Ultrasound for diagnosis of soft-tissue lipoma : accuracy and differentiating features from other soft-tissue mass

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การใช้อัลตร้าซาวด์ในการวินิจฉัยเนื้องอกไขมันไลโปมา : ความถูกต้องและลักษณะที่ช่วยแยกจากก้อนเนื้องอกอื่น

Abstract

Objectives : To evaluate diagnostic accuracy of ultrasound for diagnosis of soft-tissue lipoma and to figure out sonographic features differentiating lipoma from other soft-tissue mass

Materials and methods : Sixty-nine masses were retrospectively reviewed. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of ultrasound diagnosis for lipoma were determined using histologic diagnosis as the reference standard. Sonographic features were compared between lipoma and non-lipoma group. Lipomas were subdivided into superficial vs deep-seated location and small vs large size, then subgroup analysis was performed.

Results : The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of ultrasound diagnoses for lipoma were 84.85%, 91.67%, 90.32%, 86.84%, and 88.41%, respectively. Sonographic characteristics which were significantly different between lipoma and non-lipoma group include echogenicity, cystic portion, and internal vascularity. Most lipomas appeared as well-defined masses with iso- or hyperechogenicity relatively to subcutaneous fat tissue with absent cystic portion and absent internal vascularity. Accuracy of ultrasound for diagnosis of deep-seated lipoma was lower than its superficial counterpart. One large lipoma was missed by ultrasound and was further evaluated by MRI.

Conclusion : Ultrasound demonstrates good accuracy in the diagnosis of superficial soft-tissue lipoma. Iso- or hyperecho-genicity with absent cystic portion and absent internal vascularity are significant sonographic features. Further investigation may be needed in deep-seated or large masses.

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Keywords : lipoma, ultrasound, accuracy

บทคัดย่อ

วัตถุประสงค์ : ศึกษาความถูกต้องของอัลตร้าซาวด์ในการวินิจฉัยเนื้องอกไขมันไลโปมา และศึกษาลักษณะทางอัลตร้าซาวด์ที่ช่วยแยกเนื้องอกไขมันไลโปมาออกจากเนื้องอกชนิดอื่น

วิธีการ : เป็นการศึกษาย้อนหลังในก้อนเนื้องอก 69 ก้อน หาค่าความไว ความจำเพาะ และความถูกต้องของการวินิจฉัยเนื้องอกไขมันไลโปมาโดยอัลตร้าซาวด์ โดยเปรียบเทียบกับผลตรวจทางพยาธิวิทยา และเปรียบเทียบลักษณะทางอัลตร้าซาวด์ของเนื้องอกไขมันไลโปมากับของเนื้องอกชนิดอื่นว่ามีลักษณะใดที่แตกต่างกัน รวมทั้งมีการวิเคราะห์ในกลุ่มย่อยของเนื้องอกไขมันไลโปมาที่แบ่งตามความลึก และขนาดของก้อน

ผลการศึกษา : อัลตร้าซาวด์มีค่าความไว ความจำเพาะ และความถูกต้องในการวินิจฉัยเนื้องอกไขมันไลโปมาร้อยละ 84.85, 91.67และ 88.41 ตามลำดับ ลักษณะทางอัลตร้าซาวด์ของเนื้องอกไขมันไลโปมาที่แตกต่างจากเนื้องอกอื่นอย่างมีนัยสำคัญทางสถิติได้แก่ สีของก้อน ส่วนที่เป็นน้ำภายในก้อน และการเห็นหลอดเลือดเข้าไปเลี้ยงก้อน โดยเนื้องอกไขมันไลโปมาส่วนใหญ่จะมีขอบเขตชัด สีใกล้เคียงหรือขาวกว่าเนื้อเยื่อไขมันใต้ผิวหนัง ไม่มีส่วนที่เป็นน้ำภายในก้อน และไม่เห็นหรือแทบจะไม่เห็นหลอดเลือดเข้าไปเลี้ยงก้อน ความถูกต้องของอัลตร้าซาวด์ในการวินิจฉัยเนื้องอกไขมันไลโปมาที่อยู่ในชั้นลึกจะไม่ดีเท่าก้อนที่อยู่ในชั้นตื้น และในการศึกษานี้มีเนื้องอกไขมันไลโปมาขนาดใหญ่ 1 ก้อนที่มองไม่เห็นจากอัลตร้าซาวด์ และได้รับการตรวจเพิ่มเติมด้วยเอ็ม อาร์ ไอ

