Sonography of Facial Cutaneous Basal Cell Carcinoma

A First-line Imaging Technique

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Invited paper

The Sound Judgment Series consists of invited articles highlighting the clinical value of using ultrasound first in specific clinical diagnoses where ultrasound has shown comparative or superior value. The series is meant to serve as an educational tool for medical and sonography students and clinical practitioners and may help integrate ultrasound into clinical practice.

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Cutaneous basal cell carcinoma is the most common cancer in human beings, and the face is its most frequent location. Basal cell carcinoma is rarely lethal but can generate a high degree of disfigurement. Of all imaging techniques, sonography has proven to support the diagnosis and provide detailed anatomic data on extension in all axes, the exact location, vascularity, and deeper involvement. This information can be used for improving management and the cosmetic results of patients.

Overview and Description of the Clinical Problem

Even though the diagnosis of skin cancer predominantly relies on clinical inspection, imaging techniques are needed to provide unknown or critical characteristics of the tumor that are unavailable to a naked-eye examination. This noninvasive anatomic information could support the early diagnosis and management of the primary tumor as well as staging.

In recent years, the development of new technologies in sonography, including probes with upper-range frequencies that currently can vary from 15 to 22 MHz, has allowed us to discriminate between skin layers. Thus, it is possible to detect and characterize a growing number of common dermatologic entities, including skin cancer, sonographically.

Sonography, a widely available imaging technique, can provide high-definition images of both the skin layers and deeper structures. This property is currently unmatched by other imaging techniques. Moreover, sonography does not expose the patient to radiation or restrict him or her to a confined, lonely, and noisy space. Thus, this imaging modality elicits a rich and live interaction between the sonographer and the patient that permits taking the history, visual inspection, palpation, and sonographic representation of the lesion in real time, to obtain high-quality data. This detailed anatomic information on the features of the primary lesion is of the utmost importance and may influence critical decisions about skin cancer such as the site and extension of the incision, the free margins, and the type of surgery or nonsurgical treatment.

Nonmelanoma skin cancer represents the most common form of malignancy in human beings.[1] Nonmelanoma skin cancer is composed of basal cell carcinoma and squamous cell carcinoma; of these, basal cell carcinoma is the most frequent type and represents

75% to 90% of all skin cancers. Furthermore, 85% of basal cell carcinomas develop in the head and neck region.[2]

Recurrent cases of basal cell carcinoma tend to have a more aggressive progression, ranging between 5% and 50%. Incomplete excision, deep margin involvement, and pleomorphic variants have all been related to an increase in the probability of recurrence.[3]

Moreover, basal cell carcinoma frequently affects sun-exposed areas, such as the face, where it shows a high predilection for sites where the skin is thin, such as the nose, lips, and eyelids, and the tumor may easily involve cartilage or muscle. Hence, basal cell carcinoma has low mortality rates but may be locally aggressive and cause a high degree of disfigurement and morbidity. This factor is a matter of the highest importance, especially in the face, which is the major conveyor of identity and recognition among human beings. To add complexity to the equation, at the same time, there is a patient with high expectations, who demands the best cosmetic results.

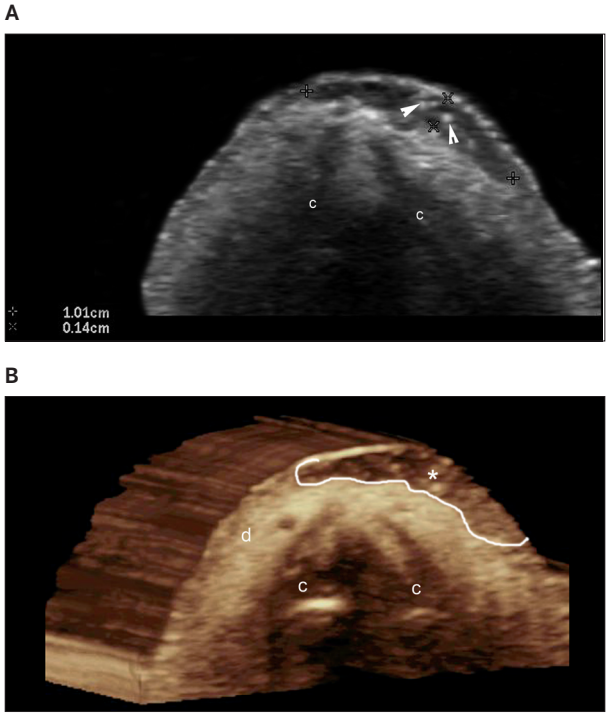
Use of Sonography in Facial Basal Cell Carcinoma to Solve the Problem

