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The diagnostic accuracy of depth prediction for lipomas by preoperative imaging with distribution according to anatomical site in Korea: a retrospective analysis

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Original Article

Background: Lipomas are common benign connective-tissue tumors that usually present as slow-growing, painless, subcutaneous masses. Deeper variants, such as intramuscular, intermuscular, and submuscular lipomas, are larger and rarer. Accurate preoperative depth determination is crucial for planning appropriate surgical resection.

Methods: We retrospectively reviewed 190 lipoma cases treated at a single medical center from January 2013 to August 2023. The accuracy of preoperative imaging techniques–ultrasonography (USG), computed tomography (CT), and magnetic resonance imaging (MRI)–in predicting lipoma depth was assessed.

Results: USG, CT, and MRI showed accuracies of 72.5%, 56.5%, and 79.3%, respectively, with MRI showing the highest predictive accuracy. The trunk was the most common site for lipomas (49.5%), followed by the upper (20.5%) and lower extremities (13.2%). USG was more accurate for lipomas in the lower extremities and neck, whereas CT was less accurate for lipomas in the trunk.

Conclusion: MRI is preferable for the preoperative depth assessment of lipomas, especially those located in the trunk. Accurate imaging is essential for guiding surgical planning and avoiding complications. Further studies with larger sample sizes are required to validate our findings.

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; USG, ultrasonography

Keywords: Lipoma / Magnetic resonance imaging / Tomography, X-ray computed / Ultrasonography

INTRODUCTION

Lipomas are the most common benign connective-tissue tumors and have a relatively high prevalence [1]. The typical clinical presentation in adults is a solitary, slow-growing, painless subcutaneous tumor located in the trunk or extremities, most often arising in subcutaneous tissues [2,3]. Although most lipomas are found within the subcutaneous tissues, it is necessary to determine their location through preoperative examination; this is because deep-seated lipomas, including intramuscular, intermuscular, and submuscular lipomas, are less common and tend to be larger than subcutaneous lipomas [2,4]. Modifying the preoperative planning based on depth is often necessary to prevent damage to vital neurovascular or muscular tissues and avoid functional impairment. In many cases, preoperative imaging is used to gather information about lipomas before planning surgery [5].

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Nonetheless, discrepancies frequently arise between the depth of the lipoma, as depicted by preoperative imaging modalities, and the actual depth observed during surgical intervention. Such inconsistencies can present substantial challenges for surgeons. This issue becomes particularly problematic when there is confusion between the subcutaneous layer and the lipoma itself, potentially leading to unexpected circumstances during surgery if the actual depth of the lipoma deviates from the preoperative imaging indications.

Consequently, by categorizing the depth of lipomas into two distinct layers–subcutaneous and deeper (layers deeper than the subcutaneous layer, including intramuscular, intermuscular, and submuscular layers)–this study sought to ascertain and contrast the accuracy of their actual depths as evaluated by preoperative imaging techniques, including ultrasonography (USG), computed tomography (CT), and magnetic resonance imaging (MRI). Furthermore, we endeavored to report on the variance in accuracy regarding the actual depth of lipomas, as determined by preoperative imaging modalities, relative to their anatomical locations.

METHODS

Study design

We conducted a retrospective review of medical records (from January 1, 2013 to August 31, 2023) of patients who underwent surgical removal of lipoma at the Nowon Eulji Medical Center and were subsequently diagnosed with lipoma based on the results of histological examinations. We analyzed the location of the lipoma recorded on the operative notes, wherein the surgeon visually identified it through dissection during surgery and recorded the reading results of the preoperative imaging examination. This study specifically focused on patients who underwent preoperative examinations using USG, CT, and MRI.

Inclusion and exclusion criteria

We included patients in whom layers related to lipomas were documented on preoperative examinations, including USG, CT, and MRI. Additionally, cases wherein two or more lipomas were removed during surgery were excluded owing to unclear differentiation of the layers for each lipoma. We only included cases wherein one lipoma was removed per patient.