สรุป : การวินิจฉัยเนื้องอกไขมันไลโปมาโดยใช้อัลตร้าซาวด์ มีความถูกต้องสูง โดยเฉพาะในก้อนที่อยู่ตื้น โดยลักษณะทางอัลตร้าซาวด์ที่สำคัญคือ สีของก้อนที่ใกล้เคียงหรือขาวกว่าเนื้อเยื่อไขมันใต้ผิวหนัง ไม่มีส่วนที่เป็นน้ำภายในก้อน และไม่เห็นหรือแทบจะไม่เห็นหลอดเลือดเข้าไปเลี้ยงก้อน ทั้งนี้ก้อนที่อยู่ลึกหรือก้อนที่มีขนาดใหญ่ อาจต้องการการตรวจเพิ่มเติมด้วยเอ็ม อาร์ ไอ

คำรหัส : เนื้องอกไขมันไลโปมา, อัลตร้าซาวด์

Original Articles นิพนธ์ต้นฉบับ

*กลุ่มงานรังสีวิทยา โรงพยาบาลสมุทรปราการ จังหวัดสมุทรปราการ

INTRODUCTION

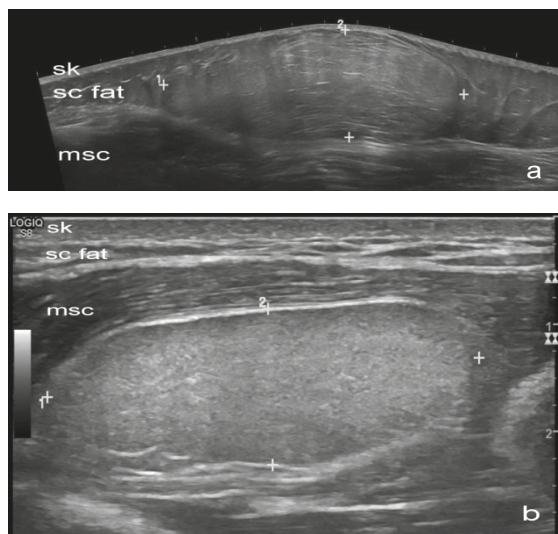Lipomas are the most common soft-tissue tumor encountered in clinical practice[1], usually present with palpable lumps. They are benign adipocytic tumors according to WHO classification of soft tissue tumors[2]. Some of them are treated with surgical excision to confirm histologic diagnosis, especially in large or rapid-growing lesions. Some of them are removed under the circumstances of patient's concern or cosmetics. Pre-treatment imaging is commonly needed for proving existence of the mass, size measurement, and evaluation of depth and extension. The type of imaging technique initially selected varies depending on the history and physical findings as well as the suspected location of the mass. MRI is by far the best imaging for detecting and characterizing soft-tissue masses[3]. However, because of unavailability in some institutions and high cost, it may not be performed as primary imaging. Ultrasound, on the other hand, has been increasingly used initially in the clinical scenario of palpable lumps due to its accessibility and inexpensiveness. According to ACR Appropriateness Criteria, focused ultrasound at area of interest can be a valuable tool in the initial assessment of soft-tissue mass clinically suspected for superficial lipoma[3]. Results of multiple studies have established the variable ultrasound appearance of lipomas [4, 5, 6, 7, 8, 9, 10]. The purpose of this study was to retrospectively identify sonographic features differentiating lipoma from other soft-tissue tumor and to determine accuracy of ultrasound in diagnosis of lipoma using histologic finding as the reference standard.

