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Dr. B Prakash Kumar

Assistant Professor,

Department of Veterinary
Surgery and Radiology, College
of Veterinary Science, Garividi,
Andhra Pradesh, India

Dr. Mala Shammi

Professor (Retd), Department of
Veterinary Surgery and
Radiology, Madras Veterinary
College, Chennai, Tamil Nadu,
India

Dr. C Ramani

Professor and Head (Retd),
Department of Clinics &
Veterinary Surgery, Madras,
Veterinary College, Chennai,
Tamil Nadu, India

Dr. Geetha Ramesh

Retd Professor and Head,
Department of Veterinary
Anatomy, Madras Veterinary
College, Chennai, Tamil Nadu,
India

Dr. Balagadharthilagar

Associate Professor, Department
of Clinics, Madras Veterinary
College, Chennai, Tamil Nadu,
India

Corresponding Author:

Dr. B Prakash Kumar

Assistant Professor,

Department of Veterinary
Surgery and Radiology, College
of Veterinary Science, Garividi,
Andhra Pradesh, India

Use of ultrasound technique in predicting histopathological characterization of mammary tumors in dogs

B Prakash Kumar, Mala Shammi, C Ramani, Geetha Ramesh and Balagadharthilagar

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Abstract

Canine mammary tumors are the most common neoplasms in female dogs, comprising nearly 50% of all tumors. Fifteen bitches with mammary tumors presented to the Small Animal Soft Tissue Surgery Ward, Madras Veterinary College, Chennai, were included in the present study. Each case underwent physical examination, hematological and biochemical evaluation, fine needle aspiration cytology (FNAC), B-mode, and Doppler ultrasonography of the inguinal lymph node, followed by surgical excision and histopathological confirmation. Ultrasonographic findings were compared with histopathological results. B-mode variables such as echogenicity, echotexture, and capsule definition showed limited specificity for malignancy prediction. In contrast, Doppler assessment of vascular pattern and hilar perfusion demonstrated higher diagnostic value. Though histopathology remains the gold standard, ultrasound imaging, especially Doppler evaluation, provides a valuable non-invasive adjunct for preoperative assessment of mammary tumors in dogs.

Keywords: Doppler Ultrasonography, FNAC, canine mammary tumor, malignancy, histopathology

Introduction

Canine mammary tumors (CMTs) are among the most frequently diagnosed neoplasms in intact female dogs, accounting for 35-50% of all tumors (Sorenmo *et al.*, 2013) ^[7]. These neoplasms exhibit significant biological variability, ranging from benign adenomas to highly malignant carcinomas with metastatic potential, predominantly via lymphatic spread to regional lymph nodes and lungs. Early ovariohysterectomy (before the first or second estrus) has been shown to markedly reduce the risk of mammary neoplasia, indicating the hormonal dependency of these tumors (Sorenmo *et al.*, 2013) ^[7]. Surgical excision remains the treatment of choice; however, early detection and accurate characterization of the tumor are essential for determining prognosis and therapeutic planning. Ultrasonography, being a non-invasive and readily available imaging modality, offers real-time evaluation of tumor structure and vascularity. Previous studies have highlighted the potential of ultrasonographic characteristics, particularly Doppler indices, in differentiating benign from malignant lesions (Feliciano *et al.*, 2012; Nyman *et al.*, 2006) ^[1, 4]. This study aimed to evaluate the diagnostic potential of B-mode and Doppler ultrasonography in predicting the histopathological nature of canine mammary tumors.

Materials and Methods

The study was conducted on 15 bitches presenting with mammary tumors at the Small Animal Soft Tissue Surgery Ward, Madras Veterinary College, and Chennai (Figure 1). Each dog underwent general physical examination, hematological and biochemical analysis, and fine needle aspiration cytology (FNAC). The inguinal lymph node, serving as the sentinel node, was evaluated using an Esaote ultrasound machine with both B-mode and Color Doppler modalities (Figure 2). In B-mode ultrasonography, echogenicity, echotexture, and capsule margins were recorded. In Doppler ultrasonography, vascular signal pattern, distribution, and hilar perfusion were analyzed.

