What is the difference in size of spontaneous pneumothorax between inspiratory and expiratory *x*-rays?

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Emerg Med J 2009 26: 861-863
doi: 10.1136/emj.2008.068742

What is the difference in size of spontaneous pneumothorax between inspiratory and expiratory *x*-rays?

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Accepted 16 March 2009

ABSTRACT

Objective: The aims of this study were to compare the estimated size of primary spontaneous pneumothorax (PSP) calculated on inspiratory and expiratory radiographs using the volumetrically derived Collins method and to determine whether radiograph type influences size classification for treatment according to published guidelines.

Method: This retrospective cohort study included patients treated for PSP in the emergency departments of two metropolitan teaching hospitals. Data collected included patient demographics and interpleural distances required to calculate pneumothorax size by the Collins method and to classify PSP according to guidelines. The outcomes of interest were the difference in size estimate between radiograph types and agreement in size classification for treatment according to guidelines. Analysis is by bias-plot analysis, kappa analysis and descriptive statistics.

Results: A total of 49 pneumothoraces (44 patients) were studied. Median age was 22 years; 66% were men. Median PSP size on inspiratory radiographs was 24% (IQR 14% to 31%, range 5% to 100%). The average size difference between expiratory and inspiratory films was 9%, with size on expiratory radiographs being larger. The 95% limits of agreement were wide (−5% to 23%). For each guideline, size estimation on expiratory rather than inspiratory radiographs would have suggested a change in treatment for an additional seven patients (14%, 95% CI 7% to 27%).

Conclusions: On average, PSP size calculated on expiratory radiographs is 9% higher than that calculated on matched inspiratory radiographs. Applying current management guidelines, the size difference between inspiratory and expiratory *x*-rays may alter initial treatment recommendation for some patients.

The management of primary spontaneous pneumothorax (PSP) is somewhat controversial. There are currently two guidelines that have been developed by major professional groups: the American College of Chest Physicians (ACCP)[1] and the British Thoracic Society (BTS).[2] Both agree that compromised patients require drainage of PSP, but for patients who are clinically well, the treatment recommended is based on the calculated size of the pneumothorax on plain radiographs, with each guideline using different cut-off points for instigation of intervention.

There has also been controversy over the role of radiographs taken in expiration in the evaluation and management of patients with pneumothorax. It has been suggested that there is little gained from using expiratory radiographs in the diagnosis of PSP.[2–4] However, some clinicians still consider it reasonable practice to obtain expiratory films in difficult cases in the belief that these films ease diagnosis and increase the relative size of the pneumothorax.[5] Anecdotally, the radiological practice of taking expiratory films is not uncommon. Although the BTS guideline discourages the use of expiratory radiographs for diagnosis, both guidelines are silent on what radiograph type should be used for size estimation to guide treatment. There is no published evidence quantifying the difference in PSP size calculated on expiratory versus inspiratory radiographs.

The aim of this study was to compare the calculated size of PSP using the volumetrically derived Collins method[6] on radiographs taken in inspiration with those taken in expiration and to determine whether radiograph type influences size classification for treatment according to published guideline recommendations.

METHODS

This was a retrospective cohort study. Participants were patients treated for PSP in the emergency departments of Western Hospital and Sunshine Hospital, two community teaching hospitals in Melbourne, Australia, between 1996 and 2005 who were identified from a pre-existing database. Only patients for whom matched initial preintervention inspiratory and expiratory radiographs could be found were included.

Data collected included demographics, side of pneumothorax and the interpleural distances required for size classification according to BTS[2] and ACCP[1] guidelines (table 1) and for calculation of pneumothorax size by the Collins method.[6] This method, developed using helical computerised tomography, uses a formula based on interpleural distances on the erect *x* ray to estimate pneumothorax size (size in % = 4.2+4.7×{sum of interpleural distances in centimetre at apex, midpoint of the upper half of the collapsed lung and the midpoint of the lower half of the collapsed lung}).

To reduce bias, inspiratory and expiratory radiographs were separated from their pair and arranged in random order. Interpleural distances were measured by two trained observers (one clinician and one research assistant), who were blinded to each other's measurements. The average of the measurements by the two observers was taken as the "true" value. The size of each PSP was then determined using the Collins formula, with calculated values >100% rounded down to 100%.

