BJGH Brazilian Journal of Global Health
Revista Brasileira de Saúde Global

Ultrasound in the early diagnosis of skin cancer in the elderly: a systematic review

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ABSTRACT

OBJECTIVE

To identify the ultrasound findings of skin cancer as an auxiliary tool in the diagnosis and management of elderly patients.

METHODS

This is a systematic review with searches conducted in PubMed/MEDLINE, Virtual Health Library (VHL — including LILACS and MEDLINE), and SciELO databases. Studies from the last five years, in any language, reporting cases of skin cancer evaluated by ultrasound in patients aged ≥65 years were included, encompassing case reports and case series that employed the method as a diagnostic adjunct.

RESULTS

The sample consisted of 71 medical students, varying in gender, age, cycle (basic or clinical), and other variables. The average age of participants was 22.3 years, ranging from 18 to 52. Individual and combined analyses of the BECK and SPIN questionnaires revealed symptoms of social anxiety in 47.89% and moderate to severe anxiety in 30.99%. When comparing the results of both questionnaires, it was found that 21.12% of students had symptoms of both pathologies. On the BECK Anxiety Questionnaire, the most frequently reported symptom was nervousness (83.3%). On the SPIN inventory, the most common symptom was fear of criticism (76.5%).

DISCUSSION

Findings reinforce ultrasound as a noninvasive, accessible, and effective method for evaluating skin tumors in elderly patients, impacting surgical decisions. Limitations include lack of technical standardization and insufficient information regarding operator training, which may affect reproducibility.

CONCLUSION

Ultrasound proved useful in the assessment of cutaneous neoplasms in the elderly, influencing both diagnosis and clinical-surgical management. More robust studies and technical standardization are needed to consolidate its use as a complementary diagnostic resource.

KEYWORDS

Ultrasound; Early Diagnosis; Skin Cancer; Elderly.

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DOI: https://doi.org/10.56242/globalhealth.2025.5.19.33-39

INTRODUCTION

Ultrasonography (US) is an important tool for the diagnosis and management of various diseases, standing out for its accessibility, rapid execution, noninvasive nature, and safety.[1] In dermatology, its use has expanded since the 1970s, particularly with the development of high-frequency ultrasound (HFUS), which has improved the evaluation of superficial cutaneous structures.[2,3]

HFUS employs transducers with frequencies of at least 15 MHz, according to international guidelines, allowing excellent resolution of superficial structures and proving useful for the diagnosis, staging, and follow-up of lesions such as basal cell carcinoma (BCC) and melanoma.[1,2,4] The examination requires the use of a large amount of gel and appropriate technique, including gentle pressure and adequate operator training.[2,4]

Skin cancer is the most common type of malignant neoplasm in Brazil, including both melanoma and non-melanoma types.[5,6] It is a multifactorial disease, mainly triggered by mutations in the tumor suppressor gene p53, and is characterized by abnormal growth of skin cells, accounting for approximately 30% of all malignant tumors affecting the Brazilian population.[6-8] Risk factors include a family history of skin cancer, lower skin phototypes, and exposure to ultraviolet radiation.[5,6]

Age is also associated with an increased risk of skin cancer, and its incidence rises in parallel with population aging.[9] Consequently, the demand for diagnostic evaluations in the elderly population has increased, in line with the World Health Organization's (WHO) goal of promoting "healthy aging".[10] In this context, the importance of tools capable of early detection of skin cancer and its precursors is reinforced.[9]

Among non-melanoma skin cancers, BCC is the most prevalent subtype, accounting for approximately 75% of cases.11 HFUS may assist in post-treatment follow-up after non-surgical therapies, contributing to decision-making regarding reintervention. Although it does not replace histopathological analysis, US can improve clinical management and positively impact prognosis. In addition, color Doppler ultrasound aids in distinguishing between benign and malignant tumors.[1,12]

Therefore, US represents a relevant tool in the management of skin cancer, especially in elderly patients, given the high incidence of this neoplasm. The present study aims to identify and describe ultrasonographic findings of skin cancer in order to assist in diagnosis and patient management. Specifically, it seeks to evaluate echogenicity, microvasculature, and lesion depth on ultrasonographic images, highlighting their importance in the diagnosis of skin cancer in older adults.