Basal cell carcinoma lesions are recognizable on sonography, and the sonographic examination of these tumors can be performed using the same technique that has been previously described for studying localized lesions of the skin using variable-frequency sonography.[4] This technique includes the application of a copious amount of gel over the lesional area and high-resolution equipment with high-frequency probes (upper frequency range, 15–22 MHz). Ideally, hockey stick–shaped probes are recommended because they have a better adaptation to the contour of the face. A grayscale examination in at least 2 axes is performed, followed by a color or power Doppler ultrasound scan of the lesion. Three-dimensional reconstructions are usually used to improve presentation and the understanding of the referring clinicians. Measurements of all diameters (longitudinal, transverse, and deep axes) are registered. In the presence of lesions with irregular borders, the deepest or greatest distance is reported. Descriptions of the type, size, and nature (arteries or veins) of the tumor vessels and the peak systolic velocity of the arterial vessels are also given. Importantly, the presence of involvement of deeper layers such as cartilage, muscle, and bone is noted.

On sonography, basal cell carcinoma tumors tend to appear as well-defined oval hypoechoic or heterogeneous dermal structures; although the lesions can also affect deeper layers.[5] Commonly, basal cell carcinomas have hyperechoic spots, which may be a useful sign to differentiate this tumor from other types of skin cancer.[6] These hyperechoic spots have been reported to have a cotton flower–like appearance and seem not to show the posterior acoustic shadowing artifact that is classically described in gross calcified structures. According to the literature, these spots appear to correlate on histologic analysis with the presence of horn cysts, microcalcifications, or clusters of apoptotic cells in the center of nests of basal cell carcinomas (Figures 1 and 2).[6] Occasionally, the tumors show pleomorphic sonographic appearances and can present variable shapes such as flat, " hourglass," "butterfly," lobulated, asymmetric, irregular, or bulging lesions (Figure 3), as well as multiple locations. The detection of subclinical multiple locations of basal cell carcinoma on sonography has already been documented in the literature.[5]

Frequently, blood flow can be detected within the tumor and its periphery, with slow-flow arteries or veins.[5,7] The latter vascular data can orient the clinician about the distribution and amount of blood flow that he or she will face during surgery. Despite the fact that basal cell carci-

Figure 1. Basal cell carcinoma with dermal involvement (transverse view, nasal tip). Grayscale sonography (**A**) and 3-dimensional reconstruction (**B**, 5- to 8-second sweep) show a 10.1-mm (wide) × 1.4-mm (deep) well-defined hypoechoic oval lesion (between markers in **A** and outlined in **B**) that affects the dermis (d) of the left nasal wing. Notice the hyperechoic spots (arrowheads) within the lesion. The nasal cartilage (c) is unremarkable; asterisk indicates basal cell carcinoma.



nomas usually do not present high vascularity, it should be kept in mind that many of basal cell carcinoma operations are performed in the offices of clinicians and not in the main operating rooms of large hospitals. Nevertheless, the finding of high vascularity within a clinically diagnosed basal cell carcinoma may suggest another type of skin can-

Figure 2. Basal cell carcinoma with dermal and subcutaneous involvement (transverse view, frontal region). **A**, Grayscale sonography shows a 11.4-mm (wide) × 6.6-mm (deep) well-defined oval hypoechoic lesion that involves the dermis (d) and subcutaneous tissue (st). There are hyperechoic spots (arrowheads) within the tumor. **B**, Color Doppler sonography shows increased vascularity within the tumor (asterisk). **C**, Three-dimensional sonographic reconstruction (5- to 8-second sweep) highlights the lesion (asterisk, outlined); b indicates bony margin of the skull.