Table 1 Comparison of criteria for classification as "small" PSP

Guideline	Cut-off for classification as "small" PSP	Approximate size at cut-off by the Collins formula (%)
BTS	Less than 2 cm rim between lung and chest wall	32
ACCP	Less than 3 cm apical distance	16

ACCP, American College of Chest Physicians; BTS, British Thoracic Society; PSP, primary spontaneous pneumothorax.

The primary outcome of interest was the difference in size between inspiratory and expiratory radiographs of the same PSP. Secondary outcome measures were difference in classification into size groups between inspiratory and expiratory radiographs according to the BTS and ACCP guidelines.

Data were analysed using descriptive statistics, bias plot (Bland and Altman) analysis for agreement and kappa analysis for differences in classification. Intraclass correlation was used to evaluate agreement in measurement by the two data collectors. The study received approval under the National Health and Medical Research Council (NHMRC) (Australia) quality assurance project guidelines.[7]

RESULTS

A total of 49 pneumothoraces in 44 patients were studied. Twenty-nine (66%) were men, and the median age was 22 years (interquartile range (IQR) 19–29). A total of 35 (71%) pneumothoraces were on the left side.

The median PSP size on inspiratory films was 24% (IQR 14% to 31%, range 5% to 100%). The average difference between expiratory and inspiratory films was 9% (expiratory being larger in size), with 95% limits of agreement of −5% to 23% (figs 1 and 2).

On inspiratory films, the BTS guideline classified 25 (51%) PSPs as small, whereas on expiratory films, applying the same criteria, only 18 (37%) PSPs were classified as small. Kappa for agreement between film types was 0.72. Using the ACCP guidelines criteria, on inspiratory films, 15 (31%) PSPs were classified as small. On expiratory films, applying the same criteria, eight (16%) were classified as small. Kappa for agreement between film types was 0.61. In each case, an additional seven patients would have had a change in treatment if expiratory rather than inspiratory films had been used (14%, 95% confidence interval 7% to 27%). Note that, because of differences in the guidelines definitions, these were not the same group of patients for each guideline.

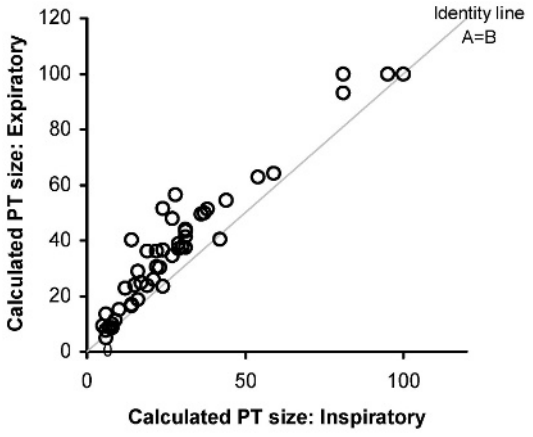

Figure 1 Scatter plot of relationship between size calculated on inspiratory and expiratory *x*-rays.

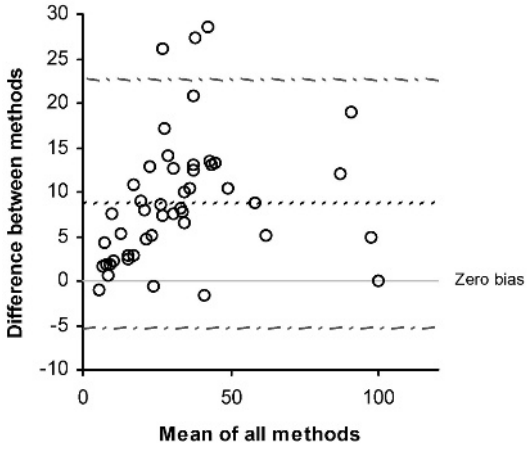

Figure 2 Bias plot of the relationship between size calculated on inspiratory and expiratory *x*-rays.

Agreement in measurement between the observers was good, with an intraclass correlation of 0.961 for the inspiratory radiographs and 0.986 for the expiratory radiographs.

