

Evaluation of Role of USG as a First Line Investigation in Non-Traumatic Lesions of Musculoskeletal System

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Abstract: *Non-traumatic musculoskeletal pathologies frequently present in clinical practice, with ultrasonography USG emerging as a primary imaging modality due to its accessibility, real-time capabilities, cost-effectiveness, and absence of ionizing radiation. This study examines the accuracy of USG in diagnosing superficial soft tissue tumors, highlighting its strengths and limitations. Through a review of 100 patients with musculoskeletal soft tissue swellings, this study emphasizes the need for standardization in USG techniques to minimize machine-related, operator, and interpretive errors. Findings indicate that USG shows high sensitivity and specificity in identifying various soft tissue lesions, though it remains operator-dependent and susceptible to artifacts. Histopathological correlation confirmed USGs reliability in diagnosing lipomas, vascular lesions, and ganglion cysts, among others. The study underscores the importance of adequate training and consistent use of USG protocols to enhance diagnostic accuracy.*

Keywords: Ultrasonography, musculoskeletal pathology, soft tissue tumors, diagnostic accuracy, non invasive imaging

1. Introduction

Non traumatic musculoskeletal pathologies are commonly encountered in day-to-day practice. Developments in digital ultrasound technology, availability of high frequency broadband transducers, lack of ionizing radiations, easy availability, real time capability, cost effectiveness and freedom to examine in any direction makes ultrasonography the first line imaging modality for examination of soft tissue lesions. Ultrasonography also plays an indispensable role in guided FNAC and biopsy. Knowledge of basic anatomy and pathology of joints & soft tissues in conjunction with adequate knowledge of clinical indications, limitations of the technique and adequate technical expertise in USG is necessary for evaluation of soft tissue lesions and their accurate diagnosis. The benefits of ultrasound include its ready applicability and availability. However, ultrasonography is operator dependent and has a number of artefacts that may result in misinterpretation. Reliability of ultrasonography technique is an issue and requires standardization of the technique. The results can be improved by reducing the three errors of USG scanning such as Machine-related error, Operator error and error in interpretation of the images generated.

- 1) Machine Error can be reduced by standardizing machine parameters, such as the power Doppler gain, using a standard pulse repetition frequency (PRF), and by using the same equipment.
- 2) Operator error can be reduced by having the same operator perform scanning following the guidelines of musculoskeletal ultrasound scanning and ensuring that operator uses minimal pressure on the tissue when

recording the images since this minimizes power Doppler blanching.

- 3) Error in image acquisition can be reduced by adequately training radiologists.

The aim of this study was to review the experience using ultrasound to assess superficial soft tissue tumors to

- 1) To determine the accuracy of ultrasound in identifying the type of tumor.
- 2) To recognize the tumors that cause diagnostic difficulty.
- 3) To highlight the spectrum of superficial soft-tissue tumors encountered in clinical practice.

2. Review of Literature

- 1) **Esther Hou Yee Hung, James Francis Griffith, Alex Wing Hung Ng, Ryan Ka Lok Lee, Doomily Ting Yi Lau and Jason Chi Shun Leung conducted a study in 2014 to "Evaluate the Diagnostic Accuracy of Ultrasound in assessing Musculoskeletal Soft tissue Tumors superficial to the Investing Fascia"**

- Seven hundred fourteen superficial soft-tissue tumors evaluated with ultrasound by two musculoskeletal radiologists were retrospectively reviewed.
- In all ultrasound reports, the reporting radiologists provided one, two or three diagnoses depending on their perceived level of diagnostic certainty.
- Two hundred forty-seven tumors had subsequent histologic correlation, thus allowing the accuracy of the ultrasound diagnosis to be determined. Four hundred sixty-seven tumors without pathologic confirmation were followed up clinically.

- **Results:** Overall the accuracy of ultrasound examination for assessing superficial soft tissue masses was 79.0% when all differential diagnoses were considered and 77.0% when only the first differential diagnosis was considered.
 - The sensitivity and specificity of the first ultrasound diagnosis were 95.2% and 94.3%, respectively for **lipoma**
73.0% and 97.7% for **vascular malformation**
80.0% and 95.4% for **epidermoid cyst**
68.8% and 95.2% for **nerve sheath tumor**.
 - Reduced observer awareness of specific tumor entities tended to contribute to underdiagnosis more than poor specificity of ultrasound findings.
 - Most tumors (236/247, 96%) were benign.
 - The sensitivity and specificity of ultrasound for identifying malignant superficial soft-tissue tumors was 94.1% and 99.7%, respectively.
- 2) **Bradley J. Carra, Liem T. Bui-Mansfield, Seth D. O'Brien and Dillon C. Chen conducted a study in 2013 to review the appropriate use of ultrasound in the workup of soft tissue masses of the extremities.**
- The normal sonographic appearance of superficial soft tissues,
 - The importance of proper technique in image acquisition,
 - The characteristic sonographic appearance of certain masses and potential pitfalls.

Conclusion: certain clinical and imaging findings allow diagnosis of selected soft-tissue masses. However, most imaging findings are nonspecific, and further evaluation is necessary.

- 3) **"The Diagnostic Accuracy of Ultrasonography for Soft Tissue Lipomas: A Systematic Review", a study conducted by George Ramani, Peter McCarthy and Diane**

Conclusion: true diagnostic value of USG for diagnosis of lipomas which revealed an overall sensitivity and specificity of 86.87% and 95.95% respectively.

- 4) **"The Spectrum of Vascularized Superficial Soft-Tissue Tumors on Sonography with a Histopathologic Correlation" a study conducted by WoukJinn. Gou Young Kim, So Young Park, Young Soo Chun, Deok Ho Nam, Ji Seon Park and Kyung Nam Ryu**

Conclusion: Sonography can play an important role in the diagnosis of benign, vascularized superficial soft-tissue tumors.

Awareness of these findings is important in establishing the correct diagnosis and determining the optimal treatment.

- 5) **"Accuracy of Ultrasound of Musculoskeletal Soft-Tissue Tumors", a study conducted by Liam T Bui-Mansfield, Dillon C. Chen and Seth D. O'Brien**

Conclusion: there is significant risk of mistaking malignant lesions as benign if one solely relies on ultrasound for characterizing superficial soft-tissue masses.

Radiologists interpreting ultrasound examinations of soft-tissue masses must recognize the limitations of this technique for differentiating benign from malignant lesions.

- 6) **"Ultrasound of Musculoskeletal Soft Tissue Masses", a study conducted by Arun Kinare, Mugdha Brahmalkar and Shalini D'Costa,**

Conclusion: USG is useful in the assessment of soft tissue tumors.

It offers basic information about the nature of the mass and its extent and relationship with the surrounding structures, USG guidance for biopsies, abscess drainage and removal of foreign bodies, is promising and popular.

The importance of adequate training and the operator's competence cannot be overemphasized.