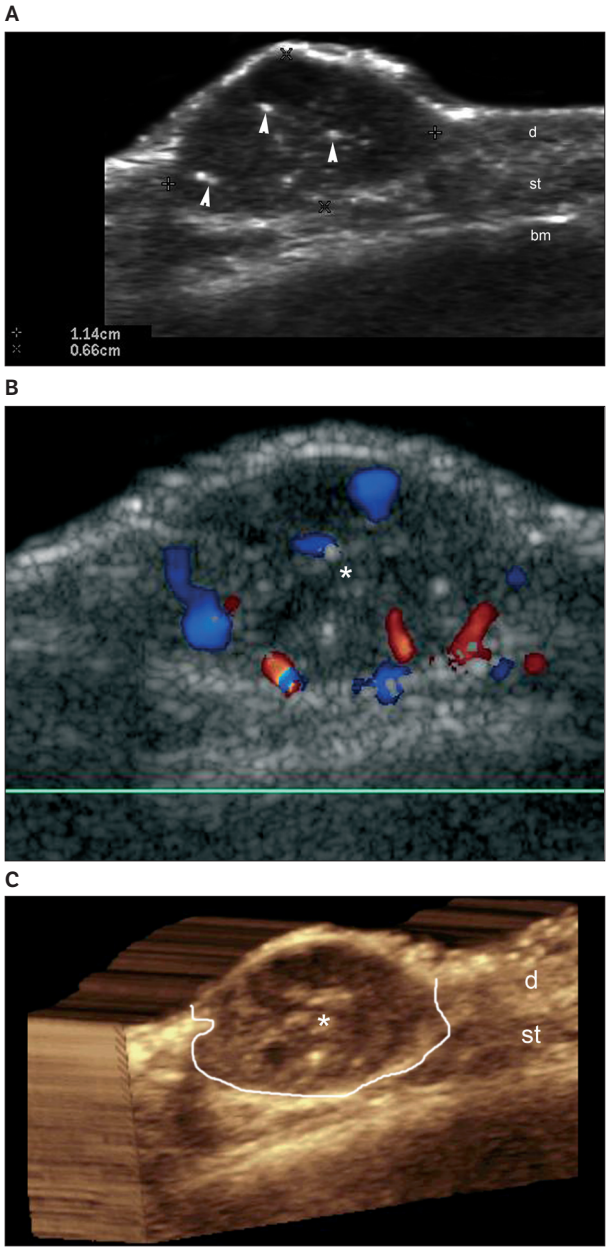
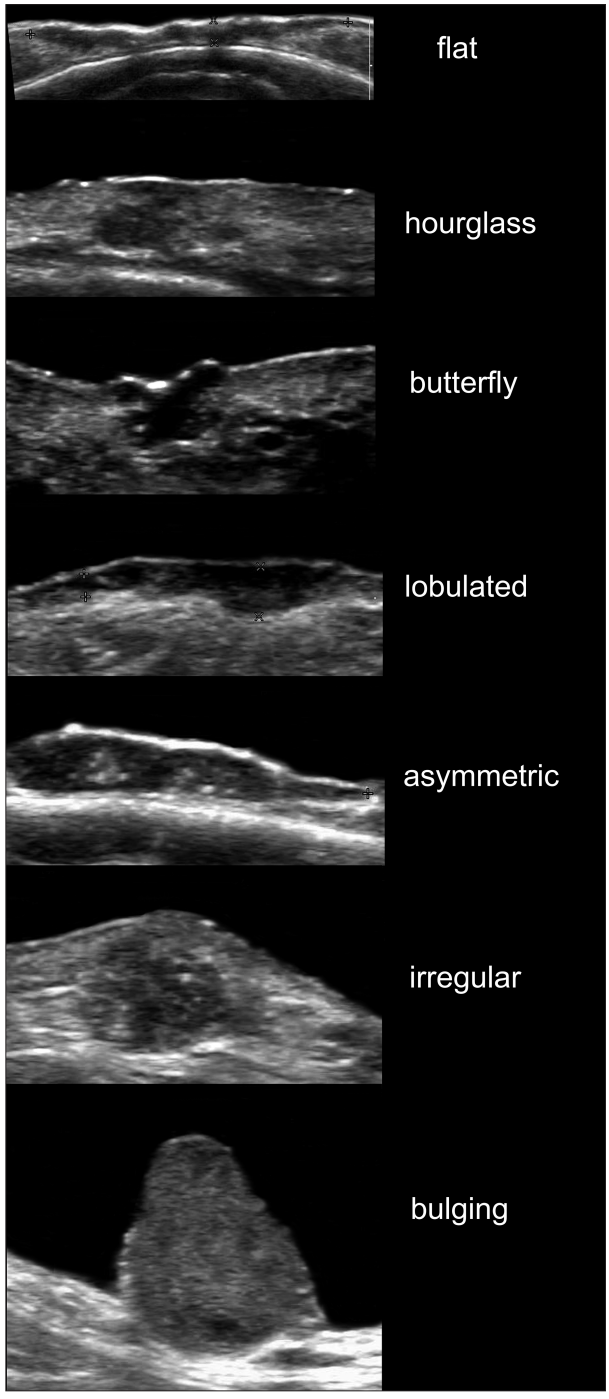