METHODS

Study Design and Search Strategy

This study is a systematic review of case reports and case series with an emphasis on ultrasonographic findings. Based on the PICO strategy, the following research question was formulated: "What is the importance of ultrasound in the early diagnosis of skin cancer in elderly individuals?" This question guided the selection of Health Sciences Descriptors and their alternative terms, according to MeSH: Ultrasonography; Ultrasonics; Ultrasound; Skin Neoplasms; Skin Cancer; Skin Tumors; Aged; Elderly.

A literature search was conducted in the PubMed, Virtual Health Library (VHL), and SciELO databases, combining the descriptors and Boolean operators according to the strategy appropriate for each database. Studies published within the last five years were selected, and articles in any language were considered.

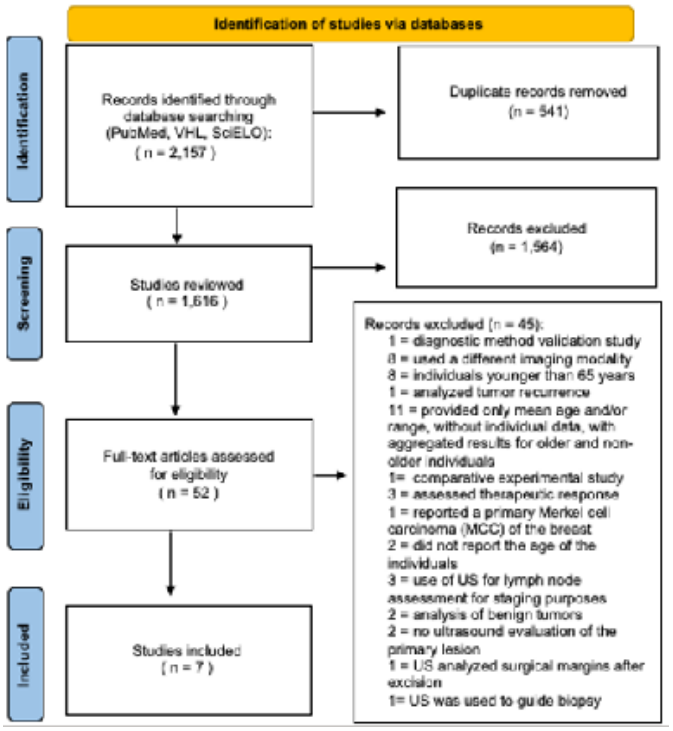
Inclusion and Exclusion Criteria

Case reports and case series of malignant cutaneous neoplasms in which ultrasound was used as an adjunct to diagnosis were included, considering individuals of both sexes aged 65 years or older, since international public health guidelines, including those of the World Health Organization (WHO), consider this cutoff as the definition of the elderly population in developed countries, a definition widely used in clinical and epidemiological studies related to aging.[13,14] Studies in which ultrasonography was used for the analysis of metastases and/or lymph node staging, as well as those that evaluated tumor recurrence, were excluded.

Study Selection and Methodological Quality

In total, 2,157 records were identified and imported into the Rayyan tool. After the removal of 541 duplicates, 1,616 studies were screened by title and abstract, resulting in the exclusion of 1,564. Of the 52 articles assessed in full text, 7 met the inclusion criteria. The process of identification, screening, eligibility, and inclusion of studies followed the recommendations of the PRISMA 2020 statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) and is presented in the flowchart (Figure 1) .[15]

Figure 1 - Flowchart of the literature search



Source: Adapted from PRISMA 2020.[15]
Note: US = ultrasonography

The methodological quality of the included studies was assessed using the JBI Checklist, developed by the Joanna Briggs Institute (JBI), affiliated with the University of Adelaide, Australia. According to the study design, the JBI Critical Appraisal Checklist for Case Reports and the JBI Critical Appraisal Checklist for Case Series were used.[16]

Study Variables

For data standardization and synthesis, the following variables were extracted from the included studies:
Study-related variables: author and year; study design (case report or case series); methodological quality (assessment using the JBI).