RESULTS

Distribution by gender and age

The patients who underwent surgery were aged 7–78 years, with patients in their 50s accounting for the largest proportion (n = 57, 30.0%), followed by those in their 40s (n = 53, 27.9%), 60s (n = 27, 14.2%), and 30s (n = 25, 13.2%). Of the 190 participants, there were 80 men and 110 women. The average age was 50.8 years for men and 48.9 years for women, resulting in an overall average age of 49.7 years for all patients. Among the 190 patients diagnosed with lipoma through histological examination, 138 (72.6%) underwent preoperative USG, 23 (12.1%) underwent CT, and 29 (15.3%) underwent MRI (Table 1). Using preoperative USG, 120 cases were predicted to be in the subcutaneous layer and 18 cases in the layers deeper than the subcutaneous layer. Using preoperative CT, 19 cases were predicted in the subcutaneous layer and four in the layers deeper than the subcutaneous layer. Using MRI, 22 cases were predicted in the subcutaneous layer and seven in the layers deeper than the subcutaneous layer. Overall, among the 190 patients, predictions from the preoperative tests indicated 161 cases (84.7%) in the subcutaneous layer and 29 cases (15.3%) in the layers deeper than the subcutaneous layer. Among the 190 patients with lipomas, the actual distribution of lipomas was as follows: subcutaneous layer: 118 cases (62.1%); layers deeper than the subcutaneous layer: 72 cases (37.9%) (Table 2).

The overall accuracy for the depth of lipomas using USG, CT, and MRI was 71.6%, with 136 of 190 cases showing concordance with the actual surgical depth (Table 3). For USG, the accuracy of the preoperative lipoma depth was 72.5%, with 100 of 138 cases matching the actual depth of the lipoma. Among the patients predicted to have subcutaneous layer involvement, 120

Table 1. Distribution by the preoperative radiological examination

Preoperative radiological examination	Predicted depth of the lipoma		Total
	Subcutaneous	Deeper than subcutaneous	
USG	120	18	138 (72.6)
CT	19	4	23 (12.1)
MRI	22	7	29 (15.3)
Total	161 (84.7)	29 (15.3)	190 (100)

Value are presented as number (%).
USG, ultrasonography; CT, computed tomography; MRI, magnetic resonance imaging.

Table 2. Distribution by the actual depth of the lipoma

Preoperative radiological examination	Actual depth of the lipoma		Total
	Subcutaneous	Deeper than subcutaneous	
USG	88	50	138 (72.6)
CT	10	13	23 (12.1)
MRI	20	9	29 (15.3)
Total	118 (62.1)	72 (37.9)	190 (100)

Value are presented as number (%).
USG, ultrasonography; CT, computed tomography; MRI, magnetic resonance imaging.

Table 3. Accuracy during actual surgery based on differences in lipoma depth predicted from preoperative examinations of USG, CT, and MRI

Preoperative radiological examination	Accuracy of the depth of lipoma (%)		Total
	Subcutaneous	Deeper than subcutaneous	
USG	88/120 (73.3)	12/18 (66.7)	100/138 (72.5)
CT	10/19 (52.6)	3/4 (75.0)	13/23 (56.5)
MRI	18/22 (81.8)	5/7 (71.4)	23/29 (79.3)
Total	116/161 (72.0)	20/29 (69.0)	136/190 (71.6)

Value are presented as number (%).
USG, ultrasonography; CT, computed tomography; MRI, magnetic resonance imaging.

were identified, with 88 cases accurately reflecting subcutaneous presence, resulting in an accuracy of 73.3%. Among these, 25 cases showed invasion of the muscle layer and seven were submuscular. In cases where USG predicted a layer deeper than the subcutaneous layer (18 cases), 12 patients (66.7%) were confirmed to have lipomas in the layers deeper layer than the subcutaneous layer, resulting in lower accuracy. For CT, the accuracy of the preoperative lipoma depth was 56.5%, with 13 of 23 cases matching the actual depth. Among patients predicted to have subcutaneous layer involvement (19 cases), the involvement of the subcutaneous layer was accurately reflected in 10 cases, resulting in an accuracy of 52.6%. Among these cases, seven showed invasion of the muscle layer, and two were submuscular. In cases where CT predicted a layer deeper than the subcutaneous layer (four cases), three patients (75%) were confirmed to have lipomas in layers deeper than the subcutaneous layer. For MRI, the accuracy of the preoperative lipoma depth was 79.3%, with 23 of 29 cases matching the actual depth. Among patients predicted to have subcutaneous layer involvement (22 cases), 18 accurately reflected the involvement of the subcutaneous layer, resulting in an accuracy of 81.8%. Among these cases, three showed invasion of the muscle layer. In cases where MRI predicted a layer deeper than the subcutaneous layer (seven cases), five patients (71.4%) were confirmed to have lipomas in layers deeper than the subcutaneous layer.

