologic evaluation of regional lymph nodes also plays a central role in pathology. Ultrasound features of cortical thickening, loss of hilum, or abnormal vascularity help pathologists anticipate metastatic involvement and adjust grossing protocols accordingly. Sentinel lymph node biopsies performed with radiologic guidance generate specimens that pathologists must evaluate meticulously using serial sections and immunohistochemical stains such as Melan-A, HMB-45, SOX10, cytokeratins, or neuroendocrine markers depending on the tumor type. The radiologist's detailed mapping assists the pathologist in determining whether the sentinel node findings truly correspond to lymphatic drainage patterns or represent atypical metastasis.

Pathologists also rely on radiology for postoperative correlation. When imaging suggests incomplete resection, deep persistence, or recurrent disease, the pathologist reviews previous histology for any microscopic features of infiltration that may have been subtle or focal. Conversely, when pathology reveals positive or close margins, radiologists refine follow-up imaging to identify subclinical disease or early recurrence. This continual loop of communication enhances diagnostic consistency and improves patient care.

Ultimately, from the pathologist's perspective, radiology is not merely adjunctive—it is an intellectual partner that supplies the macroscopic and functional context within which microscopic interpretation occurs. The pathologist expects imaging to be accurate, anatomically precise, clinically relevant, and meticulously correlated with biopsy findings. In return, the radiologist depends on detailed histopathologic feedback to refine impressions, validate imaging patterns, and strengthen interdisciplinary decision-making. This carefully coordinated collaboration ensures that diagnoses are not only morphologically accurate but also clinically actionable, enabling optimal therapeutic planning and improved patient outcomes.

Chapter 13

Postoperative Management and Imaging Follow-Up From the Dermatologist's Perspective

Hatice Gencer Başol

The postoperative phase in dermatologic oncology represents a critical continuum of care in which the dermatologist remains the central coordinator, bridging surgical outcomes, radiologic surveillance, pathologic interpretation, and long-term clinical management. While the surgical excision itself constitutes a decisive step in the treatment of dermatologic neoplasms, the period following surgery is equally important, as it determines wound healing, defines recurrence risk, guides adjuvant therapy decisions, and establishes the foundation for lifelong surveillance in high-risk patients. Dermatologists, as primary physicians for most cutaneous malignancies, are uniquely positioned to integrate radiologic findings with clinical examination, dermoscopic monitoring, and histopathologic details to ensure that postoperative care is both precise and personalized.

Immediately after tumor excision, dermatologists focus on wound evaluation, early complications, and the viability of grafts or flaps in cases requiring reconstruction. Distinguishing normal postoperative inflammatory changes from early signs of infection, ischemia, or hematoma is essential. In recent years, high-frequency ultrasonography (HFUS) has emerged as a valuable extension of the dermatologist's clinical assessment in this phase. HFUS allows real-time visualization of subcutaneous fluid collections, early seromas, minor hematomas, or superficial tissue disruptions that may not be evident on physical examination. Because HFUS is noninvasive and repeatable, dermatologists increasingly rely on it for early postoperative complication management and to establish a baseline against which future imaging can be compared.

As healing progresses, the dermatologist's attention shifts toward detecting residual or recurrent disease, one of the most challenging aspects of postoperative management. Dermal or subcutaneous nodularity within a scar may represent benign hypertrophic tissue, suture granulomas, fat necrosis, or true tumor regrowth. Dermatologists use a combination of dermoscopy, HFUS, and Doppler imaging to differentiate these possibilities. Doppler patterns, in particular, serve as an important discriminator: neoplastic recurrence often demonstrates internal chaotic vascularity, whereas scar tissue is typically hypovascular or avascular. When imaging and clinical findings remain equivocal, dermatologists integrate pathology reports—margin status, perineural invasion, tumor subtype—to determine whether re-biopsy, MRI, or closer short-interval follow-up is appropriate.