- 7) **"Superficial Soft Tissue Swellings: Accuracy of Ultrasonography in Diagnosis with Pathological Correlation" study conducted by Rudresh Hiremath, Gowtham Gowda, Harish T Reddy, Jebin Ibrahim, Rushit Sandeep Shah, Haritha Chodiboina**

Conclusion: sensitivity of the study was 97% with confidence interval of 91.48% to 99.18%,

The positive likelihood ratio was 0.97,

Positive predictive value of the study was 100% with confidence interval of 96.27% to 100%.

They concluded that USG has high specificity and predictive value to diagnose superficial soft tissue swellings and it wouldn't be erroneous to infer that USG is almost equivalent to the pathological diagnosis especially in non-tumoral superficial soft tissue swellings

- 8) **"The Accuracy of Diagnostic High Frequency Ultrasound Imaging for Musculoskeletal Soft Tissue Pathology" a study conducted by Dr Pooja Shamsukha, Dr Prasanna Mishrikotkar in 2019.**

They carried out the study on a cohort of 200 patients with varied soft tissue lesions and compared the accuracy of USG based on the histopathological confirmation of the lesion,

Conclusion: high frequency ultrasound imaging is capable of diagnosing musculoskeletal soft tissue pathologies with high accuracy.

It has the distinct advantage of being dynamic non-invasive, affordable, accurate.

quick and accessible imaging modality for a variety of musculoskeletal soft tissue pathologies.

- 9) **"Accuracy of Sonographic Diagnosis of Superficial Masses" a study conducted by Jason M. Wagner, MD, Kenneth S. Lee, MD, Humberto Rosas, MD, Mark A. Kliever, MD to retrospectively review the diagnostic accuracy of sonography in the of superficial masses with surgical and histologic findings as the reference standard Surgery and histopathologic analysis yielded 39 lipomas, 6 hernias, 4 foreign bodies, 4 hemangiomas, and 19 other non-lipomatous lesions, including 1 malignancy.**

The rendered diagnosis was concordant with the reference standard in 93% of cases for reader 1 and in 89% of cases for all readers. The sensitivity, specificity, and accuracy for the diagnosis of lipoma were 92%, 100%, and 96% for reader 1 and 96%, 97%, and 96% for all readers.

They concluded that sonography has high accuracy in the evaluation of superficial masses, particularly lipomas.

3. Aims and Objectives

- 1) To evaluate the role of USG as a first line investigation in non-traumatic lesions of Musculo skeletal system-with findings further being confirmed by histopathology.
- 2) To provide noninvasive means for early provisional diagnosis.

4. Material and Methods

Inclusion Criteria

- Patients, with complain related to soft tissue swellings of MSK, referred to radiology department were included in the study.
- This is a prospective study, which includes 100 patients over a period of 18 months.

Exclusion Criteria

- Pathologies of Lymph nodes are not included in the study.

Imaging Protocols

- Ultrasonography was performed on Samsung high end doppler ultrasonography machine using a high frequency linear transducer (4-10Mhz & 13-17Mhz)
- The patients were examined in appropriate position and imaging was carried out in both longitudinal and transverse planes in B-mode and color doppler mode.
- The sonographic indices of the soft tissue swellings were noted and location/plane, nature, size, margin, echo pattern and calcification were described accordingly.
- Dynamic assessment during contraction and relaxation of the structures of interest is essential. This helps in establishing the exact relationship of the lesion with the surrounding muscle or tendon. Soft tissue lesions in the

anterior abdominal wall should also be evaluated during deep inspiration and expiration to define relationship of the lesion with the peritoneum.

- Compression ultrasonography in cases of certain benign and cystic lesions gives a better yield.
- Split image technique is helpful for defining the exact extent of the lesion and dimensional measurements.

Histopathological Correlation

- Histopathological confirmation of the diagnosis was made by biopsy or FNAC of the lesion.

5. Observation & Results

- Data of 100 patients were analyzed in this study.
- Majority of the patients presented as painless swelling (82%), while painful swelling was seen in 18% of the patients.
- 8 patients had soft tissue swelling adjacent to a joint of which 5 patients complained of restricted movement.

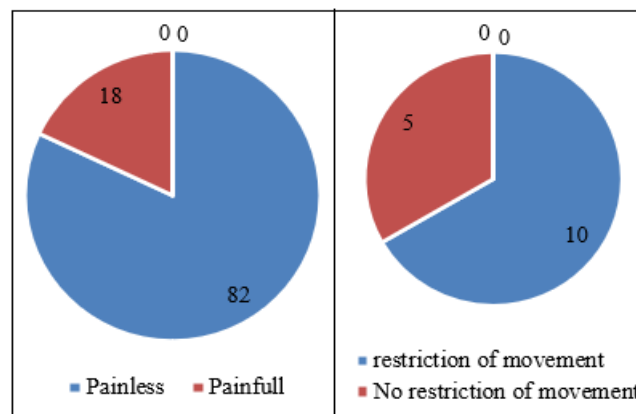


Chart 1: Presenting complaints of the patients

Age and Sex Distribution of the Patients

- Out of total 100 patients studied, there were 61 males and 39 females with a male: female ratio of 1.63:1.
- The age group varied from pediatric patients of less than 1 year of age to over 50 years of age with majority of people in 21-30 years age group.

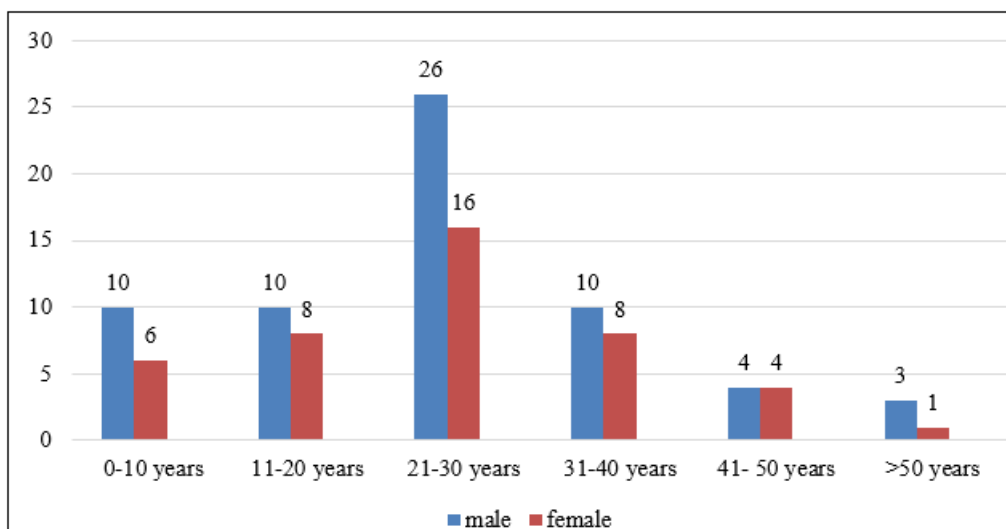


Chart 2: Age distribution of Lesions

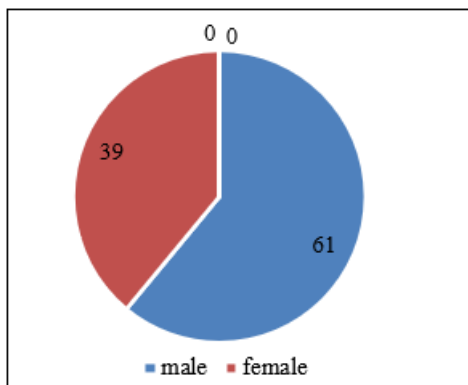


Chart 3: Gender distribution of lesion

Clinical examinations

Distribution of Lesion: Lesions was tabulated according to its location in body as being located on torso, upper limb, lower limb or head & neck