Saved images were retrieved and analyzed using DICOM software. Tumor samples collected post-surgery were fixed in 10% buffered formalin, processed routinely, and stained with

hematoxylin and eosin (H&E). Histopathological classification served as the gold standard for comparison.



Fig. 1: A bitch presented with a visible mammary tumor at the caudal abdominal region prior to ultrasonographic evaluation



Fig 2: Ultrasonographic examination of the inguinal lymph node (sentinel node) using an ultrasound machine in a bitch with a mammary tumor.

Results

Out of the fifteen canine mammary tumors evaluated, 13 (86.6%) were histologically diagnosed as malignant carcinomas, while 2 (13.3%) were benign in nature. Ultrasonographic evaluation was performed without technical difficulties.

All benign tumors appeared isoechoic and homogeneous with well-defined, regular capsule margins (Figure 3, Table 1). In contrast, malignant tumors were hypoechoic in 11 cases and inhomogeneous in texture, with irregular or ill-defined capsule borders in all 13 cases (Figure 4). These findings indicate that echogenicity, internal texture, and margin definition are valuable sonographic indicators of malignancy.

B-mode Ultrasonographic Findings

Table 1: B-mode ultrasound observations of canine mammary tumors

B-mode ultrasound observation	Benign	Malignant
Echogenicity	Isoechoic-2	Hypoechoic-11
Echotexture	Homogeneous-2	Inhomogeneous-11
Capsule features	Well defined with regular margins-2	Irregular-13



Fig 3: Ultrasonographic image showing clear margins of capsule with uniform echogenicity

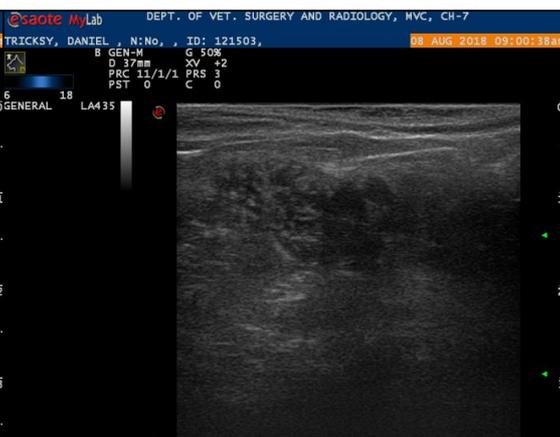


Fig 4: Ultrasonographic image showing inhomogenous lymphnode parenchyma without any capsule

Doppler Ultrasonographic Findings

Color Doppler findings (Table 2) revealed that benign tumors exhibited ordered vascular signals with radial distribution from the hilum toward the capsule, while malignant tumors demonstrated chaotic or unordered vascular patterns with

peripheral or subcapsular flow (Figure 5 & 6). The hilar region was identifiable in all benign lesions but absent in 8 out of 13 malignant ones, reflecting neoplastic angiogenesis and loss of normal vascular architecture.

Table 2: Doppler ultrasound findings of canine mammary tumors

Doppler observation	Benign	Malignant
Vascular signal pattern	Ordered-2	Chaotic / unordered-13
Distribution	Radial from hilum towards capsule – 2	Peripheral or subcapsular-13
Hilar region	Present-2	Absent-8