Population-related variables: age; sex; total number of participants.

Variables related to cutaneous lesions: type of neoplasm; anatomical location; histopathological diagnosis.

Ultrasonography-related variables: type and frequency of the transducer; described ultrasonographic patterns (dimensions, echogenicity, internal architecture, contours, vascularization, depth, margins, among others); clinical contribution of ultrasonography to diagnosis.

Data Extraction

Data extraction was performed using standardized tables containing all previously defined variables. These data included characteristics of the studies, the population, cutaneous lesions, ultrasonographic findings, and the clinical con-

tribution of the examination (Tables 1 and 2 in the Results section).

RESULTS

Six case reports and one retrospective case series were included, all involving elderly patients (>65 years).[17-23] A meta-analysis could not be performed due to the methodological nature of the studies. Of the seven studies, five demonstrated high quality[17-20,22] and two demonstrated moderate quality[21,23] according to the scores obtained using the applied JBI Checklist tools. The extracted information allowed a descriptive analysis of the applications of ultrasonography in the early diagnosis and surgical management of malignant cutaneous lesions (Tables 1 and 2).

In total, 19 patients were evaluated (16 men and 3 women), aged between 66 and 89 years (mean: 80.2), with malignant cutaneous neoplasms diagnosed by ultrasonography and confirmed by biopsy.

The tables derived from the collected data are presented below. For better understanding, the results were organized and divided into thematic groups, allowing a structured visualization of information relevant to the analysis.

Table 1 - General characteristics of the clinical case reports included in this systematic review

Study	Study design	Methodological quality	Population	Ultrasound frequency	Analyzed lesion	Ultrasound features	Histopathological results	Clinical relevance of ultrasound
Hoang TT, 2021	Clinical case report	High	Female, 88 years	Orbital ultrasound with unspecified frequency	Subcutaneous mass on the left eyebrow	Well-defined hypervascular subcutaneous lesion without invasion of adjacent structures.	Malignant spindle cell melanoma (MSCM)	Assessment of the local extent of the lesion and exclusion of orbital invasion; suggested malignancy due to hypervascularization, prompting excision; contributed to safe surgical planning.
Kim HJ, 2021	Clinical case report	High	Male, 76 years	Multifrequency linear transducer (12–5 MHz)	Reddish, lobulated mass on the posterior aspect of the right elbow	Hypoechoic, heterogeneous, poorly defined mass at the dermal–hypodermal junction; no posterior acoustic enhancement or shadowing; prominent internal vascularization with a branching or chaotic pattern; predominantly hard lesion with intermediate or soft areas associated with peripheral necrosis.	Merkel cell carcinoma (MCC)	Identified an infiltrative, hypoechoic, and hypervascular lesion consistent with carcinoma; aided in early diagnostic suspicion of Merkel cell carcinoma; enabled assessment of necrosis and delineation for resection.
Raimondo G, 2023	Clinical case report	High	Male, 70 years	Breast ultrasound with unspecified frequency	Lesion of the left nipple–areolar complex with rapid growth and ulceration	No specific features were described; however, ultrasound excluded involvement of the mammary gland.	Basosquamous carcinoma (BSC)	Helped exclude involvement of the mammary gland and lymph nodes; guided the surgical plan (mastectomy) with appropriate margins; assisted in the differential diagnosis with other nipple–areolar complex diseases.
Navarro González-Moncayo J, 2023	Clinical case report	High	Male, 66 years	12-MHz linear transducer	Supramalleolar ulcerated lesion on the right leg	Anechoic area with internal hyperechoic foci; mild posterior acoustic enhancement; well-defined dermal–epidermal location; no internal vascularization on Doppler imaging.	Basal cell carcinoma (BCC) — nodular type	Ultrasound raised diagnostic suspicion of basal cell carcinoma; allowed visualization of the extent and dermal depth of the lesion; influenced the decision for biopsy and early excision.
Itani Y, 2019	Clinical case report	Moderate	Female, 73 years	12-MHz linear probe	Asymptomatic subcutaneous nodule in the left posterior neck region	Ovoid, well-defined, mildly hypoechoic mass; no evident vascular flow on Doppler; presence of indistinct echogenic striations within the mass.	Atypical lipomatous tumor (ALT)	Helped differentiate ALT from lipoma based on internal characteristics (indistinct striations, absence of vascularization); indicated the need for excision and complete histopathological evaluation; proposed ultrasound as a useful tool for screening and suspicion of malignancy in atypical adipose tumors.
Vázquez-Osorio I, 2019	Clinical case report	High	Male, 74 years	Frequency not specified	Purplish-reddish macular lesions, well defined, congestive, and non-infiltrated	Increased blood flow within the lesion, consistent with active tumor vascularization.	Kaposi sarcoma, lymphangioma-like type	Doppler demonstrated increased intralesional blood flow, contributing to clinical suspicion of a vascular tumor; it was crucial in differentiating the lesion from infectious or inflammatory causes, supporting the decision for biopsy that confirmed Kaposi sarcoma.