Table 3: Body Distribution of Lesions

| Torso | Upper Limb | Lower Limb | Head & Neck |
|-------|------------|------------|-------------|
| 32 | 22 | 28 | 18 |

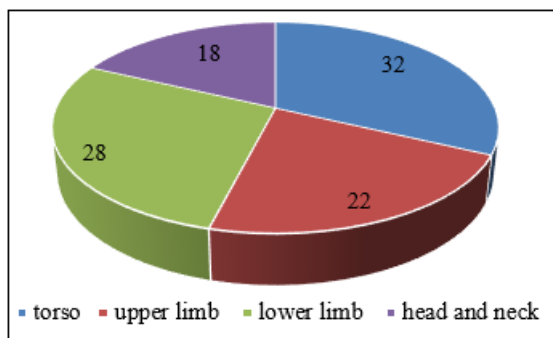


Chart 4: Body distribution of lesions

Consistency of Lesions: The lesions were examined by palpation with volar aspect of hand to determine its consistency. They were divided in 2 categories: Firm Lesions and Soft Lesions

Table 4: Clinical Features – Consistency of Lesions

| Torso | | Lower Limb | | Upper Limb | | Head & Neck | |
|-------|------|------------|------|------------|------|-------------|------|
| Firm | Soft | Firm | Soft | Firm | Soft | Firm | Soft |
| 22 | 10 | 18 | 10 | 8 | 14 | 10 | 8 |

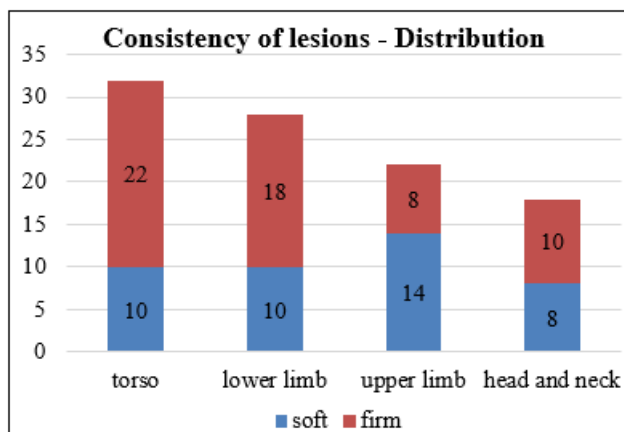


Chart 5: Clinical features – Consistency of Lesions

Multiplicity of Lesions: Some of the pathologies presented as a single localized swelling while some had multiple swellings distributed over a particular portion of body or all over body. Majority of the lesions were solitary.

Table 5: Clinical Features – Multiplicity of Lesions

| Torso | | Lower Limb | | Upper Limb | | Head & Neck | |
|-----------|---------|------------|---------|------------|---------|-------------|---------|
| Multipl e | Singl e | Multipl e | Singl e | Multipl e | Singl e | Multipl e | Singl e |
| 10 | 22 | 1 | 27 | 1 | 21 | 1 | 17 |

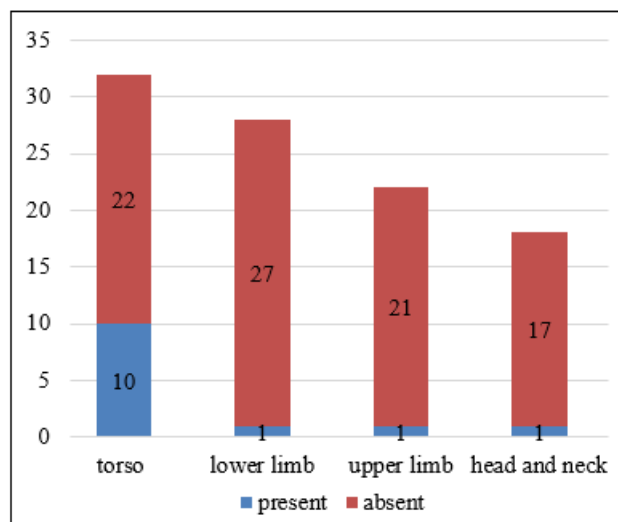


Chart 6 : Clinical features – Multiplicity of lesions

Ultrasonographic Evaluation

USG Consistency: Each lesion was evaluated by USG by scanning in appropriate planes and the consistency of the lesions were recorded as being Solid, Cystic or Mixed.

Table 6: USG Characteristics – Consistency of Lesions

| Consistency | Number of Lesions |
|-------------|-------------------|
| Solid | 56 |
| Cystic | 28 |
| Mixed | 16 |

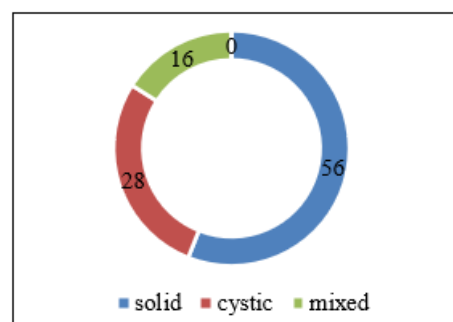


Chart 7: USG Characteristics – Consistency of lesions

Margins of Lesions: The margins of the lesions were evaluated and the lesions were accordingly classified as having smooth regular margins, smooth lobulated margins or irregular margins.

Table 7: USG Characteristics - Margins of Lesions

| Margins of Lesions | Number of Lesions |
|--------------------|-------------------|
| Smooth Regular | 65 |
| Smooth Lobulated | 22 |
| Irregular | 13 |

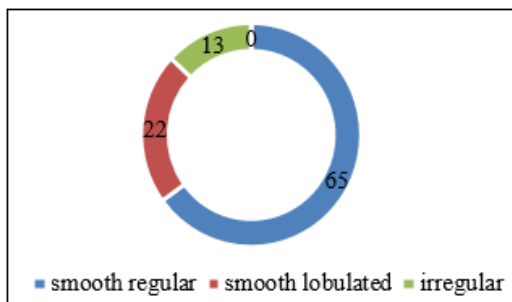


Chart 8: USG Characteristics – Margins of lesions

Echogenicity of Lesions: Echotexture of the lesions were described as anechoic, hypoechoic, echogenic, heteroechoic. Most of the solid lesions were either hypoechoic or echogenic while cystic lesions were mostly anechoic or had mixed echotexture.