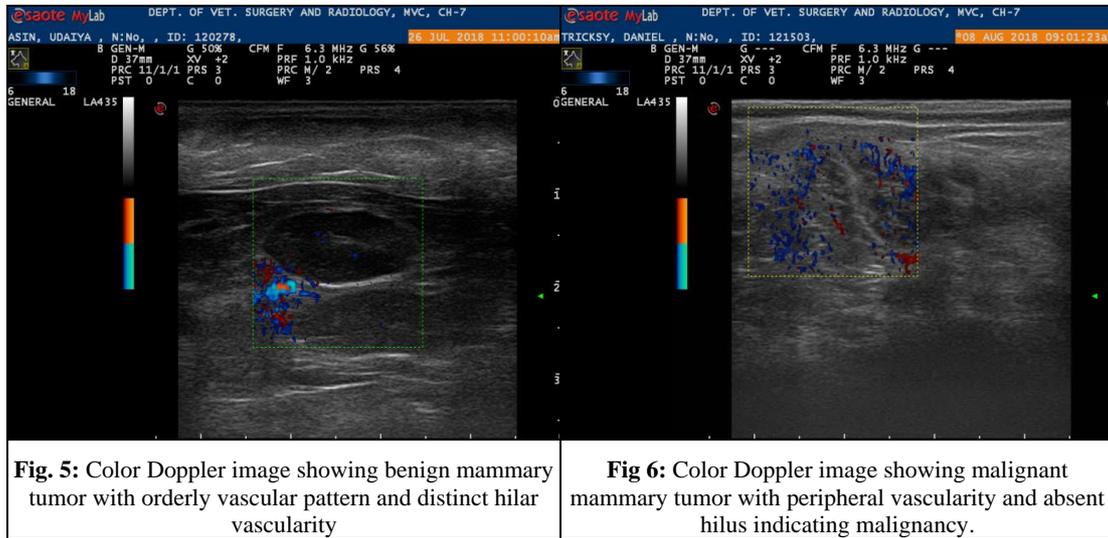


Fig. 5: Color Doppler image showing benign mammary tumor with orderly vascular pattern and distinct hilar vascularity

Fig. 6: Color Doppler image showing malignant mammary tumor with peripheral vascularity and absent hilus indicating malignancy.

Histopathological Classification

Histopathological examination (Table 3) confirmed the ultrasonographic findings. Among malignant cases, 12 were simple carcinomas and one was a carcinoma in mixed tumor (osteosarcoma type). Benign tumors included one adenoma and one lipoma. These results validate the diagnostic potential of ultrasonography for preliminary classification of canine mammary tumors.

Table 3: Histopathological classification of canine mammary tumors

Classification	Type	Diagnosis	Number
Malignant	Carcinomas	Carcinoma in mixed tumor (Osteosarcoma)	1
		Carcinoma	12
Benign	Adenoma		1
	Lipoma		1
Total			15

Discussion

The present study demonstrates the diagnostic relevance of B-mode and Doppler ultrasonography in evaluating canine mammary tumors, with Doppler providing superior discrimination between benign and malignant lesions. Our findings align with those of Feliciano *et al.* (2012) [1] and Nyman *et al.* (2006) [4], who reported that malignant tumors often exhibit irregular margins, hypoechoic texture, and chaotic peripheral vascularization. In the present study, B-mode ultrasonography alone exhibited limited specificity, as irregular contours and inhomogeneous echotexture were not always indicative of malignancy consistent with the observations of Gasparini *et al.* (2018) [2]. Conversely, Color Doppler ultrasonography significantly enhanced diagnostic accuracy. The presence of disorganized, peripheral vascular patterns and loss of hilar architecture were characteristic of malignancy, corroborating the findings of Lamb *et al.* (2015) [3] and Silva *et al.* (2018) [5]. The increased neovascularization observed in malignant tumors corresponds to angiogenic activity associated with tumor aggressiveness. Eight malignant cases in this study still exhibited hilar vascularity, suggesting transitional angiogenic stages or partial lymph node involvement a finding also noted by Zotti *et al.* (2010) [8]. Therefore, while Doppler ultrasonography improves diagnostic confidence, histopathology remains essential for definitive diagnosis and grading. Future integration of advanced imaging modalities such as contrast-enhanced ultrasonography and elastography could provide better

quantification of perfusion and tissue stiffness, further enhancing diagnostic precision.

Conclusion

Benign mammary tumors in dogs generally appear as well-encapsulated, homogeneous, and isoechoic masses with organized vascularization, whereas malignant tumors demonstrate irregular margins, hypoechogenicity, inhomogeneous structure, and chaotic peripheral vascularity. B-mode and Doppler ultrasonography of sentinel lymph nodes provide valuable non-invasive indicators for predicting malignancy; however, histopathological examination remains the gold standard. This is the first report from India evaluating sentinel lymph node ultrasonography for histological prediction of canine mammary tumors. Further studies on larger sample sizes using advanced imaging modalities are warranted for standardization.

Conflict of Interest

Not available

Financial Support

Not available

Reference

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