DISCUSSION

The major management guidelines for PSP recommend treatment strategies for clinically stable patients according to the size of the PSP as measured radiographically.[1 2] Although the BTS guideline discourages the use of expiratory radiographs for the diagnosis of PSP, both guidelines are silent about which radiograph type should be used to perform this size estimation. Anecdotally, a proportion of clinicians continue to use expiratory radiographs. This is the first study to quantify the size disparity of PSP as measured on inspiratory compared with expiratory radiographs.

We found an average difference of 9% between film types, favouring calculated PSP size being larger on expiratory radiographs. The limits of agreement were, however, large (−5% to 23%). Use of expiratory radiographs for decision making would have resulted in an additional 14% of patients being recommended for interventional rather than conservative management. Thus, although expiratory radiographs may not necessarily aid in the diagnosis of PSP, the difference in measured size may alter the treatment approach. This has implications in terms of resource use, patient convenience and complications risk.

The finding that the guidelines classified different proportions of PSP (on both film types) as "large" or "small" is particularly interesting. It is, however, not surprising, as the guidelines use very different criteria to define "small" (table 1). Both guidelines suggest that small PSPs can usually be managed with outpatient observation alone, so the issue is of disagreement about the size of a PSP that can safely be managed this way. This disagreement may reflect different comfort levels with non-interventional treatment and may also be a reflection of the dearth of high-quality comparative trials of larger PSPs that include conservative management as a treatment option.

Although there is no evidence to support one radiograph type over the other for identification and monitoring of pneumothorax, there are arguments for preferring inspiratory films as they better define other conditions that may have similar presenting symptoms to PSP—for example, pneumonia. Given the difference found in this study, progress of resolution is best monitored using the same film type as was used for diagnosis.

This study has some limitations that should be considered when interpreting the results. It is a retrospective cohort study with all the recognised limitations of retrospective data collection. That said, the *x*-ray measurements are not subject to these problems. It is a relatively small sample from a single health service, which may lead to bias. The patients were identified from pre-existing database, so miscoding may have resulted in eligible cases being missed. The Collins method for estimating PSP size has yet to be externally validated.

CONCLUSION

On average, PSP size calculated on expiratory radiographs is 9% higher than that calculated on matched inspiratory radiographs. Applying current management guidelines, the size difference between inspiratory and expiratory radiographs may alter initial treatment recommendation.

Acknowledgements: The authors would like to thank People Strategy Innovation (Essendon, Victoria, Australia) for data and research support services and critical review of the manuscript.

Competing interests: None.

Provenance and peer review: Not commissioned; externally peer reviewed.

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Images in emergency medicine

Spontaneous iliopsoas muscle haematoma

A 55-year-old man presented to the emergency care centre complaining of right flank and groin pain from early that morning. His occupation was a Buddhist monk in a temple. In the morning he prayed and kowtowed many times in his temple. During the ritual he experienced sudden onset of severe pain in the right flank and groin. He reported that he had conducted the ritual kowtow as usual every morning. His vital signs were stable. Laboratory testing at the time of presentation revealed the following: haemoglobin, 12.1 g/dl; haematocrit, 36.2%; platelet count, 247 000/μl; activated partial thromboplastin time, 26.1 s; prothrombin time, 12.7 s; international normalised ratio, 1.02. He did not report any specific past medical history of haemophilia or other coagulopathies. A contrast CT scan showed an iliopsoas muscle haematoma (fig 1). He was admitted, treated with conservative therapy and discharged without specific complications after 8 days.

Spontaneous iliopsoas muscle haematomas occur rarely, even in patients receiving anticoagulant treatment or suffering from a coagulopathy. Iliopsoas muscle bleeding episodes are often large in volume, causing inhibition of muscular function and nerve involvement.[1] A history of acute flank or groin pain in a patient without a pertinent past medical history (haemophilia or coagulopathy) should include spontaneous iliopsoas muscle haematoma in the differential diagnosis.

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Figure 1 Abdominopelvic CT scan showing haemorrhage with haematoma formation in the right iliopsoas muscle at the lumbosacral level.

Competing interests: None.

Patient consent: Obtained.

Accepted 9 October 2008

Emerg Med J 2009;**26**:863. doi:10.1136/emj.2008.066365

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