Three-dimensional analysis of pulmonary nodules by MSCT with Advanced Lung Analysis (ALA1) software

Analisi volumetrica tridimensionale mediante TCMS con software Advanced Lung Analysis (ALA1) del nodulo polmonare

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Abstract

Purpose. The purpose of this study was to test the reproducibility of the three-dimensional (3D) Advanced Lung Analysis software (3D-ALA, GE Healthcare) in the estimation of pulmonary nodule volume.

Materials and methods. We retrospectively reviewed the unenhanced multislice CT scans (Lightspeed Pro 16 GE) of 77 patients with a solitary pulmonary nodule (n=71) or metastatic pulmonary disease (n=6). A total of 103 pulmonary nodules (19 well-circumscribed, 45 juxtavascular and 39 juxtapleural) were analysed grouped into five classes based on diameter: <5 mm, 10 nodules (9.7%); ≥5 to <10 mm, 25 nodules (24.2%); ≥10 mm to <15 mm, 41 nodules (39.8%); ≥ 15 to <18 mm, 14 nodules (13.6%); ≥ 18 to <30 mm, 13 nodules (12.6%). The following acquisition parameters were used: slice thickness 0.625 mm, reconstruction interval 0.4 mm, pitch 0.56:1, 140 kV, 300 mAs, field of view 13 cm, bone kernel. For each of the 103 nodules three, 3D volume measurements were obtained by the 3D-ALA software. The reproducibility of nodule segmentation was evaluated according to a visual score (1=optimal, ≥95%; 2=fair, 90–95%; 3=poor, ≤90%) by three observers working in consensus. The reproducibility of volume estimation was evaluated by comparing all 3D volume measurements and all segmentations obtained for each pulmonary nodule using the ANOVA test.

Results. ALA-1 software allowed segmentation in all nodules (type 1 segmentation n=43, type 2 n=35, type 3 segmentation n=25). ALA-1 provided an identical 3D volume measurement in 62 nodules: 16 out of 19 well circumscribed (84.2%), 31 out of 45 juxtavascular (68.8%), 15 out of 39 juxtapleural (38.4%). Repeatability of 3D volume measurement was not possible in 41 out of 103 nodules [3 out of 19 (15.7%) well-circumscribed, 14 out of 45 (31.1%) juxtavascular, 24 out of 39 (61.5%) juxtapleural]. Among the 41 nodules with nonrepeatable 3D volume measurements, segmentation was scored as 1 in 2 out of 41 (4.8%), as 2 in 15 out of 41 (36.5%) and as 3 in 24 out of 41 (58.5%). The difference between the mean volume on three measurements and each type of nodule was not statistically significant (p>0.05).

Riassunto

Obiettivo. Valutare l’affidabilità della versione 1 del software Advanced Lung Analysis (ALA1, GE Healthcare) nella determinazione del volume di un nodulo polmonare.

Materiali e metodi. Sono stati analizzati retropsectivamente gli esami TC multistrato (Lightspeed Pro 16 GE), senza MdC per ve- na di 77 pazienti (71 con noduli polmonari solitari e 6 con noduli secondari). Complessivamente sono stati analizzati 103 noduli (19 circoscritti, 45 iuxta-vascolari e 39 iuxta-pleurici), suddivisi per dimensione in 5 categorie: <5 mm, 10 noduli (9,7%), 5–10 mm, 25 noduli (24,2%), 10–15 mm, 41 (39,8%), 15–18 mm, 14 (13,6%), 18–30 mm, 13 (12,6%). I parametri di acquisizione utilizzati per il calcolo volumetrico sono stati i seguenti: spessore di strato 0,625 mm, intervallo di ricostruzione 0,4 mm, pitch 0,56:1, 140 KV, 300 mAs, FOV 13 cm, algoritmo di ricostruzione ad elevata risoluzione spaziale. Per ciascun dei 103 noduli, impiegando il software ALA1, sono state effettuate tre misurazioni volumetriche. Tre osservatori in consenso, in ogni misura, hanno assegnato alla segmentazione dei contorni di ciascun nodulo, un punteggio visivo (1=ottimo, ≥95%; 2=discreto, 90–95%; 3=scarso, ≤90%). La riproducibilità nel calcolo del volume è stata valutata confrontando i valori stimati nelle tre misurazioni ottenute per ciascun nodulo mediante l’analisi della varianza (ANOVA test).