Source: Authors' own work

Table 2 - General characteristics of the retrospective case series included in this systematic review

Study	Study design	Methodological quality	Population	Ultrasound frequency	Analyzed lesion	Ultrasound features	Histopathological results	Clinical relevance of ultrasound
Crisan D, 2024	Retrospective case series	Moderate	12 men and 1 woman, mean age 82.9 years. Individual data are presented below:	High-frequency linear transducers: 17 MHz and 11 MHz	Lesions predominantly located in the parietal scalp region (92%), with one case on the helix of the ear	Hypoechoic, well-defined lesions; some infiltrating the subcutaneous tissue, periosteum, or cartilage. Increased vascularization in nearly all cases. Key difference: AFX—confined to the dermis, without deep invasion; PDS—infiltrating the subcutaneous tissue or beyond.	Atypical fibroxanthoma (AFX) (n = 5) Pleomorphic dermal sarcoma (PDS) (n = 8)	Preoperative differentiation between AFX and PDS; surgical guidance (type of excision and reconstruction); avoidance of treatment delays; noninvasive and efficient method.
			Male, 69 years		Lesion in the left parietal area	Hypoechoic, well-defined lesion located in the dermis, with infiltration into the subcutaneous tissue; evident vascularization on Doppler.	Pleomorphic dermal sarcoma (PDS)	Identified the depth of infiltration and vascularization, modifying the initial expectation of AFX and altering surgical management.
			Male, 89 years		Lesion in the high parietal area	Hypoechoic, well-defined lesion located in the dermis, with infiltration into the subcutaneous tissue reaching the periosteum; evident vascularization on Doppler.	Pleomorphic dermal sarcoma (PDS)	Identified the depth of infiltration and vascularization, enabling suggestion of the specific pleomorphic spindle cell tumor; allowed definition of the surgical plan.
			Male, 85 years		Lesion on the helix of the right ear	Hypoechoic, well-defined lesion with infiltration up to the cartilage line, without infiltration beyond this level; evident vascularization on Doppler.	Pleomorphic dermal sarcoma (PDS)	Identified the depth of infiltration and vascularization, modifying the initial expectation of AFX and altering surgical management.
			Male, 87 years		Lesion in the high parietal area	Hypoechoic, well-defined lesion located in the dermis, without infiltration into the subcutaneous tissue; evident vascularization on Doppler.	Atypical fibroxanthoma (AFX)	Identified lesion depth and excluded subcutaneous infiltration, allowing planning of simple Mohs micrographic surgery.
			Male, 78 years		Lesion in the high parietal area	Hypoechoic, poorly defined lesion located in the dermis after shave biopsy, without infiltration into the subcutaneous tissue; evident vascularization on Doppler.	Atypical fibroxanthoma (AFX)	Modified the initial suspicion; absence of infiltration avoided extensive resection and complex reconstruction.
			Male, 89 years		Lesion in the high parietal area	Hypoechoic, well-defined lesion located in the dermis, with infiltration into the subcutaneous tissue; evident vascularization on Doppler.	Pleomorphic dermal sarcoma (PDS)	Identified the depth of infiltration and vascularization; allowed definition of the surgical plan.
