# Can 3D Shape and Textural analysis Differentiate Liposarcomas from Benign Lipomas?

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**Introduction:** The differentiation of lipoma from low-grade liposarcoma is difficult with imaging [1]. This is a significant clinical problem because biopsy is invasive, particularly for abdominal and pelvic tumors. In addition, biopsy is vulnerable to sampling error [2], and can potentially exacerbate spreading of tumor cells [3]. Liposarcomas have been evaluated for greater internal heterogeneity and border spiculation than lipomas [4], but these signs may be subtle or unapparent even to the experienced eye. We used post-processing analysis of tumor margins and texture to determine the ability of quantitative shape and texture analysis to differentiate lipoma and liposarcoma on conventional T1-weighted MR images.

**Methods:** We retrospectively studied 44 histologically proven cases (24 lipoma, 20 liposarcoma) in 16 men and 28 women. Patient ages were 20-86 yrs (mean 56 yr). All studies were performed at 1.5T and included a T1-weighted spin echo or turbo spin echo sequence (ETL = 1-3, median TR/TE/slice thickness/in-plane resolution = 522 ms/12 ms/5 mm/0.67 mm). Two experienced MSK radiologists (>10 years) blindly and independently assessed each case as either benign (lipoma) or malignant (liposarcoma). We used the Seeded Region Growing plugin in ImageJ (http://ij-lugins.sourceforge.net/plugins/segmentation/ based on the algorithm described by Adams and Bischof) to define tumor volumes of interest (VOIs) on T1-weighted images. Seventy textural features were initially computed including gray-level co-occurrence and run-length matrix features [5]. Seventy-three shape features were initially computed based on the defined VOI morphologies. In addition to measuring the lengths, widths, and perimeters of the VOI, we also computed shape features based on the inscribed circle, ellipse and rectangle. These simple geometrical parameters were used to derive other descriptors such as roundness, circularity, and eccentricity of the tumor VOI. The remaining features were determined by finding the medial axes and branch-points of the tumor. All textural and shape features were computed using MaZda version 4.6 (P.M. Szczypiński, Institute of Electronics, Technical University of Lodz, Poland). For feature selection, we reduced the dimensionality of our feature space from 143 to 6 on the basis of the Fisher coefficient of each feature (ie, the ratio of between-class and within-class variance [6]). Combinations of shape and textural features were used to train multiple linear discriminant analysis (LDA) classifiers: (a) top 6 features (3 shape + 3 texture), (b) top 3 (2 texture + 1 shape), as well as (c) shape- and (d) texture-only combinations of 3 features each. We assessed the performance of each classifier (sensitivity, specificity and accuracy) for delineating lipoma from liposarcoma diagnosis using 10-fold cross validation [7]. Diagnostic accuracy of the two radiologists was determined using contingency tables. Inter-reader agreement was evaluated by Kappa statistics.

**Results:** T1W spin-echo images obtained from (a) lipoma misclassified as a liposarcoma by both radiologists, and (b) a liposarcoma misidentified as a lipoma by both radiologists are provided in Fig. 1. Both tumors were correctly identified by shape & textural analysis. The diagnostic performance of each shape and textural feature combination is provided in Table 1. There was no significant difference in classification performance between the LDA classifier generated with the top 6 features and either the top 3 features (P=0.53), or the texture-only features (P=0.12), although it was superior to the classifier generated with the shape-only features (P=0.003). Regarding standard radiologic assessment, liposarcomas were correctly identified with sensitivity, specificity and accuracy of 75%, 83%, and 80% (Radiologist A) and 84%, 74%, and 79% (Radiologist B). Inter-reader agreement was good (kappa =0.72).

| LDA Classifier | Accuracy | Se | Sp |
|---|---|---|---|
| All 6 features | 89 | 88 | 90 |
| 2 Texture ( *f6*, *f9*) + 1 Shape (#branch pts) | 87 | 78 | 95 |
| **Texture:** ( *f6*, *f9*, Run-length non-uniformity) | 85 | 78 | 92 |
| **Shape:** #branch pts, convexity, length contours | 76 | 78 | 75 |

**TABLE 1:** Shape and Textural feature Classification Performance.

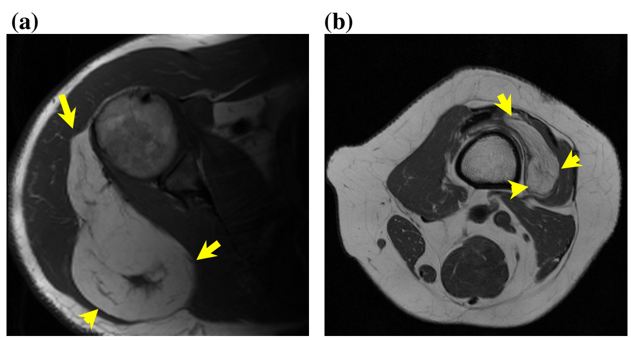


**FIGURE 1:** T1W spin-echo images obtained from (a) a lipoma misclassified as a liposarcoma by both radiologists, and (b) a liposarcoma misidentified as a lipoma by both radiologists.

**Conclusion:** In this preliminary study, we have identified a potential morphological and textural 'fingerprint' of malignant lipomatous tumors. With sufficient cases, this computer-aided classification approach promises to provide improved accuracy compared to conventional radiologic methods.

**References:** [1] Brisson et al. Skeletal Radiol. 2012 Sep 18. [Epub ahead of print]; [2] Skrzynski et al. J Bone Joint Surg Am. 1996;78(5):644-9; [3] Robertson et al. Clin Radiol. 2011;66(11):1007-14; [4] Ohguri et al. AJR Am J Roentgenol. 2003 ;180(6):1689-94; [5] Szczypinski et al. Comput Methods Programs Biomed 2009; 94:66; [6] Mayerhoefer et al. JMRI 2005;22(5):674-80; [7] Witten and Frank. Data mining-practical machine learning tools and techniques, 2nd ed. 2005.