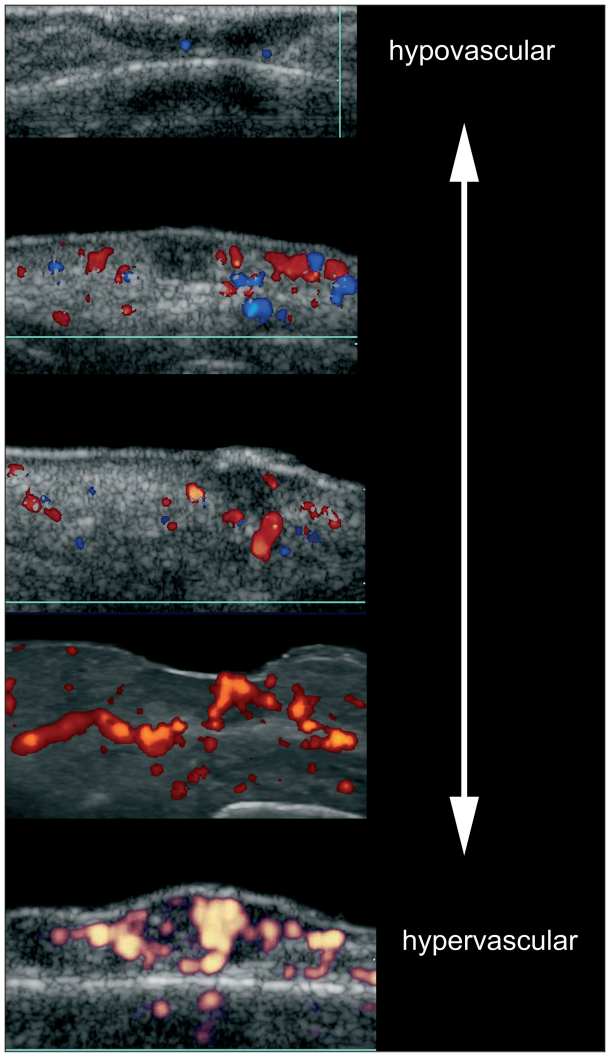
Figure 3. Pleomorphic presentations of basal cell carcinoma lesions on grayscale sonography (transverse views). Notice the variable shapes of the tumors.



cer that could occasionally mimic basal cell carcinoma, such as squamous cell carcinoma, Merkel cell carcinoma, or a metastatic tumor (Figure 4).