For tumors with a high propensity for local recurrence or regional spread—such as melanoma, aggressive squamous cell carcinoma, Merkel cell carcinoma, DFSP, or adnexal carcinomas—postoperative dermatologic management involves a structured radiologic surveillance strategy. Dermatologists coordinate scheduled imaging of regional lymph node basins using ultrasonography, which offers high sensitivity for detecting early nodal metastases. HFUS allows detailed assessment of lymph node morphology, hilar integrity, cortical thickening, and abnormal vascular patterns. In melanoma and MCC, dermatologists frequently use ultrasound in conjunction with PET-CT or CT for more accurate systemic staging and to detect distant metastasis during follow-up. Imaging findings help dermatologists adjust surveillance intervals, escalate care to oncology, or initiate adjuvant therapy referrals.

In cases where postoperative pathology reveals close or positive margins, perineural invasion, deep fascial involvement, or high-risk histologic features, dermatologists assume the central role in coordinating additional imaging and multidisciplinary discussion. MRI may be ordered to assess residual deep tumor, while PET-CT may be needed to evaluate subclinical metastasis. Dermatologists collaborate with radiation oncology for adjuvant radiotherapy planning or with medical oncology when immunotherapy or targeted therapy becomes appropriate. Throughout these decisions, dermatologists serve as the primary communicator with patients, explaining imaging findings, their prognostic implications, and the rationale for further treatment.

An often overlooked but essential component of postoperative care is the management of patient expectations, psychosocial well-being, and behavioral risk reduction. Dermatologists counsel patients on wound care, scar management, sun protection, and the identification of early signs of recurrence. Dermoscopy plays a vital role in long-term monitoring for new primary lesions, particularly in patients with melanoma or syndromic tumor predisposition. Dermatologists also guide patients in performing self-examinations and understanding the significance of any new or changing lesions. By integrating imaging results with comprehensive skin examinations, dermatologists help prevent diagnostic delays and reduce anxiety associated with postoperative uncertainty.

In the long term, dermatologists oversee chronic surveillance protocols, often extending years or decades. This longitudinal framework involves scheduled clinical exams, dermoscopy, targeted imaging, and ongoing coordination with radiology, oncology, surgery, and pathology. Dermatologists interpret evolving radiologic findings within the clinical context of scar maturation, prior treatments, immune-related changes, and patient-specific risk factors such as immunosuppression. With the increasing complexity of systemic therapies—particularly immunotherapy—dermatologists must also recognize imaging patterns associated with pseudoprogression, immune-mediated inflammation, or treatment-induced skin changes.

Ultimately, postoperative management from the dermatologist's perspective is defined by continuity, integration, and vigilance. Dermatologists synthesize clinical examination, dermoscopic patterns, radiologic findings, and histopathologic data to ensure that each patient receives tailored, evidence-based follow-up. Through this coordinated approach, dermatologists not only safeguard against recurrence but also support optimal functional and cosmetic outcomes, maintaining their role at the center of multidisciplinary care in dermatologic oncology.

Chapter 14

Postoperative Radiologic Assessment From the Surgical Oncology Perspective

Buket Dursun Çoban

From the surgical oncologist's standpoint, the postoperative period represents a decisive phase in the continuum of tumor management, during which radiologic evaluation becomes essential for confirming the completeness of tumor excision, identifying early complications, and detecting residual or recurrent disease. Surgeons rely on imaging not merely as a diagnostic adjunct, but as an indispensable tool for validating the success of operative planning, guiding additional interventions, and informing multidisciplinary discussions. High-frequency ultrasound, MRI, CT, and PET-CT play distinct and complementary roles in this context, offering crucial insights into tissue integrity, oncologic clearance, and deeper patterns of disease spread.

Immediately after surgery, surgeons focus on evaluating wound integrity and detecting early postoperative complications, such as hematoma, seroma, infection, or early flap ischemia. Ultrasound is frequently the first modality employed due to its availability, real-time imaging capabilities, and utility in differentiating benign postoperative fluid collections from concerning nodules. Surgeons expect radiologic differentiation between normal postoperative inflammatory changes and persistent masses that may represent residual tumor. In certain high-risk tumors—especially squamous cell carcinoma (SCC), melanoma, and Merkel cell carcinoma (MCC)—residual disease may be microscopic or hidden beneath postoperative distortion, making early sensitive imaging particularly valuable.