Distribution by location of lesions

The d istribution of lesions in the body was as follows: trunk, 94 cases (49.5%); upper extremities, 39 cases (20.5%); lower extremities, 25 cases (13.2%); neck, 24 cases (12.6%); and head, nine cases (4.7%). On the trunk, 77.7% of the lesions were on the back, 8.5% were on the chest, 7.4% were on the flank, and 6.4% were on the abdomen. Among the upper extremities, the shoulder exhibited the highest distribution, with 25 cases (64.1%), followed by the elbow and upper arm, each with four cases (10.3%). The forearm accounted for three cases (7.7%), the hand for two cases (5.1%), and the axilla for one case (2.6%). In the lower extremities, the thigh area was the most prevalent (n = 15, 60.0%), followed by the buttocks and lower legs, each with three cases (12.0%). The foot and ankle each had two cases (8.0%). Within the head area, the face dominated with seven cases (77.8%), whereas the scalp area had two cases (22.2%). The diameters (4.9 cm) of the lipomas directly identified through surgery and those (5.0 cm) identified by preoperative imaging examination were similar.

Table 4. Distribution by location of lesions with the preoperative ultrasonography

Location	No. of cases	Accurate cases	Accuracy (%)
Trunk	82	53	64.6
Back	65	43	66.2
Chest	7	2	28.6
Flank	5	5	100
Abdomen	5	3	60.0
Upper extremities	21	16	76.2
Shoulder	13	9	69.2
Elbow	2	1	50.0
Upper arm	3	3	100
Forearm	1	1	100
Hand	1	1	100
Axilla	1	1	100
Lower extremities	18	17	94.4
Thigh	10	9	90.0
Buttock	3	3	100
Lower leg	3	3	100
Foot	1	1	100
Ankle	1	1	100
Neck	12	11	91.7
Head	5	3	60.0
Face	4	3	75.0
Scalp	1	0	0
Total	138	100	72.5

When examining lipomas using preoperative USG, there were 138 cases, of which 100 cases showed concordance with the actual depth observed during surgery, resulting in an accuracy rate of 72.5%. The accuracies for the lower extremities and neck were the highest at 94.4% and 91.7%, respectively, whereas the trunk and head exhibited lower accuracies of 64.6% and 60%, respectively (Table 4). For the trunk, preoperative USG demonstrated the highest accuracy in predicting lipoma depth in the flank area, whereas the chest area had the lowest accuracy. The overall accuracy for lipoma depth in the upper extremities was 76.2%, slightly higher than the overall accuracy using USG; however, for the most prevalent case in the shoulder, the accuracy of USG was 69.2%, slightly lower than the average accuracy.

Table 5. Distribution by location of lesions with the preoperative computed tomography

Location	No. of cases	Accurate cases	Accuracy (%)
Trunk	8	2	25.0
Back	4	1	25.0
Chest	1	0	0
Flank	2	0	0
Abdomen	1	1	100
Upper extremities	2	1	50.0
Shoulder	1	1	100
Forearm	1	0	0
Lower extremities	1	1	100
Thigh	1	1	100
Neck	9	7	77.8
Head	3	2	66.7
Face	3	2	66.7
Total	23	13	56.5

Table 6. Distribution by location of lesions with the preoperative magnetic resonance imaging

Location	No. of cases	Accurate cases	Accuracy (%)
Trunk	4	4	100
Back	4	4	100
Upper extremities	16	11	68.8
Shoulder	11	8	72.7
Elbow	2	2	100
Forearm	1	1	100
Upper arm	1	0	0
Hand	1	0	0
Lower extremities	6	5	80.0
Thigh	4	3	75.0
Foot	1	1	100
Ankle	1	1	100
Neck	2	2	100
Head	1	1	100
Scalp	1	1	100
Total	29	23	79.3

When examining lipomas using preoperative CT, there were 23 cases, of which 13 showed concordance with the actual depth observed during surgery, resulting in an accuracy of 56.5%. The accuracies for the neck and head areas were relatively higher, at 77.8% and 66.7%, respectively, compared to the overall accuracy (Table 5). However, for the trunk area, the accuracy was relatively low (25%). For the upper and lower extremities, the use of preoperative CT was limited (with two cases and one case, respectively; the accuracies were 50% and 100%, respectively).