			Male, 87 years		Lesion in the left parietal area	Hypoechoic, well-defined lesion located in the dermis, with infiltration into the subcutaneous tissue up to the galea; evident vascularization on Doppler.	Pleomorphic dermal sarcoma (PDS)	Identified the depth of infiltration and vascularization; allowed definition of the surgical plan.
			Female, 85 years		Lesion in the high parietal area	Hypoechoic, well-defined lesion located in the dermis, without infiltration into the subcutaneous tissue; evident vascularization on Doppler.	Atypical fibroxanthoma (AFX)	Identified lesion depth and excluded subcutaneous infiltration, allowing planning of simple Mohs micrographic surgery.
			Male, 85 years		Lesion in the left parietal area	Hypoechoic dermal lesion without infiltration into the subcutaneous tissue; absence of vascularization on Doppler.	Atypical fibroxanthoma (AFX)	Identified lesion depth and excluded subcutaneous infiltration, allowing planning of simple Mohs micrographic surgery.
			Male, 83 years		Lesion in the high parietal area	Well-defined hypoechoic dermal lesion with infiltration into the subcutaneous tissue; evident vascularization on Doppler.	Pleomorphic dermal sarcoma (PDS)	Identified the depth of infiltration and vascularization, modifying the initial expectation of AFX and altering surgical management.
			Male, 81 years		Lesion in the right parietal area	Hypoechoic, well-defined lesion located in the dermis, with infiltration into the subcutaneous tissue; evident vascularization on Doppler.	Pleomorphic dermal sarcoma (PDS)	Identified the depth of infiltration and vascularization, enabling suggestion of the specific pleomorphic spindle cell tumor; allowed definition of the surgical plan.
			Male, 83 years		Lesion in the high parietal area	Well-defined hypoechoic hypodermal lesion; evident vascularization on Doppler.	Pleomorphic dermal sarcoma (PDS)	Delineated the lesion; allowed definition of the surgical plan.
			Male, 77 years		Lesion in the right parietal area	Hypoechoic, well-defined lesion located in the dermis, without infiltration into the subcutaneous tissue; evident vascularization on Doppler.	Atypical fibroxanthoma (AFX)	Identified lesion depth and excluded subcutaneous infiltration, allowing planning of simple Mohs micrographic surgery.

Source: Authors' own work.

Transducers and Operator Training

Of the nineteen malignant cutaneous tumors evaluated, three did not report the transducer frequency.[17,19,22] In the retrospective case series, linear transducers of 17 MHz and 11 MHz were used[23]; in two cases, 12 MHz transducers were employed[20,21]; and in one case, a multifrequency linear probe of 5–12 MHz was used[18], resulting in a frequency range of 5 to 17 MHz in the acquired images. None of the seven reviewed studies described operator training; however, in Kim et al. (2021)[18] the examination was performed by a musculoskeletal radiologist, and in Crisan et al. (2024)[23] all assessments followed a standardized protocol performed by the same operator in accordance with dermatologic ultrasonography guidelines.