MATERIALS AND METHODS

Electronic medical records of patients sent for evaluation of palpable lumps by ultrasound between October 2013 and March 2017 were retrospectively reviewed. Demographic data, clinical information, radiology reports, ultrasound images, and pathology reports were collected. Exclusion criteria were masses without histologic diagnosis, organ-specific masses (eg. thyroid gland, breast, salivary gland), inflammatory masses (eg. cellulitis, abscesses), hernia, and hematoma.
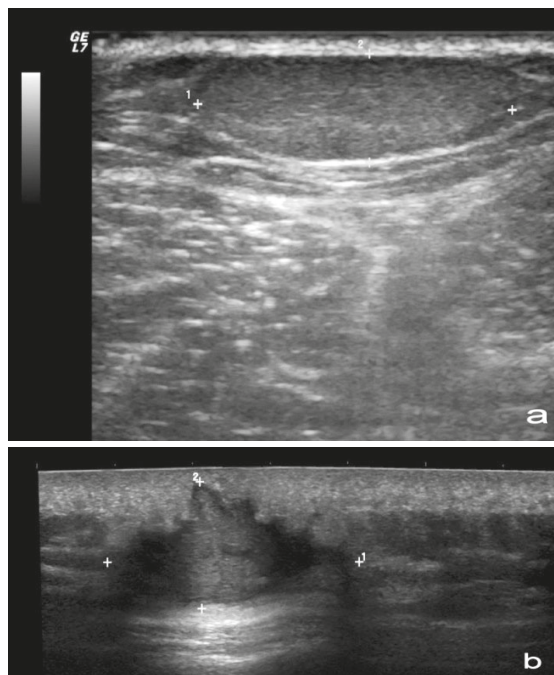
All ultrasound examinations were performed by one of five radiologists in institution, using one of two ultrasound machines (Logiq 7, GE Healthcare; or Logiq S8, GE Healthcare). All masses were evaluated by high-frequency linear transducers. Additional assessment by low-frequency curved transducers 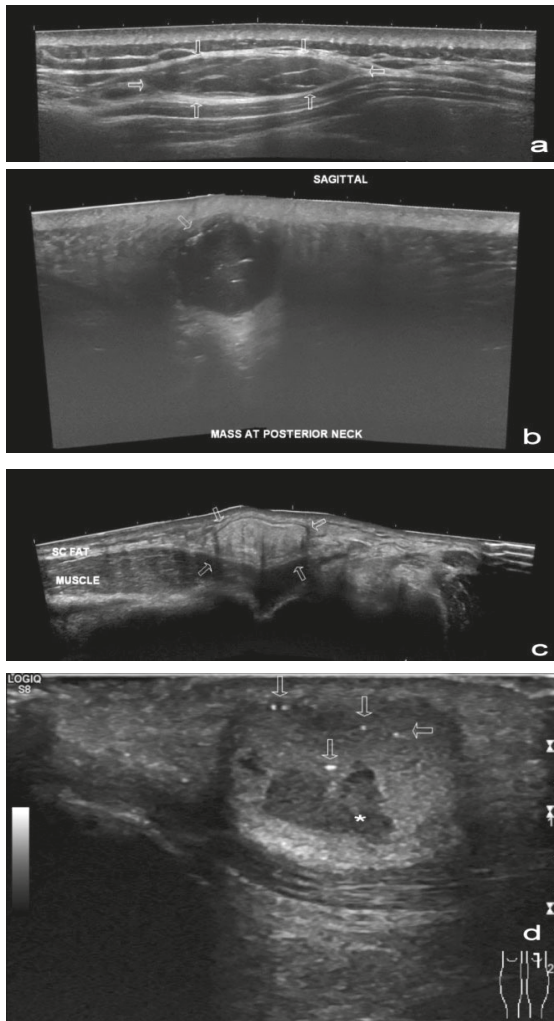or panoramic-view application were selectively used in large masses. Ultrasound reports were analyzed alongside ultrasound images. Sonographic features studied were as follows: (Figs. 1 – 4)
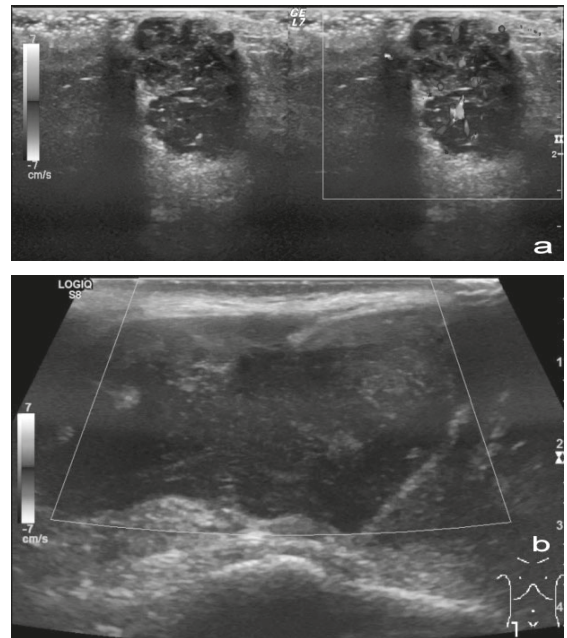
1. Depth: (a) superficial, i.e. superficial to investing fascia (b) deep-seated, i.e. deep to investing fascia such as intramuscular or intermuscular position