Evaluation of the depth of lipomas using MRI before surgery was conducted in 29 cases, with 23 cases showing concordance between the predicted depth from MRI and the actual surgical depth, resulting in an accuracy of 79.3% (Table 6). In cases of lipomas located in the trunk, neck, and head, the accuracy was 100%, indicating consistent depth assessment between MRI and surgical findings. Most preoperative MRI examinations were performed on the upper extremities, totaling 16 cases, with an accuracy of 68.8%. In the lower extremities, there were six cases wherein preoperative MRI was conducted; among them, five cases demonstrated concordance between the predicted depth from MRI and the actual surgical depth, resulting in an accuracy of 80%.

DISCUSSION

Lipomas are the most prevalent form of soft-tissue tumors, accounting for nearly half of all such tumors [6]. These tumors have been found across a wide range of ages, but typically first emerge in individuals aged 40–60 years [2]. In our study, the highest occurrence of lipomas was noted in individuals in their 50s, followed by those in their 40s and 60s. Moreover, the number of lipomas excised was higher in women than in men.

Typically located in the subcutaneous layer, lipomas can easily be excised through incisions in the skin directly above them [4]. However, they can occasionally be found in deeper layers, such as the intra- or intermuscular layers, complicating their diagnosis and surgical removal [5]. Even for subcutaneous lipomas, distinguishing it from subcutaneous tissue can be difficult; therefore, it is meaningful to differentiate it using preoperative investigations. For this reason, we classified the depth into the subcutaneous layer and deeper layer than the subcutaneous layer. The incidence rates of intramuscular and intermuscular lipomas are approximately 1.8% and 1.7%, respectively [7,8]. In a Korean study, Kim et al. [9] indicated that the proportion of intramuscular, intermuscular, and submuscular lipomas was 15.5%. In this study, lipomas were most commonly located in the subcutaneous layer (n = 118, 62.1%), and the total percentage of lipomas found in the layer deeper than the subcutaneous layer, including the intramuscular, submuscular, and intermuscular layers, was 37.9%. This distribution indicates a greater prevalence of deep-seated lipomas than that reported in previous studies. The significant prevalence of deep-seated lipomas in our study can be attributed to the nature of our patient cohort, which consisted exclusively of patients who underwent surgery. It is likely that these patients were referred from primary care or dermatology clinics to specialized centers owing to the deep placement of the lipomas.

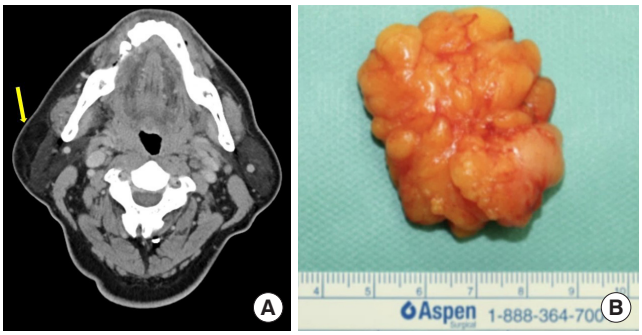

Fig. 1. Discrepancy between the actual depth of the facial lipoma and the predictive depth of the preoperative diagnosis. (A) Preoperative computed tomography finding: about 3.4×1.5×4 cm sized well-defined nonenhanced fat-attenuated mass at right parotid space, peri-parotid subcutaneous fat layer, suggesting lipoma (arrow). (B) The record of the operative note: 4×5 cm round-oval, soft, movable mass, attached to the parotid-masseteric fascia from the subplatysmal muscle in the right mandibular angle area.