Table 8: USG Characteristics - Echogenicity of Lesions

| Echogenicity | Number of Lesions |
|---------------------------|-------------------|
| Anechoic | 26 |
| Hypoechoic | 20 |
| Hyperechoic | 33 |
| Heterogenous echogenicity | 21 |

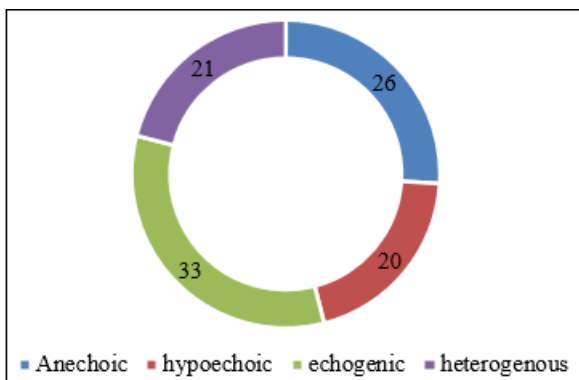


Chart 9: USG Characteristics - Echogenicity of Lesions

Presence of Additional Features (Septations & Calcifications) and Vascularity on CFM mode:

- Very few of the lesions had additional features of septations and calcifications.

- All of these lesions were mostly anechoic cystic lesions. Very few lesions had evidence of internal vascularity, most of them had origins form skin or vessels.

Table 9: USG Characteristics - Additional Features & Vascularity

| Additional Features | | Vascularity | |
|---------------------|--------|-------------|--------|
| Present | Absent | Present | Absent |
| 35 | 65 | 21 | 79 |

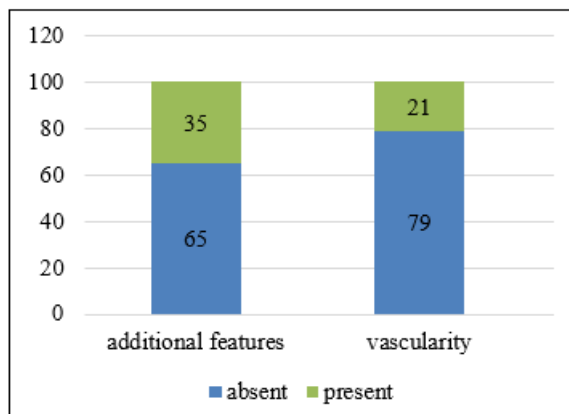


Chart 10: USG Characteristics – Additional features & Vascularity

Histopathological Evaluation

Nature of Tissue of Origin: Histopathological confirmation of the lesion was obtained either by preoperative FNAC or biopsy or by postoperative histopathological evaluation of the specimen excised. The specimens were examined and the nature of the tissue of origin was determined.

Table 10: Number of Lesions arising from different Body Tissues

| Tissue of Origin | Number of Lesions |
|------------------------------|-------------------|
| Fat | 33 |
| Vessels | 16 |
| Nerves | 8 |
| Tendon & its structures | 14 |
| Muscle and Connective Tissue | 6 |
| Others | 23 |

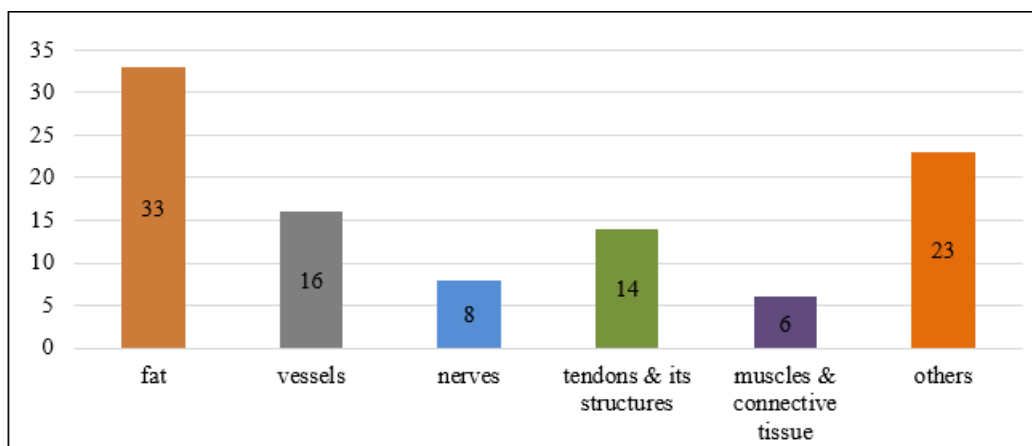


Chart 11: Number of lesions arising from different body tissues

Spectrum of Lesions based on Histopathology: The different confirmed histopathology diagnoses were tabulated each under the respective groups of tissue of origin.

Table 11: Histopathological Diagnosis (N =100)

| Tissue of Origin | Specific Diagnoses | | Total (100) |
|-----------------------------|------------------------------|----|-------------|
| Fat | Lipoma | 23 | 33 |
| | Liposarcoma | 6 | |
| | Other Lipomatous lesions | 4 | |
| Vessels and Lymphatics | AV Malformation | 6 | 16 |
| | Lymphatic Malformation | 2 | |
| | Hemangioma | 4 | |
| | Aneurysm | 2 | |
| Nerves | Superficial Thrombophlebitis | 2 | 8 |
| | Neurofibroma | 4 | |
| | Schwannoma | 2 | |
| Tendons & its structures | Malignant NS Tumor | 2 | 14 |
| | Ganglion | 10 | |
| | Tenosynovitis | 4 | |
| Muscles & Connective tissue | Rhabdomyosarcoma | 2 | 6 |
| | Desmoid Tumor | 2 | |
| | Fibromatosis | 2 | |
| Others | Epidermoid&Dermoid | 6 | 23 |
| | Pilomatricoma | 3 | |
| | Synovial Cysts | 4 | |
| | Baker's Cyst | 2 | |
| | Hematoma/Abscesses | 8 | |