2. Marginal border: (a) well-defined (b) ill-defined

3. Echogenicity relative to subcutaneous fat tissue: (a) isoechoic (b) hypoechoic (c) hyperechoic (d) mixed echoic

4. Cystic portion: (a) presence (b) absence

5. Internal vascularity: (a) presence (b) absence

Fig. 1 Depth of lesion (a) superficial lesion: a well-defined hyperechoic mass located in subcutaneous fat tissue of shoulder. Histologic diagnosis: lipoma. (b) deep-seated lesion: a well-defined hyperechoic mass located in muscle of arm. Histologic diagnosis: lipoma. *sk* skin, *sc fat* subcutaneous fat tissue, msc muscle

Fig. 2 Marginal border: (a) well-defined: a well-defined isoechoic lesion in subcutaneous fat tissue of thigh. Histologic diagnosis: lipoma. (b) ill-defined: an ill-defined hypoechoic lesion in subcutaneous fat tissue of back. Histologic diagnosis: ruptured epidermal inclusion cyst.

Fig. 3 Echogenicity relative to subcutaneous fat tissue: (a) isoechoic: a well-defined isoechoic lesion in subcutaneous fat tissue of chest wall. Histologic diagnosis: lipoma. (b) hypoechoic: a well-defined hypoechoic lesion in subcutaneous fat tissue at posterior aspect of neck. Histologic diagnosis: epidermal inclusion cyst. (c) hyperechoic: a well-defined hyperechoic mass in subcutaneous fat tissue of elbow. Histologic diagnosis: fibrolipoma. (d) mixed echoic: a well-defined lesion in subcutaneous fat tissue of knee, showing isoechoic major part, central hypoechoic area (asterisk), and multiple tiny hyperechoic spots (open arrows). Histologic diagnosis: epidermal inclusion cyst

Fig. 4 Internal vascularity: (a) presence: an ill-defined hypoechoic mass with internal vascularity located in subcutaneous fat tissue of chest wall. Histologic diagnosis: dermatofibrosarcoma protuberans. (b) absence: a well-defined hypoechoic mass with no internal vascularity located at groin. Histologic diagnosis: myxoid neurofibroma.

The masses were classified into two groups; lipoma and non-lipoma. Demographic data, clinical information, and sonographic features of each group were compared. The average value of age, palpable duration, and tumor size were analyzed with Student's t-test. All other factors were analyzed using chi-squared test. A p-value of less than 0.05 was considered statistically significant difference. For lipoma-group, comparisons between provisional ultrasound diagnoses and histologic diagnoses were made to determine sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of ultrasound for diagnosis of lipoma. In addition, lipomas were further categorized into

superficial and deep-seated subgroups as well as small (< 5 cm) and large (≥ 5 cm) subgroups. Subsequently, sensitivity and specificity of ultrasound diagnoses in each subgroups were assessed.