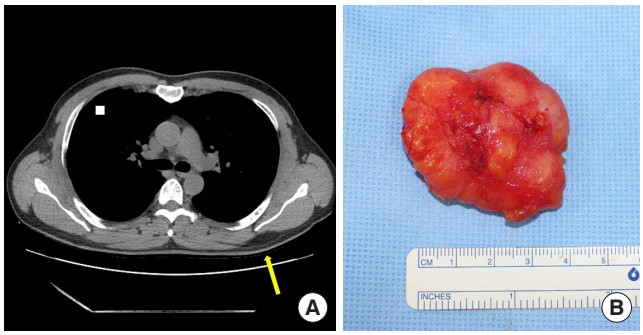

Fig. 2. Discrepancy between the actual depth of the non-facial lipoma and the predictive depth of the preoperative diagnosis. (A) Preoperative computed tomography finding: a well-defined, non-enhancing, fat-attenuated mass measuring approximately 5.3×4.2×1.4 cm located in the deep subcutaneous layer of the left subscapular area, suggestive of a lipoma (arrow). (B) The record of the operative note: a 4.5×4×2 cm lobulated, firm mass located beneath the rhomboid muscle fascia, firmly attached to the muscle.

There was a difference between the actual depth of the lipoma and the predictive depth in the preoperative diagnosis, and these results were expected to be due to errors in interpretation by the radiologist (Figs. 1, 2). The overall preoperative diagnostic accuracy for assessing the depth of lipomas was the highest with MRI (79.3%), followed by USG (72.5%), and CT, at a relatively lower accuracy of 56.5%. These outcomes can serve as a reference for estimating the actual depth of lipomas during surgery, with CT showing particularly low accuracy rates for tumors located in the trunk. This may be attributed to CT being performed in response to other morbidities in the trunk area. Lipomas occur most frequently on the trunk [9,10]. In this study, the trunk was the primary site of lipomas, constituting 94 cases (49.5%), followed by the upper and lower extremities, neck, and head. The accuracy of preoperative USG varies according to the anatomical site, with higher rates observed in the lower extremities (94.4%), neck (91.7%), and upper extremities (76.2%). Conversely, lower rates were noted in the trunk (64.6%) and head (60%). A limitation of this study was the small number of head cases, with only five undergoing preoperative USG. Surgeons who perform sonography before surgery should be aware that lipomas located in the trunk and head may be located deeper. Recognizing this can aid in surgical planning and execution. The predictive accuracy of preoperative CT scans varied by anatomical site, with the neck (77.8%) and head (66.7%) showing relatively high accuracy, whereas the trunk had a significantly lower accuracy rate of 25%. Thus, when using preoperative CT for lipoma surgery, especially in the trunk area, surgeons should exercise caution regarding the tumor depth. All cases involving the trunk, neck, and head showed a 100% diagnostic accuracy rate with preoperative MRI, with the accuracy for trunk locations being notably higher than that for other radiological examinations. Therefore, for masses suspected to be lipomas of the trunk, MRI is recommended over CT to acquire more precise depth information.

Our study had some limitations. As our study was related to imaging, excluding image reading bias, it is necessary to include a large number of cases of lipoma with only one radiologist reading or analysis between radiologists. However, as this was a retrospective study in a single institution, there was no analysis between radiologists on the cases and cases in which several radiologists performed reading; therefore, further studies including more cases are needed in the future.

This 10-year retrospective analysis detailed the classification of lipomas by anatomical site and variation in actual depth as determined by preoperative imaging studies. Such insights can facilitate surgical planning, potentially saving operative time, and highlight the need for further investigation involving a larger number of cases.

NOTES

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Ethical approval

The study was approved by the Institutional Review Board of

Nowon Eulji University Hospital (IRB No. WKIRB-2024-05-001) and performed in accordance with the principles of the Declaration of Helsinki.

Patient consent

The patients and their guardians provided written informed consent for the publication and use of their images.

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Conceptualization; Data curation: Jong Hun Lee. Formal analysis: Geon Hwi Kim, Jong Hun Lee. Funding acquisition; Methodology; Project administration: Jong Hun Lee. Writing - original draft: Geon Hwi Kim, Jong Hun Lee. Writing - review & editing: Jong Hun Lee. Investigation: Geon Hwi Kim. Resources; Supervision: Jong Hun Lee.

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