The depth correlation between sonography (variable frequency) and histologic analysis in facial basal cell carcinoma has been reported to be excellent.[5] Thus, the intraclass correlation coefficient for comparing thickness for the two methods (sonography and histologic analysis) that has been described in literature is 0.9 (intraclass correlation coefficient values ≥0.9 are very good; 0.70–0.89 are good; 0.50–0.69 are moderate; 0.30–049 are mediocre; and ≤0.29 are bad).

Figure 4. Variable degrees of vascularity in basal cell carcinoma lesions going from hypovascular to hypervascular on color and power Doppler sonography (transverse views).



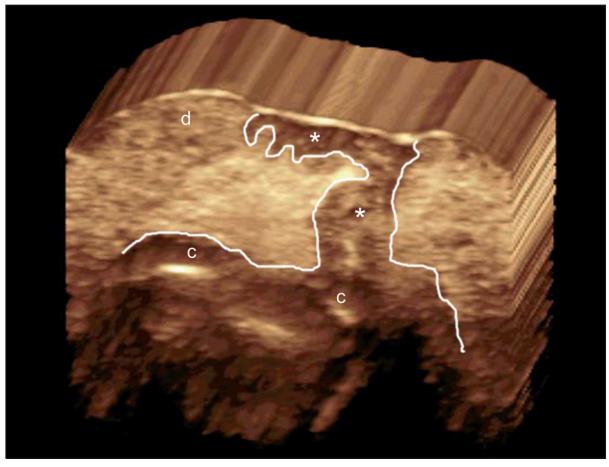
Two rare sonographic artifacts have been described in basal cell carcinoma. One is the "angled border" that is produced by an inflammatory giant cell reaction underlying the tumor, which may falsely increase the apparent size of the tumor. The other is the "blurry border," which is produced by large hypertrophy of the sebaceous glands surrounding the lesion. According to the literature, both artifacts can be recognized by a well-trained operator.[5] The sonographic involvement of deeper layers such as the nasal cartilage and orbicularis muscles in the face is of critical importance and may change the decision about the type of surgery (Figures 5 and 6).

Other Methods of Assessing Tumors and Invasion Besides Sonography

The characterization of basal cell carcinoma is first obtained from the physical examination, which can register the shape, color, pigmentation, ulceration, and firmness of the lesion. Clinically, basal cell carcinoma usually presents as a slow-growing erythematous pearly papule or nodule that may easily bleed or ulcerate. Thus, physical examination can provide the diagnosis but cannot provide information on the deeper extent and anatomic features of the tumor.

Histologic analysis, the reference standard diagnostic modality, shows abundant islands of basaloid cells, variable degrees of mucin, horn cysts, microcalcifications, a pseudoglandular appearance, fibrous stroma, and hyalinization, according to the subtype. Nevertheless, histologic analysis does not provide a wide field of view or anatomic spatial

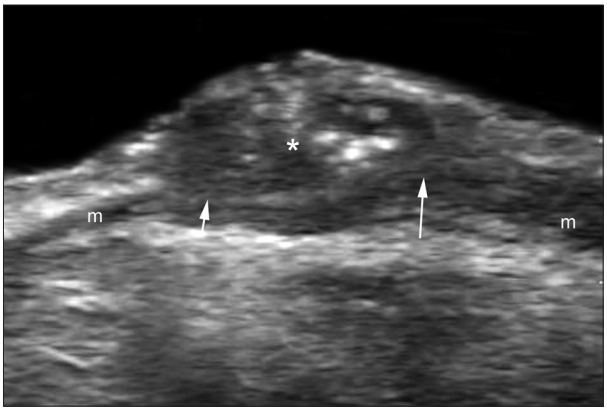
Figure 5. Basal cell carcinoma with nasal cartilage involvement (3-dimensional reconstruction, 5- to 8-second sweep, transverse view, left nasal wing). Notice the extension of the tumor (asterisk, outlined) to the nasal cartilage region (c); d indicates dermis.