RESULT

During the study period, there were 590 patients referred for sonographic evaluation of palpable lumps. Three hundred and fifty patients were excluded due to organ-specific masses, inflammatory masses, hernia, or hematoma. One hundred and seventy-two patients were excluded by reason of no histologic diagnosis. Sixty-eight patients were included, comprised of 34 male and 34 female with the mean age of 47 years (1-84 years). One subject had two masses (histologic diagnosis: metastastic clear cell carcinoma), so there were 69 masses analyzed. Anatomical locations of the masses were as Fig. 5. The mean palpable-mass duration was 706 days (3-4,260 days). The surgical procedures were excision of 63 masses, wide excision of 4 masses, and core needle biopsy of 2 masses.
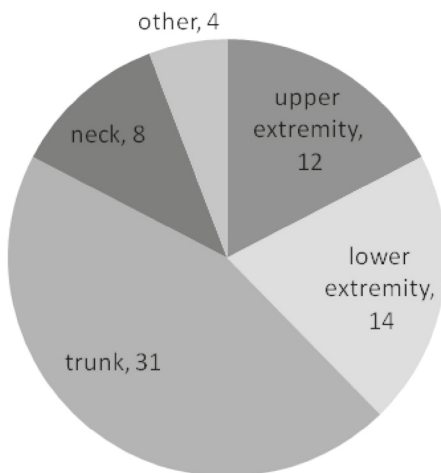

Fig. 5 Pie chart showing anatomical locations of masses and the number of masses in each anatomical location

Concerning additional imaging examination other than ultrasound, four patients underwent MRI after ultrasound examinations because of non-visualized palpable mass in 1 patient (histologic diagnosis: lipoma) and suspicious malignant sonographic appearances in 3 patients (histologic diagnosis: 2 lipomas and 1 myxoid liposarcoma) (Fig. 6). Two patients had pre-operative CT scans for evaluation of pelvic extension of the masses (histologic diagnosis: myxoid neurofibroma and nodular melanoma)
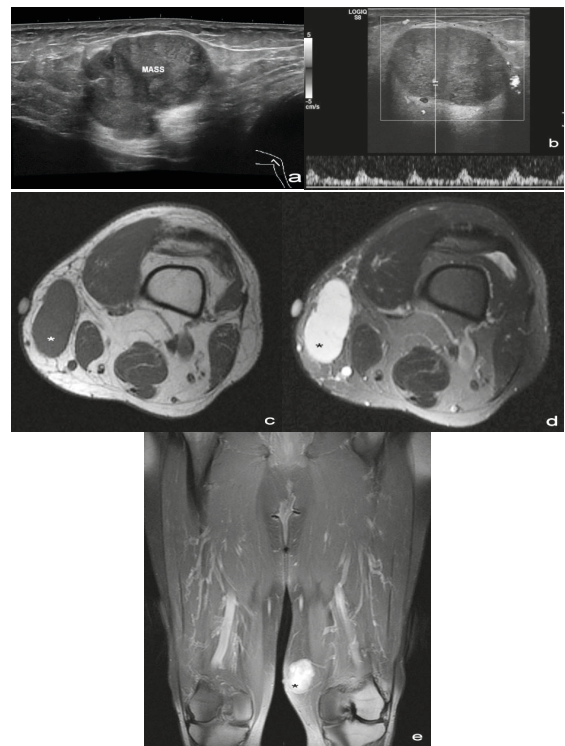

Fig. 6 Myxoid liposarcoma. (a) a well-defined lobulated hypoechoic mass in subcutaneous fat tissue at medial aspect of left knee (b) presence of arterial blood flow within the mass. The mass (asterisk) showed hyposignal intensity on axial T1W (c), hypersignal intensity on axial T2W/FS (d), and intense contrast enhancement on coronal T1W with gadolinium administration (e).

Fifty-six masses were located superficial to investing fascia while 13 masses were deep-seated. There were 33 lipomas (29 superficial lipomas, 4 deep-seated lipomas) and 36 non-lipoma masses. Among non-lipoma masses, pathological diagnoses were as Table 1. Table 2 informed results of demographic and clinical data comparison between lipoma and non-lipoma group with distribution of ages, palpable-mass durations, and largest diameters as in Figs.7-9. There was no statistically significant difference in almost all demographic and clinical data between lipoma and non-lipoma group, except for largest diameters. Lipomas tend to be larger with the mean largest diameter of 57.88 mm compared with 36.78 mm of non-lipoma masses (p-value = 0.0011), however, wide range of distribution was observed and there was much overlapping of diameters between these two groups (Fig. 9).