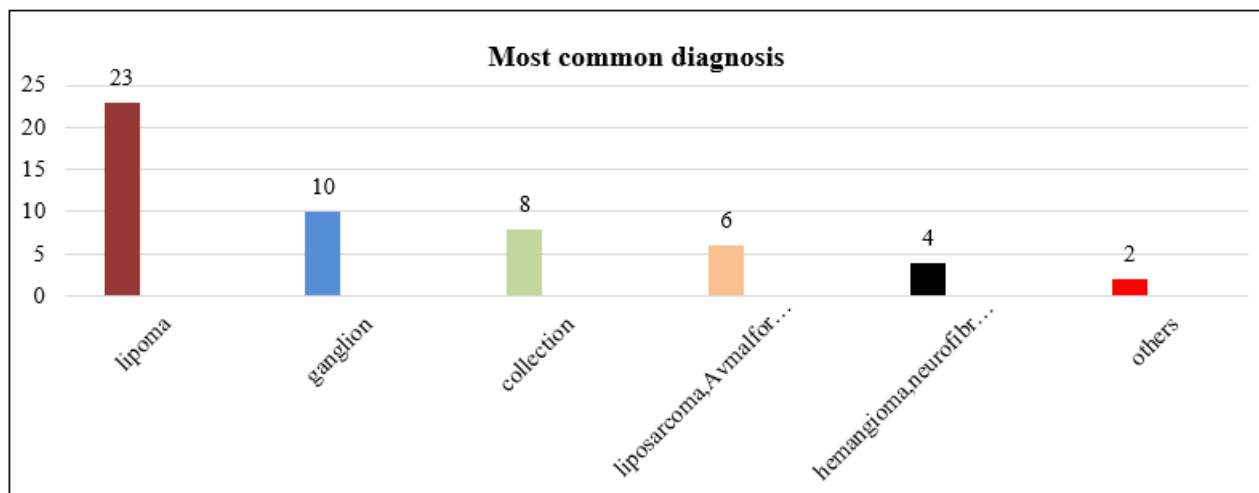


Chart 12: Most Common Diagnosis

Statistical Analysis

- Total of 100 patients were included in the study, including both males and females of various age groups.
- Common locations were torso (32 patients, 32%) followed by lower limb (28 patients, 28%), upper limb (22 patients, 22%) and head & neck (18 patients, 18%).
- 42 (42%) patients had lesions that were soft in consistency; rest 58% of the patients had firm lesions.
- Only 12% of the lesions exhibited multiplicity, i.e., presented with multiple lesions on the body.

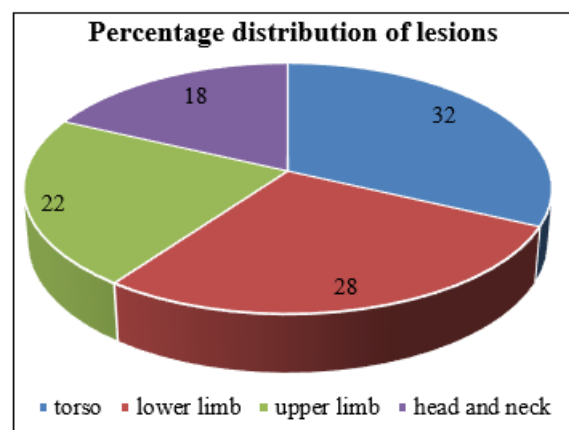


Chart 13: Percentage Distribution of Lesions

Table 12: Total lesions studied and the sensitivity of diagnosis on USG
(Sensitivity=True Positive/True Positive+ Falsenegative)

| Lesion of origin | Correctly Diagnosed | Misdiagnosed | Sensitivity |
|---------------------------------|---------------------|--------------|-------------|
| Lipoma and related lesion | 30 | 3 | 90.9% |
| Vascular lesions | 14 | 2 | 87.5% |
| Nerve sheath lesions | 6 | 2 | 75% |
| Tendon & its structure | 12 | 2 | 85.7% |
| Muscle & connective tissue | 4 | 2 | 66.6% |
| Others (as mentioned below) | 20 | 3 | 86.9% |
| • Collection (Hematoma/abscess) | 8 | 0 | |
| • Epidermoid /Dermoid | 5 | 1 | |
| • Synovial cyst | 2 | 2 | |
| • Baker’s cyst | 2 | 0 | |
| • Pilomatricoma | 3 | 0 | |

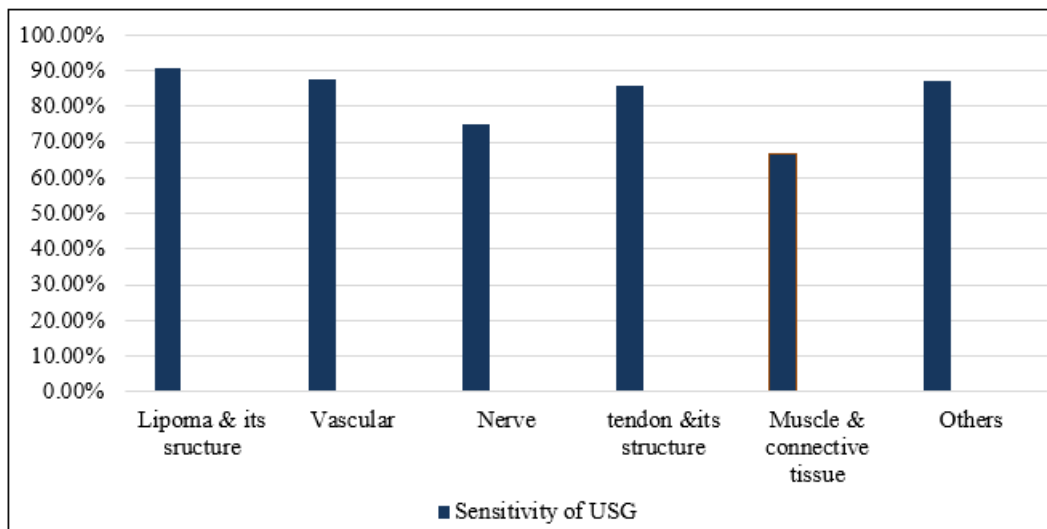


Chart 14: Sensitivity of USG

Detailed Evaluation:

Lipomatous Lesions:

- 33 cases of lipomatous lesions were evaluated in our study; of which 30 cases consisting of 26 lipomas and 4 liposarcomas were confirmed the same on histopathological evaluation.
- In the other 3 cases, the provisional USG diagnosis was later refuted on histopathological evaluation.
- This consisted of 2 cases with USG diagnosis of lipomas that were proved on histopathology to be liposarcomas and 1 cases of a profoundly obese patient in which the lesion diagnosed as lipoma was later found to be normal fat deposition.
- Hence, well differentiated liposarcomas form the main diagnostic confusion limiting the sensitivity of USG in evaluation of lipomas.

Vascular Lesions:

- Of the 16 cases of vascular lesions evaluated in our study, USG exhibited an excellent sensitivity by correctly revealing 14 of these lesions.
- The addition of color and spectral doppler USG to the routine gray scale imaging significantly boosts the sensitivity of USG for the evaluation of these lesions.
- Most of these cases in our study were vascular malformations of various origin.
- Spectral Doppler interrogation makes the evaluation of the origin of the lesion possible with arterial malformation

eliciting high resistance waveforms and venous malformation eliciting low velocity waveforms.