For deeper, more infiltrative tumors, MRI becomes the modality of choice in postoperative evaluation. MRI provides surgeons with exquisite detail regarding the involvement of fascia, muscle, neurovascular structures, or bone. Surgeons depend on MRI to distinguish postoperative edema and granulation tissue from recurrent tumor; diffusion-weighted imaging (DWI), perfusion sequences, and fat-suppressed contrast-enhanced MRI significantly aid in this differentiation. For tumors with perineural invasion, MRI is critical for mapping the nerve's postoperative appearance, detecting ongoing enhancement, and determining whether additional surgical resection or radiotherapy is necessary.

Postoperative CT plays a central role when aggressive skin cancers infiltrate bony structures or when flap integrity in calvarial or thoracic reconstructions must be assessed. CT allows surgeons to evaluate cortical continuity, osseous margins, potential osteolysis associated with recurrence, and hardware integrity in cases of reconstruction involving plates or meshes. CT evidence of progressive bone erosion or nodular soft-tissue expansion often signals early recurrence, prompting reoperation.

In advanced cutaneous malignancies, surgical oncologists heavily rely on PET-CT for systemic restaging after primary tumor resection. PET-CT identifies metabolically active lesions that may represent residual disease, in-transit metastases, nodal metastasis, or distant spread. Postoperative PET-CT timing is particularly important to avoid false positives from inflammatory postoperative changes; thus, surgeons work closely with radiologists to determine optimal imaging intervals. PET-CT findings frequently guide decisions regarding adjuvant immunotherapy, radiotherapy, or the need for re-excision. Additionally, PET-CT establishes a new postoperative baseline against which all future imaging is compared—crucial for long-term surveillance in melanoma and MCC.

Surgeons also rely on postoperative imaging for margin assessment when pathology reveals close or positive margins, particularly in anatomically constrained areas such as the head, neck, hands, and feet. In these cases, re-excision may be technically challenging, and imaging helps determine whether further tissue removal is necessary or whether adjuvant therapy may compensate for narrower margins. MRI or ultrasound can delineate subtle tumor remnants in deep tissues, improving surgical precision during reoperation.

Finally, surgeons expect postoperative imaging to support the differentiation between recurrence and treatment-related change, one of the most complex interpretive challenges. Scar tissue, fibrosis, radiation effects, and chronic inflammation can mimic recurrence. Surgeons depend on radiologists to employ advanced modalities—including contrast-enhanced ultrasound, diffusion-weighted MRI, superb microvascular imaging (SMI), and serial PET-CT metabolic trend analysis—to avoid unnecessary reoperations and ensure that true recurrence is rapidly addressed.

In summary, the surgical oncology perspective views postoperative imaging as a fundamental extension of oncologic surgery, enabling precise assessment of operative success, early detection of complications, and timely identification of recurrence. Radiology remains central to postoperative decision-making, ensuring that patients receive safe, tailored, and evidence-based oncologic care.

Chapter 15

Postoperative Imaging and Management in Reconstructive and Head & Neck Surgery

Sinan Topuz

For reconstructive surgeons and head & neck surgeons, postoperative management of dermatologic neoplasms involves not only oncologic surveillance but also the evaluation of functional restoration, tissue viability, and structural integrity following complex resections. These surgeons depend heavily on radiologic imaging to monitor flap perfusion, graft integration, and the stability of reconstructed anatomical units—especially in cosmetically and functionally sensitive regions such as the face, scalp, periorbital area, ears, nose, oral cavity, and neck.

In the immediate postoperative period, imaging plays a crucial role in assessing vascular status of skin flaps, local and regional rotational flaps, and free tissue transfers. Doppler ultrasonography is often the first-line modality, enabling real-time assessment of arterial inflow, venous outflow, capillary refill, and microvascular patency. Reconstructive surgeons expect Doppler findings to help identify early signs of flap compromise—including venous congestion, arterial insufficiency, or thrombosis—well before they become clinically evident. Prompt detection via imaging may allow salvage interventions, such as re-exploration of microvascular anastomoses or decompression of hematomas.