Table 1 Pathological diagnoses of non-lipoma masses

Pathology	No. of masses
epidermal inclusion cyst	8
fibroma	3
fibrolipoma	2
ganglion cyst	2
metastastic clear cell carcinoma	2
others*	19

* bronchogenic cyst, bursal cyst with chronic bursitis and fibrosis, cavernous hemangioma, cavernous hemangioma and lymphangioma, dermatofibrosarcoma protuberans, epithelial cyst, fibromatosis (desmoid type), fibrosarcoma, hemangiolipoma, hemangioma, Hodgkin lymphoma, infected cyst, myofibroblastoma, myolipoma, myxoid liposarcoma, myxoid neurofibroma, neurofibroma, nodular melanoma, shwannoma

Table 2 Comparison of demographic and clinical data between lipoma and non-lipoma group

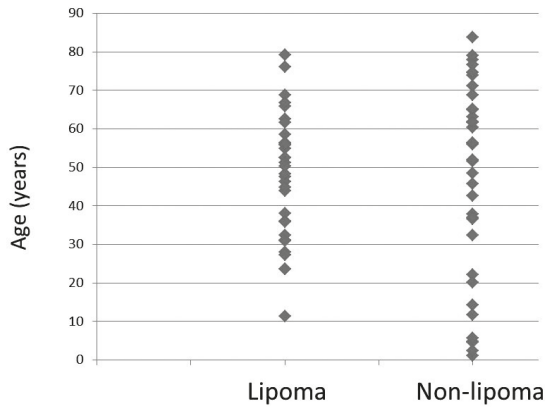| Characteristic	Lipoma (n = 33)	Non-lipoma (n = 36)	p-value
Sex			0.8999
male	17	18	
female	16	18	
Mean age (years), SD	47.70, 16.15	47.14, 25.59	0.9127
Mean palpable-mass duration (days)	937.73	492.64	0.0816
Mean of largest diameter (mm), SD	57.88, 28.55	36.78, 21.59	0.0011*
Location			0.2685
extremity	11	15	
trunk	18	13	
others	4	8	

* $p < 0.05$
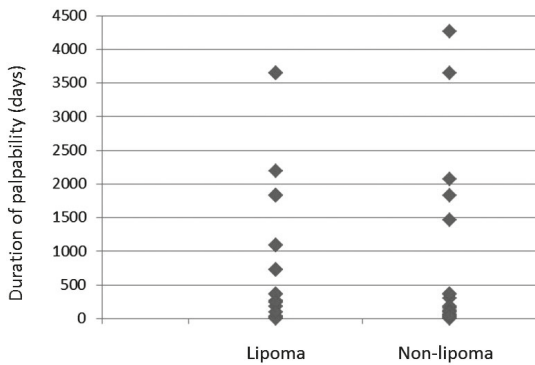
Fig.7 Distribution of patients' ages

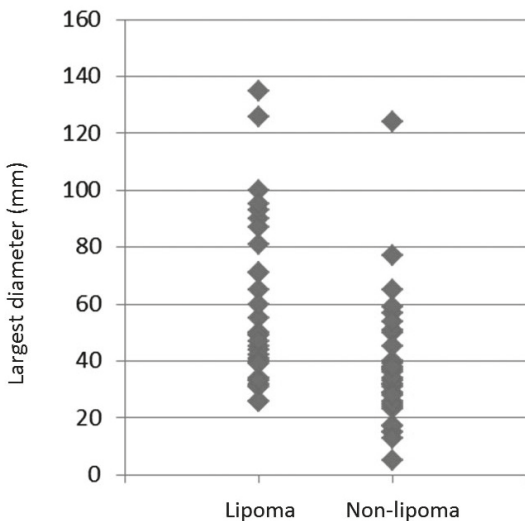**Fig. 8** Distribution of durations of palpability