Risultati. La segmentazione mediante ALA1 è stata possibile in tutti i noduli analizzati. Tale software ha consentito una segmentazione di tipo 1 in 43 noduli, una segmentazione di tipo 2 in 35 noduli ed una segmentazione di tipo 3 in 25 noduli. Il calcolo volumetrico è risultato identico, nelle tre misurazioni consecutive, in 62 dei 103 noduli: 16 dei 19 noduli circoscritti (84,2%), 31 dei 45 noduli iuxta-vascolari (68,8%) e 15 dei 39 noduli iuxta-pleurici (38,4%). ALA1 non ha effettuato una ricostruzione riproducibile in termini di volume in 41 dei 103 noduli, di cui 3 dei 19 (15,7%) circoscritti, 14 dei 45 (31,1%) iuxta-vascolari, 24 dei 39 (61,5%) iuxta-pleurici e dei quali 2 su 41 (4,8%) sono stati segmentati dal software con qualità 1, 15 su 41 (36,5%) con qualità 2 ed infine 24 su 41 (58,5%) con qualità di segmentazione pari a 3. L’analisi della varianza non ha rilevato differenza tra le medie delle tre misurazioni

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Conclusions. Three-dimensional volume measurement with ALA-1 software is reproducible for all nodules as regards dimension and site. ALA-1 software provided a good and reproducible volume measurement in well-circumscribed and most juxtavascular nodules. Volumetric evaluation and reproducibility of volume estimation in juxta-pleural pulmonary nodules, particularly those adjacent to diaphragmatic pleura, is inadequate, and software improvement is needed.

Key words Multislice computed tomography • Solitary pulmonary nodule

Introduction

Characterisation of pulmonary nodules, above all those measuring 5–10 mm, is difficult if not impossible with positron emission tomography (PET), multiphasic dynamic computed tomography (CT) or percutaneous needle biopsy [1–3]. With the exception of completely calcified nodules and/or fat-containing nodules, which are considered benign, all other nodules are to be considered potentially malignant, and it is crucial to monitor their possible growth which, if demonstrated, calls for a histological diagnosis with percutaneous biopsy, video-assisted thorascopy or surgical intervention. Currently, CT is instrumental in evaluating the “growth” parameter of a pulmonary nodule, as it allows two-dimensional (2D) comparison of diameters in the axial plane. However, the asymmetrical or minimal growth of some malignant nodules may be missed if a manual, and therefore nonreproducible, CT measurement is used [4]. The aim of this study was to demonstrate the reproducibility of volume measurement of pulmonary nodules using the Advanced Lung Analysis software (ALA-1, GE Healthcare).

Materials and methods

Patient selection

Our series comprised 77 nonconsecutive patients (42 men, 35 women) aged 45–82 years (mean age 65 years) studied by CT between January and December 2004. Inclusion criteria were solid, noncalcific pulmonary nodules according to the definition reported in the literature [5], solitary pulmonary nodules (SPN) with peripheral ground-glass attenuation and central cavitation. Nodules with a diameter >30 mm, nodules with adjacent atelectasis, calcified nodules and those with a mixed composition (solid/liquid) were excluded. The 77 patients had an SPN discovered incidentally during chest radiography or CT performed for other reasons (e.g. chronic obstructive pulmonary disease, suspected pulmonary thromboembolism, pulmonary symptoms, etc.) and without positive pathology for neoplasm at presentation. In six patients, oncological follow-up revealed multiple repetitive lesions. Overall, we retrospectively evaluated 103 nodules ranging in size between 3.8 mm and 30 mm, 19 of which were well cir-