- Lymphatic malformations do not show any color filling on doppler

Nerve Sheath Lesions:

- These particular lesions are the ones that largely remained elusive in our study; as was also found in a number of studies carried out by other researchers.
- 8 such patients were studied in our research who were later evaluated by histopathology, USG exhibited an excellent sensitivity by correctly revealing 6 of these lesions.

Tendon & its structure:

- 14 cases were studied, in which the USG findings with demonstration of neck extending to tendon sheath or a joint capsule compounded with the clinical examination in the form of typical location of the lesions, allowed accurate diagnosis of the lesion. Result was consistent with histopathology in all 10 of these cases.
- The significant other condition that poses diagnostic confusion with ganglion is synovial cyst, that arises from joint space, similar to ganglion. 2 such cases of synovial cysts were falsely diagnosed as ganglion cyst on USG; thereby limiting the specificity of USG.

Muscle and connective tissue

Of the 16 cases of vascular lesions evaluated in our study, USG exhibited an excellent sensitivity by correctly revealing 14 of these lesions.

Others

Epidermoid/Dermoid:

3 cases of epidermoid were evaluated and all were diagnosed accurately owing to the characteristic USG features of hypochoic lesions with linear strands within associated with posterior acoustic enhancement; demonstrating the reliability of the USG for evaluation of these lesions.

Collections:

- 8 such cases were studied and all 8 of these were diagnosed correctly by USG evaluation.
- 6 of these were abscesses and 2 was a hematoma in organizing stage.
- The abscesses were mostly tuberculous in origin.

6. Discussion

- Superficial soft tissue swellings comprise a wide spectrum of lesions which can be primarily classified into various types based on their origin, histological type, USG features and anatomical location.
- The ability of USG to assess and diagnose a superficial soft tissue swelling has greatly increased and as technology has advanced by leaps and bounds and so is the knowledge and confidence of radiologists to ascertain a narrow differential diagnosis.
- USG has always been a preferred modality due to its low cost, non- invasive nature, ready availability, safety, no risk of radiation, faster reporting and a comfortable modality which has high specificity and predictive value to diagnose superficial soft tissue swellings.

Table 13: Gender Distribution of Lesion

| | Present study | Study by Kransdorf and Myhre Jensen et al. Lazim et al. |
|--------|---------------|---|
| Male | 58 | 165 |
| Female | 42 | 48 |
| M:F | 1.38:1 | 1.7:1 |

- There is male preponderance in almost all soft tissue lesions. In the present study, there were 58 males and 42 females out of total 100 cases of soft tissue lesions, with M.F ratio of 1.38:1, which is similar as in the study done by Beg et al.
- Our study is also comparable with that of Kransdorf and Myhre Jensen et al. Lazim et al. studied 213 cases of soft tissue lesions in 1 year and reported a male preponderance in all with a M F ratio of 1.7:1

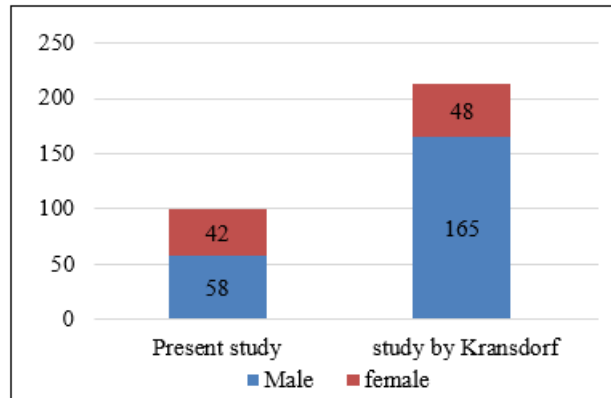


Chart 15: Body Distribution of Lesions

- Hung E et al conducted a retrospective study in Hong Kong on 247 soft tissue tumors and in this study the affected age groups varied from 1-96 years.
- Another retrospective study performed by Hong Jen Chinu et al on superficial soft tissue masses in Taipei enrolled patients with age group from 1 to 104 years.
- Based on the present study and with comparison with previous studies conducted by Hong-Jen Chiou et al and Hung E et al the most common site of presentation of superficial soft tissue swelling was torso.
- In our study also the most common site of superficial swelling was found to be torso, with marginal difference from lower limb. However, the study may have been confounded by
- limited sample size.

Table 14: Body Distribution of Lesion

| Body Distribution of Lesions | Present study | studies conducted by Heng-Jen Chios et al and Hung E et al |
|------------------------------|---------------|--|
| Torso | 32% | 35% |
| Lower limb | 28% | 25% |
| Upper limb | 22% | 21% |
| Head & neck | 18% | 19% |

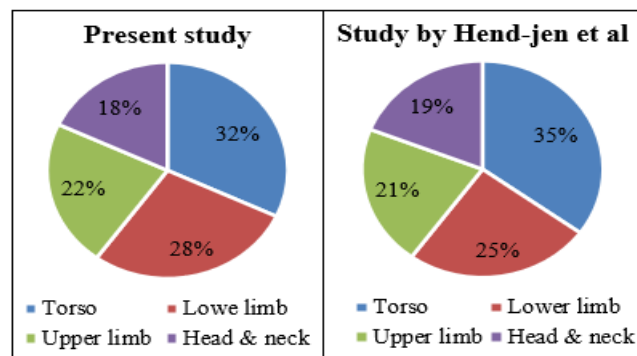


Chart 16: Spectrum of Lesions

Table 15

| Lesion of origin | Present study | Histopathological Spectrum of Soft-Tissue Tumors with Immunohistochemistry Correlation and FNCLCC grading: A North Indian Experience by Hena Paul Singh, Sumit Grover, Bhavna Garg, and Neena Sood. |
|----------------------------|---------------|---|
| Lipoma and lipoma variants | 33% | 34% |
| Vascular | 16% | 18.5% |
| PNST | 8% | 11% |