information on the extent of the tumor. Moreover, this technique may sometimes show an incomplete representation of the lesion, depending on the size and processing of the sample.

Among other imaging modalities that have been used for studying basal cell carcinomas is high-frequency sonography with fixed-frequency probes that can go from 20 to 100 MHz.[8] Despite the valuable information and good correlation that this technique may provide, it must be borne in mind that this equipment shows maps with more pixelated images, lack of a color Doppler signal, and low penetration, which commonly ranges from 5 mm (20 MHz) to 1 mm (100 MHz). Optical coherence tomography, a high-resolution technique based on the properties of light, has also been reported for studying basal cell carcinomas. According to the literature, optical coherence tomography appears more precise and less biased than high-frequency sonography for thickness measurement in basal cell carcinoma lesions smaller than 2 mm, but both optical coherence tomography and, especially, high-frequency sonography tend to overestimate tumor thickness.[9] Nevertheless, optical coherence tomography has low penetration (<2 mm) and lack of blood flow information. Confocal microscopy, also called reflectance confocal microscopy, is another high-resolution imaging technique that provides in vivo images almost comparable to histologic analysis in basal cell carcinoma lesions. In contrast to previous cross-sectional imaging techniques, confocal microscopy shows a horizontal perspective of the tumor in gray scale. It reportedly has high accuracy in the diagnosis of basal cell carcinoma[10] and has been used to monitor nonsurgical treatment of these tumors.[11] However, confocal microscopy has very low penetration (0.2–0.5 mm).

Figure 6. Basal cell carcinoma with involvement of the orbicularis muscle of the eyelid (m). Grayscale sonography (transverse view, right lower eyelid) shows that the tumor (asterisk) affects the muscle layer (arrows).



In addition, these imaging modalities (high-frequency sonography, optical coherence tomography, and confocal microscopy) have limited availability and are mostly found in some research units and selected dermatology departments. They are predominantly used on an experimental and research basis. Despite their limitations, these high-resolution techniques can give us valuable information on superficial basal cell carcinomas. Nevertheless, awareness of their penetration problems must be kept in mind because they may leave cancerous lesions that affect the lower dermis and deeper layers out of their fields of view.

Currently, no reports are available in the literature on the use of magnetic resonance imaging and computed tomography in the study of primary basal cell carcinoma lesions. The use of these imaging techniques has been focused more on staging in cases with aggressive presentation. Furthermore, currently commercially available magnetic resonance imaging and computed tomographic equipment does not have enough resolution to be able to discriminate between skin layers.

In contrast, sonography, using the current technology, can provide a full range of data that include the exact anatomic location, shape, extent in all axes, blood flow, and deeper involvement of basal cell carcinoma lesions. This imaging modality is not intended to replace histologic analysis but can provide the necessary evidence to remove the tumor with proper free margins. Therefore, a single operation or treatment can be performed that matches the anatomic characteristics of each tumor. Moreover, this management algorithm can be critical for treatment of the face, where the cosmetic prognosis of the patient is of paramount importance.

Conclusions

Sonography may be a supportive tool and first-line imaging modality in the management of facial cutaneous basal cell carcinoma. It can show the primary tumor and provide detailed anatomic data, which may allow modification of the treatment and improve the cosmetic prognosis of the patients. Moreover, the anatomic information provided by sonography is currently unmatched by any other imaging technology.

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