In more complex reconstructions, particularly microvascular free flaps used in head and neck oncologic surgery, CT angiography (CTA) or MR angiography (MRA) may be employed to evaluate vascular integrity postoperatively, assess pedicle thrombosis, or confirm the stability of arterial and venous connections. These modalities also allow surgeons to evaluate the relationship between the reconstructed flap and residual anatomical structures, identify space-occupying fluid collections, and assess osseous integration in cases of osteocutaneous flaps.

Head and neck surgeons rely extensively on postoperative MRI for evaluating deep compartments following resection of cutaneous malignancies with perineural, muscular, or glandular involvement. MRI provides critical detail for distinguishing recurrent tumor from postoperative fibrosis, seroma, or radiation changes. Advanced techniques such as diffusion-weighted imaging, T2 fat suppression, and post-contrast enhancement curves enable radiologists to detect early recurrence within complex anatomic spaces such as the parotid gland, masticator space, orbit, or skull base. Surgeons depend on these findings to plan reoperation, revision of margins, or adjuvant therapy.

Reconstructive surgeons furthermore utilize CT to assess structural reconstruction following extensive scalp, calvarial, nasal, or orbital defects. CT helps determine the integrity and positioning of bone grafts, titanium meshes, alloplastic implants, and cartilage reconstructions. CT evidence of early bone resorption, hardware loosening, or soft-tissue recurrence may prompt timely surgical intervention.

Another essential element of postoperative imaging is the evaluation of functional outcomes—including airway patency, lacrimal drainage, eyelid mechanics, mastication, phonation, and nasal airflow. Head & neck surgeons frequently rely on endoscopic correlation combined with imaging to refine postoperative management. MRI or CT may reveal causes for impaired function, such as flap bulk, scar contracture, hematoma, nerve entrapment, or deep recurrent tumor.

When postoperative pathology signals high-risk disease—positive margins, perineural invasion, extension to skull base or parotid, or aggressive histologic subtype—reconstructive and head & neck surgeons participate in multidisciplinary planning for adjuvant radiotherapy or systemic therapy. Radiologic evaluation defines radiation fields, identifies critical structures at risk, and assists in monitoring treatment-related changes post-therapy.

Ultimately, postoperative imaging for reconstructive and head & neck surgeons serves dual goals: ensuring oncologic safety while preserving or restoring anatomical form and function. Radiology becomes a key partner in validating the success of reconstruction, informing timely revisions, and ensuring long-term functional outcomes that align with the high complexity of modern dermatologic oncologic surgery.

Chapter 16

Postoperative Follow-Up: The Role of Pathology in Long-Term Management

Özlem Türelik

In the postoperative phase of dermatologic neoplasms, pathology continues to play a central role in guiding clinical decision-making, determining the need for additional treatment, and informing long-term surveillance strategies. Although the excised specimen provides the definitive diagnosis, the pathologist's contribution does not end with the issuance of the initial report. On the contrary, the postoperative period demands constant clinicopathologic correlation, re-evaluation of histologic features as new imaging or clinical findings emerge, and active participation in multidisciplinary discussions to ensure that each patient's ongoing management is biologically sound and evidence-based.

A primary responsibility of pathology in postoperative follow-up is the interpretation of margin status and its implications over time. Even when margins are negative, the exact distance from the tumor to the inked margin, the presence of infiltrative patterns, and any perineural or lymphovascular invasion help determine the risk of local recurrence and guide follow-up intensity. In cases where margins are close or focal residual disease is suspected based on imaging or physical examination, pathologists may be asked to review slides or prepare deeper sections to assess whether subtle tumor extensions were originally overlooked. This iterative re-evaluation is critical for determining whether re-excision, radiation therapy, or intensified surveillance is warranted.