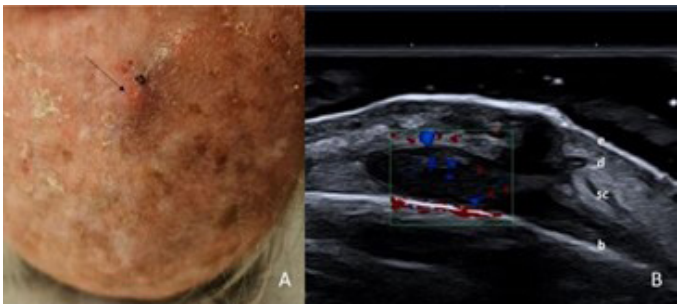
Ultrasonographic Assessment

Of the 16 lesions evaluated for echogenicity, 93.7% were hypoechoic.[18,21,23] Basal cell carcinoma (BCC) appeared as an anechoic area with internal hyperechoic spots and mild posterior acoustic enhancement[20], whereas Merkel cell carcinoma (MCC) was hypoechoic, without posterior enhancement, and on elastography was predominantly stiff, with intermediate/soft areas associated with peripheral necrosis18. Three cases did not report echogenicity.[17,19,22] Regarding vascularization, 78.9% of lesions exhibited prominent internal flow[17,18,22,23], 15.7% showed no Doppler signal[20,21,23], and no vascularization data were reported for basosquamous carcinoma (BSC) [19]. MCC was notable for intense internal flow with a branching pattern[18].

Ultrasound was useful in 94.7% of cases for defining lesion extent and margins.[17-20,23] In basosquamous carcinoma (BSC), it excluded involvement of the mammary gland[19], whereas in lymphangioma-like Kaposi sarcoma it was used only to assess vascular flow[22]. In the latter, although ultrasound did not provide topographic delineation, the examination was essential to differentiate the lesion from infectious or inflammatory processes and to indicate biopsy, which confirmed the diagnosis.

Crisan et al. (2024)[23] demonstrated that preoperative ultrasonography was able to differentiate atypical fibroxanthoma (AFX) from pleomorphic dermal sarcoma (PDS) with 100% accuracy, directly influencing surgical management, as it allowed assessment of lesion infiltration depth (dermis vs. subcutaneous tissue). It was concluded that AFX and PDS appear on ultrasound as hypoechoic tumors with differing depths, with AFX restricted to the dermis, whereas PDS extends into the subcutaneous tissue (Figure 2). [23]

Figure 2 - Clinical appearance of an erythematous nodule in the parietal region — A; HFUS with color Doppler showing a well-defined, hypervascular dermal–hypodermal tumor extending to the bone surface, consistent with a high-risk pleomorphic dermal sarcoma (PDS) ("e" – epidermis, "d" – dermis, "sc" – subcutaneous tissue, "b" – bone) — B.



Source: Crisan D et al. J Ultrasound Med. 2024;43(8):1563–1572. CC BY 4.0 license. doi: 10.1002/jum.16478

Patient Management

In three case reports, ultrasound was able to differentiate the lesions from benign conditions, guiding biopsy, and in the case presented by Hoang et al. (2021)[17] lesion excision was motivated by evident hypervascularization on Doppler imaging.[17,21,22] In the study by Kim et al. (2021)[18], although ultrasonography did not alter patient management, after histological diagnosis the echographic findings were correlated with the characteristics of Merkel cell carcinoma (MCC) described in the literature.[18] The study by Navarro González-Moncayo et al. (2023)[20] highlighted the importance of tumor anatomical location in defining the most appropriate treatment and emphasized that basal cell carcinoma (BCC) presents very characteristic features that facilitate its diagnosis by ultrasonography.[20] In the studies by Raimondo et al. (2023)[19] and Crisan et al. (2024)[23], ultrasound was important in guiding the surgical plan, and in four cases patient management was completely altered because the ultrasonographic image was opposite to the initial clinical suspicion.[19,23] Therefore, 94.73% of patients experienced an impact on subsequent management due to the ultrasonographic imaging of the lesion.

DISCUSSION

The present review sought to synthesize the available evidence regarding the use of ultrasonography in the early diagnosis of skin cancer in the elderly population. The results indicate that the use of ultrasound in the evaluation of malignant cutaneous lesions in older adults is capable of modifying patient management with a direct impact on early diagnosis, through assessment of lesion echogenicity, extent, and vascularization, thereby influencing clinical and surgical decision-making.