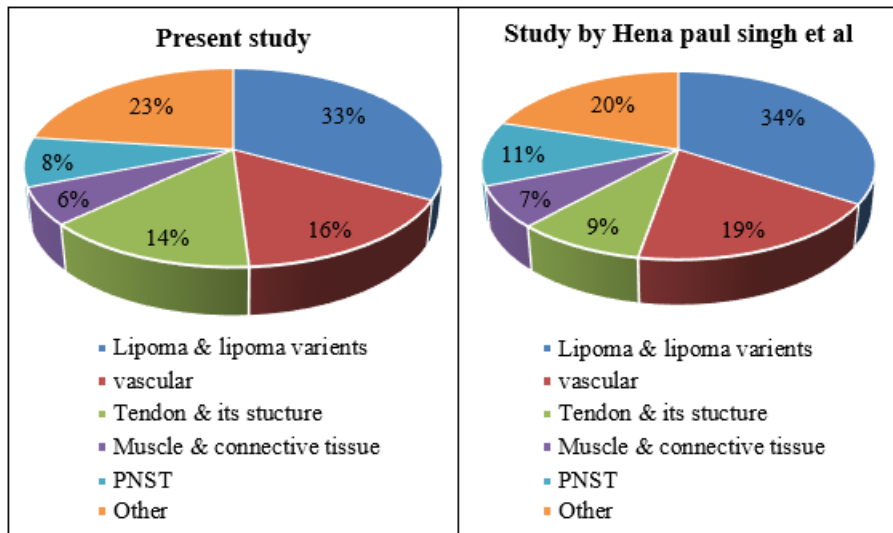


Chart 17

Lipoma

- Lipoma was the most common benign tumor encountered as soft tissue masses.
- These tumors often were found to be located in the subcutaneous plane, though their locations in intramuscular and intermuscular planes aren't infrequent.
- On USG, most of the lipomas were found to be homogeneously hyperechoic relative to the surrounding structures with peculiar pattern of echogenic parallel lines also depicted with the tumor. However, some of the lipomas were hypoechoic or even isoechoic to the surrounding structures.
- We inferred that lipoma have an echogenic pattern ranging from hyperechoic to hypoechoic with parallel echogenic lines being a characteristic feature. Similar ultrasound features of lipoma were reported by the authors such as Rahmani G et al and Ahuja et al and also found in our study.
- **The sensitivity of USG for evaluation of lipomatous in our study was 90.9%.**

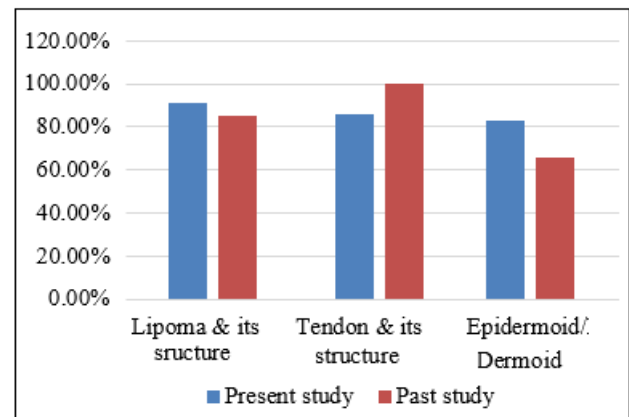


Chart 18: Sensitivity of USG in evaluation of various lesions

Table 16: Sensitivity of USG in evaluation of various lesions

| Lesion of origin | Present study | Efficacy of Diagnostic Ultrasonography of Lipomas, Epidermal Cysts, and Ganglions by Yoshihiro Kuwano, MD, PhD; Kazuho Ishizaki, CT; Rei Watanabe, MD, PhD; et al |
|--------------------------|---------------|---|
| Lipoma& its structure | 90.9% | 85.1% |
| Tendon & its structure | 85.7% | 100% |
| Epidermoid/ Dermoid cyst | 83.3% | 65.9% |

Collections (Abscess)

- In our study, a total of 8 cases of collection in the form of hematoma/abscess formation were found. Most of these, in case of abscess were evaluated in head and neck region and were associated with cervical tuberculous lymphadenitis in the form of cold abscess.
- **USG exhibited an excellent sensitivity of 100% for the evaluation of these lesions along with determining the extent of these lesions.**
- Similar high degree of accuracy of USG for evaluation of collections was found by Dr Pooja Shamsukha and Dr Prasanna Mishrikotkar in their study in which all the 20 cases were confidently diagnosed on USG with sensitivity of 100%.
- A study conducted in a rural Indian center by Saboo S et al on 123 patients showed similar high sensitivity corresponding to 94.5% Foreign bodies, usually associated with traumatic abscess formation, are usually identified as hyperechoic structure with variable acoustic shadowing with surrounding hypo echogenicity suggestive of abscess or granuloma.

Table 17

| Collection | Present study | Study done by Dr Pooja Shamsukha and Dr Prasanna Mishrikotkar |
|-------------|---------------|---|
| Sensitivity | 100% | 100% |

Ganglion Cysts

- Ganglion is a cystic mass lesion and may present as unilocular or multilocular cystic lesion with myxoid matrix.
- In the study on 200 patients by Dr Pooja Shamsukha and Dr Prasanna Mishrikotkar entitled as "The Accuracy of Diagnostic High Frequency Ultrasound Imaging For Musculoskeletal Soft Tissue Pathology", the predominant echo pattern of ganglion cysts was found to be anechoic.
- A prospective study conducted by George Wang et on 20 wrist ganglia showed majority of the lesions to be anechoic.

Same results were found in our study with the characteristic feature of "neck of the lesion" extending towards adjacent joint or tendon sheath allowed the diagnosis with high degree of confidence, with a sensitivity of 85.7 to the present study.

Peripheral Nerve Sheath Tumors

- Neurofibromas and schwannomas are the two most common neural tumors presenting as soft tissue swellings.
- Both the tumors are heterogeneous and predominantly hypoechoic.
- In a study conducted by Reynolds DL Jr, Jacobson JA, Inampudi P. Jamadar DA, Ebrahim FS and Hayes CW it was found that peripheral nerve sheath tumors are often hypoechoic with posterior acoustic enhancement and may simulate a ganglion cyst.
- The presence of intrinsic blood flow on color Doppler sonography and peripheral nerve continuity suggests the diagnosis of peripheral nerve sheath tumor.
- However, sonography cannot reliably distinguish neurofibromas from schwannomas.
- Even in our study, nerve sheath tumors frequently posed diagnostic confusion with accurate diagnosis being obtained in only 75% of the total cases studies.
- The USG features of neurofibroma and schwannoma are frequently overlapping. **The sensitivity of USG for evaluation of Nerve Sheath tumors according to the present study turned out to be 75%**

Table 18

| | | |
|-------------|---------------|--|
| | Present study | Study done by Reynolds DL Jr, Jacobson JA, Inampudi P. Jamadar DA, Ebrahim FS and Hayes CW |
| Sensitivity | 75% | 55% |

- An important finding is that a nerve eccentrically entering a mass was seen only in schwannomas, and that may allow differentiation between neurofibromas and schwannomas as was found in a study conducted by Tsai WC, Chiou HJ, Chou YH. Wang HK, Chiou SY and Chang CY entitled "Differentiation between schwannomas and neurofibromas in the extremities and superficial body: the role of high-resolution and color Doppler ultrasonography".

Epidermoid Inclusion Cysts

- In a study conducted by Lee HS, Joo KB, Song HT, Kim YS, Park DW, Park CK. Lee WM, Park YW. Koo JH and Song SY to determine the relationship between sonographic and pathologic findings in epidermal

inclusion cysts, it was found that epidermal inclusion cysts most often appeared monographically as a hypoechoic mass containing variable echogenic foci without color Doppler signals.