Pathologists also contribute significantly to follow-up by identifying histologic features that predict recurrence or metastasis, such as high mitotic rate, poor differentiation, satellitosis, infiltrative growth, or specific aggressive subtypes. These microscopic findings inform dermatologists, oncologists, and radiologists about which anatomical regions require closer imaging surveillance and which intervals are most appropriate. For example, the detection of perineural invasion mandates long-term MRI follow-up along nerve pathways, while lymphovascular invasion may prompt periodic nodal ultrasound or PET-CT.

As imaging studies reveal new nodules, asymmetric enhancement, or suspicious lymph nodes during surveillance, pathologists often re-enter the process through clinicopathologic correlation. Radiologists may request comparison with the original pathology to assess whether suspicious findings are consistent with expected postoperative changes or raise concern for recurrence. Likewise, when biopsies are performed on new lesions, knowledge of the previous tumor's subtype, immunohistochemical profile, and behavior helps the pathologist identify local recurrence versus a second primary neoplasm or benign postoperative changes.

Postoperative systemic therapies—particularly immunotherapy, targeted therapies, and radiation—also necessitate continued pathology involvement. These treatments can induce regression patterns, fibrosis, granulomatous inflammation, necrosis, or pseudo-residual masses that require expert distinction from persistent tumor. Pathologists help clinicians interpret these changes accurately, preventing unnecessary interventions while ensuring that true recurrence is not missed.

The pathologist also supports postoperative care by providing clear documentation and synoptic reporting, which are invaluable during long-term follow-up. Structured pathology reports help multidisciplinary teams quickly identify the prognostically significant elements required for decision-making, especially in complex or high-risk tumors. Participation in tumor boards allows pathologists to review challenging cases, discuss borderline or ambiguous findings, and integrate new postoperative clinical or imaging information into a cohesive interpretation.

Ultimately, the role of pathology in postoperative follow-up is an ongoing, dynamic process. It ensures that microscopic tumor biology remains at the center of long-term management decisions, that subtle indicators of recurrence or progression are recognized early, and that the surveillance strategy reflects the true oncologic risk. Through continuous correlation with radiologic and clinical evolution, pathology provides the foundational perspective required for safe, precise, and individualized postoperative care in dermatologic oncology.

Chapter 17

Postoperative Evaluation by Other Clinical Specialties in Dermatologic Neoplasms

Selma Aktaş

The postoperative period represents a critical phase during which the contributions of non-dermatologic, non-surgical specialties become essential for early complication detection, systemic surveillance, treatment toxicity management, and long-term survivorship care. Dermatologic malignancies, particularly high-risk subtypes, require ongoing input from multiple medical disciplines to ensure that postoperative recovery is safe, complication-free, and oncologically sound.

Medical oncologists guide postoperative systemic therapy decisions based on pathology results, margin status, nodal involvement, and radiologic staging. They determine whether adjuvant immunotherapy, targeted therapy, or chemotherapy is indicated and monitor treatment response in subsequent imaging. Their expertise is essential in interpreting unusual radiologic patterns—such as pseudoprogression or immune flare—frequently seen after immunotherapy. Oncologists also manage systemic recurrence or metastatic progression detected during postoperative surveillance.

Radiation oncologists evaluate the need for adjuvant radiotherapy, especially in cases of perineural invasion, deep soft-tissue involvement, positive margins, or nodal metastasis. They rely on postoperative MRI, CT, or PET-CT to define radiation fields, adjust doses, and avoid critical structures compromised during surgery. Radiation oncologists also monitor and manage radiotherapy-related complications such as fibrosis, xerostomia, mucositis, neuropathy, and skin changes.

Nuclear medicine specialists play a major role in postoperative surveillance through PET-CT or PET-MRI. They assess metabolic response to treatment, detect recurrent or residual disease, differentiate recurrence from postoperative inflammation, and identify distant metastases. Serial metabolic imaging establishes trends that guide long-term oncologic planning.