In 94.7% of the evaluated patients, ultrasonography influenced medical management, either by guiding the performance of early biopsies or by defining more precise surgical margins. The most noteworthy case was the study by Crisan et al. (2024)23, in which ultrasonography was able to accurately differentiate atypical fibroxanthoma (AFX) from pleomorphic dermal sarcoma (PDS) based on infiltration depth, highlighting its value in noninvasive preoperative stratification.[23]

When comparing the report by Kim et al. (2021)[18] with the international literature, the ultrasonographic characteristics of MCC found—such as a hypoechoic lesion with chaotic internal Doppler vascularization and ill-defined margins—are consistent with findings described by authors such as Wortsman and Gregor (2013)[24] and Catalano et al. (2018)[25], who also advocate the use of high-frequency ultrasound in oncologic dermatology for the evaluation of cutaneous tumors.[18,24,25] Similarly, the BCC described by Navarro González-Moncayo et al. (2023)[20] exhibited characteristics previously reported by Laverde-Saad et al. (2022)[1] and Hernández-Ibáñez et al. (2017)[26] — such as a well-defined lesion at the dermoepidermal junction with intralesional hyperechoic spots and absence of Doppler vascularization.[1,20,26]

Additionally, in the case reported by Hoang et al. (2021)[17], malignant spindle cell melanoma (MSCM) was described as a well-defined hypervascular subcutaneous lesion, with vascular flow motivating excision. In the basosquamous carcinoma (BSC) presented by Raimondo et al. (2023)[19], exclusion of mammary gland involvement allowed differential diagnosis with other diseases of the nipple–areolar complex. In the case of atypical lipomatous tumor (ALT) reported by Itani et al. (2019)[21], ultrasonographic screening was essential in raising suspicion of malignancy, and finally, the lymphangioma-like Kaposi sarcoma analyzed by Vásquez-Osorio et al. (2019)[22] proceeded to biopsy following ultrasonographic evaluation.

Thus, although there is no single ultrasonographic pat-

tern for skin cancer, the literature seeks to characterize each type of clinical presentation using ultrasound and demonstrates that defining features do exist. Moreover, ultrasonographic assessment plays an important role in guiding patient management.

On the other hand, the lack of standardization in some studies regarding transducer frequency, as well as the absence of descriptions of operator training, limits reproducibility and hinders direct comparison between findings.

Study Limitations

Among the limitations of this review, the small number of available studies stands out, with most publications consisting of isolated case reports, which limits the generalizability of the results. In addition, heterogeneity in technical approaches also represents a challenge for consolidating ultrasonography as a systematic method for the evaluation of cutaneous lesions. Despite these limitations, methodological quality was predominantly high, and the extracted data reinforce the potential of ultrasound as a complementary tool in oncologic dermatologic assessment of elderly patients.

In light of these findings, future studies with a larger number of participants are suggested, preferably clinical trials or cohort studies, which may confirm and expand knowledge regarding the benefits of ultrasonography in geriatric dermatologic practice. Furthermore, training of imaging professionals in dermatologic ultrasound and standardization of examination protocols may contribute to consolidating this technique as an accessible, noninvasive diagnostic method with high clinical utility.

CONCLUSION

In conclusion, ultrasound is shown to be a relevant complementary diagnostic tool in the evaluation of cutaneous neoplasms in elderly individuals. Its applicability proved significant in the morphological characterization of lesions, directly contributing to the definition of more precise clinical and surgical management.

Despite the methodological limitations of the included studies and the lack of standardization regarding transducer frequency and operator training, the analyzed data indicated a relevant clinical impact in 94.7% of the evaluated patients.

Thus, the importance of further studies with more robust methodological designs is emphasized, as well as the need for professional training and standardization of ultrasonographic examinations, so that this technology can be systematically incorporated into oncologic dermatologic practice in aging populations.

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