- Of the 24 cases studied, twenty-three cases (96%) were associated with posterior sound enhancement. Color Doppler signals were absent in 20 cases, but some vascularity was noted in 4 ruptured epidermal cysts, in areas of granulation tissue. Sonographic findings were related to the lamellar pattern of keratin debris and the granulation tissue secondary to rupture.
- These definitive features of Epidermoid allows the diagnosis of Epidermoid with high degree of accuracy, as was also concluded in our study, which found a **USG sensitivity of 83.3% for diagnosis of Epidermoid cysts.** Most cases presenting diagnostic difficulty were the cases of ruptured cysts, which exhibits lobulated configuration with color Doppler signals.

Table 19

| | | |
|--|---------------|---|
| Echogenicity of Epidermoid cysts | Present study | a study conducted by Lee HS, Joo KB, Song HT, Kim YS, Park DW, Park CK. Lee WM, Park YW |
| Hypoechoic lesion with posterior acoustic enhancement. | 5 | 23 |
| Other | 1 | 1 |
| Total | 6 | 24 |

Malignancy of Lesions

- The studies done by Umarani et al., Jain et al, and Batra et al, Kransdorf reported 60.2% benign and 39.8% malignant soft tissue neoplasms in their study.
- Petersen et al. had done a retrospective study and found 49% malignant, 11.4% intermediate, 35% benign, and 4.6% as tumors of uncertain potential.
- In present study, the frequency of benign lesions was 90% and malignant lesions was 10%; with benign lesions surpassing the malignant lesions.

Table 20

| | | |
|-----------|---------------|--|
| | Present study | studies done by Umarani et al., Jain et al, and Batra et al, Kransdorf |
| Benign | 90% | 60.2% |
| Malignant | 10% | 39.8% |

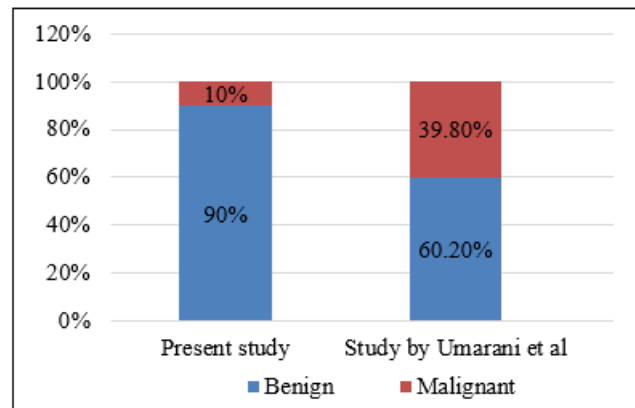


Chart 19

7. Summary & Conclusion

- 1) A total of 100 patients with complains of soft tissue swelling of musculoskeletal system anywhere on body with distribution categorized as Head & Neck, Upper Limb, Torso and Lower Limb were prospectively studied to evaluate the role and sensitivity of ultrasonography in the evaluation of non-traumatic soft tissue lesions of musculoskeletal system.
 - 2) A number of pathologies were identified and evaluated such as lipoma, nerve lesions, abscesses, hematomas, vascular lesions, ganglion cysts and a few miscellaneous lesions like rhabdomyosarcoma, plantar fibromatosis, pilomatricoma etc.
 - 3) There are certain lesions that can be diagnosed with USG evaluation with high degree of sensitivity. These include lipomas, abscess, ganglion cysts, vascular lesions, epidermoid etc.
 - 4) Common site of involvement of soft tissue lesion in our study is Torso.
 - 5) Most common soft tissue lesion in our study are Lipoma.
 - 6) Our study consisted of 33 lesions of Lipoma & related lesions, of which 90% of the lesions confirmed to be arising from Lipomatous tissue on histopathology.
 - 7) Our study included 16 lesions of vascular origin (16% of the total lesions) of which 87.5% of the lesions were diagnosed accurately to be of vascular origin. Thus, USG has reliable sensitivity for the evaluation of lesions of vascular origin.
 - 8) Our study consisted of 8 lesions of nerve origin, of which 75% of the lesions confirmed to be arising from nerves and their covering on histopathology.
 - 9) Our study consisted of 14 lesions of tendons and its structure origin, of which 85.7% of the lesions confirmed to be arising from tendons & its structure on histopathology.
 - 10) Our study consisted of 6 lesions of Muscle & connective tissue origin, of which 66.6% of the lesions confirmed to be arising from tendons & its structure on histopathology.
 - 11) Other miscellaneous lesions included in our study are,
 - a) Collection (hematoma/abscess): USG exhibited sensitivity of 100%.
 - b) Epidermoid/Dermoid: USG exhibited sensitivity of 83.3%.
 - c) Bakers' cyst: USG exhibited sensitivity of 100%.
 - d) Pilomatricoma: USG exhibited sensitivity of 100%.
- based study in Olmsted county, Minnesota. *Mayo Clin Proc* 2007; 82:817.
- [5] Sturzenegger M et al. [Microsurgical and histological observations in schwannoma of peripheral nerves]. *Handchir Mikrochir Plast Chir.* 1992;24(6):304-9. (In German).
 - [6] Bencardino J, Rosenberg ZS, Beltran J, Liu X, Marty-Delfaut E. Morton's neuroma: is it always symptomatic? *AJR Am J Roentgenol.* 2000; 175:649-653.
 - [7] Reitamo JJ, Scheinin TM, Häyry P. The desmoid syndrome New aspects in the cause, pathogenesis and treatment of the desmoid tumor. *Am J Surg.* 1986;151(2):230-237.
 - [8] Middleton W, Patel V, Teefey S, Boyer M. Giant Cell Tumors of the Tendon Sheath: Analysis of Sonographic Findings. *AJR Am J Roentgenol.* 2004;183(2):337-9.
 - [9] Murphey M, Rhee J, Lewis R, Fanburg-Smith J, Flemming D, Walker E. Pigmented Villonodular Synovitis: Radiologic-Pathologic Correlation. *Radiographics.* 2008;28(5):1493-518.
 - [10] Wolfson AB, Hendey GW, Ling LJ, Rosen CL, Schaidler J, Sharieff GQ. *Text Book Harwood-Nuss' – Clinical Practice of Emergency Medicine.* 5th ed. Lippincott: Williams and Wilkins, Wolter Kluwer Publishers; 2010. p. 1340.
 - [11] Filston HC. Hemangiomas, cystic hygromas and teratomas of the head and neck. *Semin Pediatr Surg* 1994; 3:147-59.

References

- [1] Murphey MD, Carroll JF, Flemming DJ et-al. From the archives of the AFIP: benign musculoskeletal lipomatous lesions. *Radiographics.* 24 (5): 1433-66.
- [2] Teefey S, Dahiya N, Middleton W, Gelberman R, Boyer M. Ganglia of the Hand and Wrist: A Sonographic Analysis. *AJR Am J Roentgenol.* 2008;191(3):716-20.
- [3] Kim I. *Radiology Illustrated: Pediatric Radiology.* Springer. (2014) ISBN:3642355730.
- [4] McNamara DR, Tleyjeh IM, Berbari EF, et al. Incidence of lower-extremity cellulitis: a population-