Pulmonologists become essential when postoperative imaging reveals pulmonary nodules, pleural effusion, or suspected metastasis. They conduct bronchoscopy, EBUS-guided biopsies, pulmonary function testing, and manage immunotherapy-related pneumonitis—one of the most significant complications of modern cancer therapies. They also treat infectious complications in immunosuppressed patients, which may mimic oncologic recurrence.

Endocrinologists manage endocrine toxicities that arise postoperatively or during systemic therapy. Immune checkpoint inhibitors, targeted therapies, and radiotherapy may induce thyroiditis, hypophysitis, adrenal insufficiency, or diabetes. Prompt recognition and treatment of these complications are critical for maintaining overall treatment continuity.

Internal medicine specialists ensure optimal management of multimorbidity during recovery. Cardiologists evaluate changes in cardiac function during systemic therapy;

nephrologists manage renal toxicity; hepatologists monitor hepatic effects of systemic treatments; and immunologists assist with complex immune-related adverse events.

Palliative care teams support patients with advanced disease or those experiencing significant symptom burden. They provide pain management, control of dyspnea, wound care, and nutritional support, and they address psychological and end-of-life issues with compassion and expertise.

Rehabilitation medicine assists patients recovering from extensive resections, reconstructive surgeries, or radiation-related morbidity. Physical therapists manage mobility deficits and lymphedema; speech and swallowing therapists intervene after head and neck procedures; occupational therapists support functional adaptation.

Through these contributions, other clinical specialties ensure that postoperative care extends beyond healing of the surgical site to include systemic health, treatment tolerance, functional recovery, and long-term quality of life. Their integrative role is indispensable for comprehensive postoperative management in dermatologic oncology.

10. Overall Summary Tables

Table 1. Imaging Modalities and Their Primary Roles in Dermatologic Oncology

Imaging Modality	Key Strengths	Primary Applications	Limitations
High-Frequency Ultrasonography (HFUS)	Highest resolution for superficial tissues; real-time imaging	Tumor thickness, margins, benign–malignant differentiation	Operator-dependent; limited for deep lesions
Doppler Ultrasonography	Vascular mapping; PSV/RI analysis	Angiogenesis, aggressiveness, biopsy planning	Limited in calcified or deep lesions
Contrast-Enhanced Ultrasound (CEUS)	Perfusion assessment	Vascular tumors, recurrent lesions	Not widely available
Elastography	Tissue stiffness evaluation	Differentiating benign vs malignant	Less validated in dermatologic oncology
Computed Tomography (CT)	Bone/cartilage invasion, thoracic and visceral staging	SCC staging, melanoma metastasis	Radiation exposure; limited soft-tissue resolution
Magnetic Resonance Imaging (MRI)	Superior soft-tissue contrast; neurography	Perineural invasion, deep tumor mapping	Cost, motion sensitivity
PET-CT	Whole-body metabolic imaging	Melanoma, MCC, aggressive SCC staging	False positives; radiation; limited spatial resolution
PET-MRI	Combined metabolic and soft-tissue imaging	Head & neck tumors, soft-tissue evaluation	Limited availability

Table 2. Sonographic Features of Common Benign Dermatologic Neoplasms

Benign Tumor	Ultrasound Appearance	Vascularity	Key Differentiators
Epidermal Inclusion Cyst	Hypoechoic/heterogeneous, capsule, posterior enhancement	Minimal unless infected	Rupture → surrounding inflammation
Lipoma	Iso-/hyperechoic, compressible, linear echogenic strands	Minimal	Fat-suppressed MRI signal drop
Dermatofibroma	Hypoechoic dermal lesion with "halo"	Minimal	Peripheral hyperechoic rim
Pilomatricoma	Heterogeneous, internal calcifications	Mild/moderate	Posterior acoustic shadowing
Hemangioma	Lobulated, mixed echogenicity	High flow	Phleboliths on CT/MRI
Neurofibroma	Fusiform, target sign	Minimal	Nerve continuity
Angiolipoma	Mixed echogenicity	Moderate	Enhancing vascular septa