Fig. 9 Distribution of largest diameters

Comparison of ultrasound features between lipoma and non-lipoma masses was made with the results as in Table 3. The ultrasound characteristics which were significantly different between two groups include echogenicity, cystic portion, and internal vascularity. Most lipomas were iso- or hyperechoic masses while most non-lipoma masses were hypo- or mixed echoic masses. None of the lipomas show cystic portion within the masses whereas half of the non-lipoma masses had cystic portions. Only 9% of lipomas displayed internal vascularity which was minimal. On the contrary, up to 33% of non-lipoma masses demonstrated varying internal vascularity.

Table 3 Comparison of ultrasound features between lipoma and non-lipoma group

Characteristics	Lipoma (n = 32)@	Non-lipoma (n = 36)	p-value
Depth			0.1715
superficial	28	27	
deep-seated	4	9	
Marginal border			0.1101
well-defined	31	27	
ill-defined	1	9	
Echogenicity relative to subcutaneous fat tissue			< 0.0001*
isoechoic	15	1	
hypoechoic	0	23	
hyperechoic	15	4	
mixed echoic	2	8	
Cystic portion			< 0.0001*
presence	0	17	
absence	32	19	
Internal vascularity			0.0174*
presence	3	12	
absence	29	24	

@ One lipoma was not visualized by ultrasound * p < 0.05

Comparing provisional ultrasound diagnoses with histologic diagnoses, ultrasound had sensitivity, specificity, positive predictive value, and negative predictive value for a diagnosis of lipoma at 84.85%, 91.67%, 90.32%, and 86.84%, respectively, leading to an accuracy of 88.41%. When divided lipomas into superficial and deep-seated subgroups, ultrasound showed a sensitivity of 89.66% and a specificity of 96.30% for superficial subgroup and a sensitivity of 50% and a specificity of 77.78% for deep-seated subgroup. Lipomas were subdivided by another way into small (< 5 cm) and large (> 5 cm) subgroups. A sensitivity and a specificity of ultrasound to diagnose small lipomas was 83.33% and 92.86%, respectively, while a sensitivity and a specificity for large lipomas was 86.67% and 87.50%, respectively.

DISCUSSION

In the present study, there were similiarities in demographic and clinical data between lipoma and non-lipoma group, including sex, age, palpable duration, and anatomical location. However, mean largest diameter was significantly greater in lipoma group, probably due to indolent, slow-growing, painless nature of the masses. Concerning sonographic characteristics, almost all lipomas showed well-defined margin, conformed to pattern found by previous studies[5, 6, 7, 9](Table 4).However, 75% of non-lipoma masses also had well-defined margin and this ultrasound appearance was not significantly different between two groups. The sonographic features which were significantly different between lipoma and non-

lipoma masses consisted of echogenicity, cystic portion, and internal vascularity. The majority of lipomas in the current study showed iso- or hyperechogenicity relative to subcutaneous fat tissue. The variable echogenicity of lipoma was related to the number of internal interfaces between fat and other connective elements which was quite variable for lipoma: the purer the fat, the more hypoechoic the sonographic appearance[9]. With reference to Wagner et al[4] study of superficial lipomas, 59% of lipomas were isoechoic and 26% were hyperechoic to subcutaneous fat. Other studies[5, 6, 7, 8] compared echogenicity of lipomas with muscle echogenicity, imitated the method of mass signal intensity characterization by MRI, and found that echogenicity of lipomas was mainly hyperechoic. None of lipomas in this study demonstrated internal cystic portion. Internal vascularity was manifested in only 9% of lipomas. A review of literature revealed vascularity in 0-43% of lipomas[4, 5, 6, 7, 10] and all internal blood flow was minimal. This was corresponding to hypovascular histologic feature of lipomas. Nagano et al[11] mentioned minimal vessels found inside the fibrous septa in lipomas seen in pathological sections which were significantly less than vessels of atypical lipomatous tumors or well-differentiated liposarcoma.