Table 3. Radiologic Features of Major Malignant Dermatologic Neoplasms

Malignancy	Ultrasound Features	CT/MRI Features	Metastatic Tendency
Basal Cell Carcinoma (BCC)	Hypoechoic, irregular, vascular	MRI: T2 hyperintense, perineural spread	Rare; local invasion
Squamous Cell Carcinoma (SCC)	Solid, hypoechoic, chaotic vascularity	CT: bone/cartilage invasion; MRI: perineural spread	Moderate–high (nodes, lungs)
Melanoma	Variable; high-flow nodes	MRI: T1 hyperintense mets	Very high (lung, liver, brain, bone)
Merkel Cell Carcinoma	Hypervascular nodule	Enhancing soft-tissue mass	Very high; early spread
DFSP	Hypoechoic infiltrative mass	MRI: tail-like projections	Local recurrence common
Angiosarcoma	Highly vascular, infiltrative	T2 bright, strong enhancement	Early lung & liver metastasis
Kaposi Sarcoma	Hypoechoic nodules	Enhancing infiltrative lesions	Multicentric

Table 4. Doppler Ultrasound Parameters in Benign vs Malignant Lesions

Parameter	Benign Lesions	Malignant Lesions	Clinical Interpretation
Peak Systolic Velocity (PSV)	Low/normal	Elevated	Reflects high-flow neovascularization
Resistive Index (RI)	Higher (>0.6)	Lower (<0.5)	Low-resistance vessels = malignancy
Flow Pattern	Peripheral, organized	Chaotic, penetrating	Disorder suggests aggressive lesion
Vessel Density	Sparse	Dense, irregular	Marker of angiogenesis
Spectral Waveform	Regular	Irregular, broad	Indicator of tumor vascular remodeling

Table 5. Common Metastatic Patterns of Dermatologic Malignancies

Tumor Type	Regional Lymphatics	Common Distant Sites	Best Imaging Modality
Melanoma	Cervical, axillary, inguinal	Lung, liver, brain, bone, soft tissues	PET-CT + brain MRI
SCC	Cervical, parotid, inguinal	Lung, bone, liver	CT or PET-CT
Merkel Cell Carcinoma	Multiple nodal basins	Lung, liver, skeleton	PET-CT
DFSP	Rare	Lung (rare), local recurrence	MRI for local mapping
Angiosarcoma	Early nodal involvement	Lung (common), liver	CT + PET-CT
Kaposi Sarcoma	Lymph nodes	GI tract, lungs	CT/MRI

Table 6. Clinical Decision Matrix for Imaging Selection

Clinical Scenario	Recommended Modality	Rationale
Superficial skin tumor thickness	HFUS	Highest resolution
Suspicion of perineural invasion	MRI	Superior nerve visualization
Bone invasion	CT	Best for cortical detail
Preoperative mapping (face, scalp)	HFUS + MRI	Combine depth & soft-tissue contrast
Suspected nodal spread	US ± PET-CT	Best sensitivity for small nodes
Systemic staging (melanoma/MCC)	PET-CT	Detects distant metastasis
Treatment response assessment	PET-CT or MRI	Functional metabolic data

Table 7. Summary of Modality Strengths

Modality	Strengths	Best Applications
HFUS	Highest resolution for superficial tissues	BCC, SCC, melanoma thickness, DFSP
Doppler US	Vascular assessment	Malignancy risk, biopsy planning
CEUS	Perfusion imaging	Recurrent tumors, vascular lesions
Elastography	Tissue stiffness	Differentiation of benign vs malignant
CT	Bone and deep soft-tissue assessment	Staging, bone invasion
MRI	Best soft tissue detail	Perineural invasion, deep extension
PET-CT	Whole-body metabolic imaging	Melanoma, aggressive SCC, Merkel cell
PET-MRI	Advanced hybrid imaging	Head and neck tumors

Conclusion

Betül Tiryaki Baştuğ

The evaluation and management of dermatologic neoplasms have undergone a profound transformation over the past several decades, driven by advances in imaging technology and an expanding understanding of tumor biology. What was once the exclusive domain of clinical inspection and histopathologic confirmation has evolved into a multidisciplinary field in which radiologic imaging plays a central, indispensable role. Today, effective care for patients with skin tumors—whether benign, locally aggressive, or metastatic—requires the seamless integration of dermatologic expertise with sophisticated radiologic assessment.

Radiologic modalities have become essential across every stage of oncologic care. High-frequency ultrasonography has emerged as a cornerstone of cutaneous imaging, capable of delineating microscopic anatomic structures with remarkable precision. Its ability to quantify tumor thickness, define lesion margins, and evaluate vascularity in real time offers clinicians a level of detail that enhances both diagnostic accuracy and preoperative planning. Doppler ultrasonography, in particular, provides functional insight into tumor angiogenesis, offering prognostic implications that mirror histological markers of aggressiveness.

Magnetic resonance imaging (MRI) contributes unparalleled soft-tissue contrast and multiplanar capability, making it the modality of choice for assessing deep infiltration, perineural spread, and involvement of complex anatomical regions such as the orbit, scalp, or parotid compartments. Computed tomography (CT) continues to serve a vital function in evaluating osseous invasion and thoracoabdominal metastasis, especially in advanced squamous cell carcinoma and melanoma. The advent of hybrid modalities—most notably PET-CT—has further refined staging algorithms by enabling the detection of metabolically active disease, often before structural changes become apparent. This has proven especially valuable in aggressive malignancies such as melanoma, Merkel cell carcinoma, and angiosarcoma, in which early detection of nodal or distant spread significantly alters therapeutic strategies and prognostic outlook.

Imaging also shapes the therapeutic trajectory in critical ways. Radiologic assessment guides the choice between surgical excision, Mohs micrographic surgery, radiation therapy, systemic treatment, or combined approaches. It informs reconstructive planning, ensuring oncologic safety while preserving functional and cosmetic outcomes. During systemic therapy—particularly immunotherapy and targeted therapy—radiologic imaging enables clinicians to interpret complex response patterns, including pseudoprogression and immune-mediated inflammatory changes. These nuanced insights help avoid premature discontinuation of effective treatments and support evidence-based modifications to therapeutic regimens.

In the post-treatment setting, imaging assumes an equally important role. Early detection of local recurrence, in-transit metastases, nodal metastasis, or distant disease can dramatically influence survival outcomes. As many dermatologic malignancies demonstrate unpredictable behavior, long-term surveillance must be tailored to each patient's risk profile, with radiologic imaging serving as the cornerstone of a structured and sensitive follow-up strategy.

Looking ahead, the field of dermatologic oncology is poised for further evolution as emerging technologies continue to expand the boundaries of what radiologic imaging can achieve. Functional imaging techniques, superb microvascular imaging, contrast-enhanced ultrasound, diffusion and perfusion MRI, and radiomics promise to enhance detection, characterization, and prognostication. Artificial intelligence and machine learning algorithms—already demonstrating impressive accuracy in dermatologic image classification—are expected to play an increasingly significant role in analyzing complex radiologic datasets, identifying subtle imaging biomarkers, and supporting clinical decision-making with unprecedented precision.

Perhaps most importantly, the management of dermatologic neoplasms highlights the necessity of multidisciplinary collaboration. The partnership between dermatologists, radiologists, oncologists, surgeons, and pathologists fosters a shared understanding of tumor behavior and ensures that patients benefit from the collective expertise of multiple specialties. Radiologic imaging stands at the center of this collaborative framework, serving as both a diagnostic anchor and a dynamic guide throughout the continuum of care.

In summary, radiologic imaging has become an essential pillar of modern dermatologic oncology, enhancing diagnostic accuracy, refining staging, informing treatment planning, and enabling vigilant surveillance. As technology continues to advance, the integration of cutting-edge imaging with clinical and pathological insights will further elevate the standard of care, ushering in a more precise, personalized, and prognostically meaningful approach to the management of skin tumors.

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IMAGING IN DERMATOLOGIC NEOPLASMS

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