Table 4 Sonographic features of lipoma

Authors	No. of population	Marginal border	Echogenicity	Internal vascularity	Specific type of lipoma studied
Wagner et al (2013)[4]	39		26% hyperechoic, 59% isoechoic, 15% hypoechoic to subcutaneous fat	59% absent, 41% minimal blood flow	superficial lipoma
Cheng et al (2007)[5]	6	100% well-defined	83% hyperechoic, 17% isoechoic to muscle	100% absent	lipoma in hand and forearm
Paunipagar et al (2010)[6]	64	78% well-defined, 22% ill-defined	57% hyperechoic, 21% isoechoic, 22% hypoechoic to muscle	57% absent, 43% minimal blood flow	deep-seated lipoma
Ahuja et al (1998)[7]	25	88% well-defined, 12% ill-defined	76% hyperechoic, 8% isoechoic, 16% hypoechoic to muscle	100% absent	head and neck lipoma
Inampudi et al (2004)[8]	25		most iso or hyperechoic to muscle		

Table 4 Sonographic features of lipoma

Authors	No. of population	Marginal border	Echogenicity	Internal vascularity	Specific type of lipoma studied
Fornage et al (1991)[9]	35	60% well-defined, 40% ill-defined			
Shin et al (2016)[10]	47			100% absent	superficial lipoma

In the present study, ultrasound had sensitivity, specificity, and accuracy for diagnosis of lipoma at 84.85%, 91.67%, and 88.41%, respectively, comparable to results of recently published studies by Wagner et al[4], Kuwano et al[12], and Hung et al[13] (Table 5) whose studies concerned only superficial lipomas. The findings differed substantially from those of Inampudi et al[8] who found sensitivity of 40% to 52%, specificity of 64% to 86%, and accuracy of 49% to 86% for the sonographic diagnosis of lipoma. The possible reasons were much improved ultrasound technology in this study which performed 13 years later and less deep-seated lipomas included. In subgroup analysis, the accuracy of ultrasound for diagnosis of deep-seated lipoma was obviously lower than that of superficial lipoma. Deep-seated lipomas were less common than their superficial counterparts and appeared larger at clinical presentation[2, 14]. Wagner et al[4] and Gielen et al[15] recommended MRI as diagnostic work up for these lesions according to limited visualization and characterization by ultrasound. Many studies also suggested MRI evaluation of lipomas larger than 5 cm[1, 2, 14, 16, 17, 18] due to malignant potential of large masses. However, in the present study, the sensitivity and specificity of ultrasound for diagnosis of small and large lipoma subgroups were nearly the same, nevertheless, there was a 13.5-cm lipoma which was not visualized by ultrasound, but clearly demonstrated by MRI. The potential inference was difficulty of ultrasound to perceive mass border in case of huge mass larger than ultrasound transducer.

Table 5 Sensitivity, specificity, and accuracy of ultrasound for diagnosis of lipoma

Authors	No. of population	Sensitivity	Specificity	Accuracy	Specific type of lipoma studied
Inampudi et al (2004)[8]	25	40-52%		49-64%	superficial and deep-seated lipoma
Wagner et al (2013)[4]	39	92-96%	97-100%	96%	superficial lipoma
Kuwano et al (2009)[12]	42	88.1%	99.3%		superficial lipoma
Hung et al (2014)[13]	105	95.2%	94.3%		superficial lipoma

There were some limitations of this study. First, it was a retrospective review of preexisting ultrasound images and ultrasound reports operated by five radiologists with different experience. Second, the use of histologic findings as the reference standard might be a source of selection bias, as up to 72% of the masses were excluded due to no histologic diagnosis. The masses in excluded portion might have typical benign sonographic appearances, obviated the need for surgery or histologic evaluation, and these were not analyzed. Finally, the non-lipoma group demonstrated varying sonographic appearances which were analyzed together despite vastly different pathology.

CONCLUSION

Ultrasound demonstrates good accuracy in the diagnosis of superficial soft-tissue lipoma. Sonographic features of lipoma are well-defined border, iso- or hyperechogenicity relative to subcutaneous fat tissue, absent cystic portion, and absent or minimal internal vascularity. For deep-seated or large lesions, further investigation with MRI may be needed.

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