Technical Article

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How accurate is the Light index for estimating pneumothorax size?

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SUMMARY

In Europe, the Light index is used for estimating the size of pneumothorax. It is based on the proportional relationship between the collapsed lung and the hemithorax. Other methods rely on absolute measurements on radiographs. The aim of this study was to compare the estimated size of pneumothoraces using Light index with that estimated using the CT volumetrics-derived Collins method. This was a secondary analysis of radiographs from a database of pneumothoraces treated conservatively. Radiographs were measured independently by two researchers according to the methods described by Light and Collins. Estimates of size derived by the two methods were compared using bias plot analysis techniques. The primary outcome of interest was agreement between pneumothorax size (as per cent) between the two methods. Sixty-one radiographs (27 patients) were analysed. The median age was 21 years and 76% were men. There was poor agreement between the methods. The average difference was 7.3% with the Light index underestimating the size compared with the Collins method. The 95% limits of agreement were wide (24% underestimation to 17% overestimation of size). The Light index as described does not accurately estimate the size of pneumothorax. New methods if accurate quantification of pneumothoraces is required clinically.

Key words: *Collins method; Light index; pneumothorax; size calculation*.

INTRODUCTION

It is commonly believed that the size of a pneumothorax is an important determinant of treatment, in particular regarding whether drainage is required and, if so, what method should be used.[1–3] Evidence suggests that 'best guess' estimation of pneumothorax size is inaccurate and is inconsistent.[4] In Europe, a commonly used method for estimating pneumothorax size is the Light index.[5,6] This method assumes that the volumes of the lung and the hemithorax are roughly proportional to the cube of their diameters. Thus the volume of a pneumothorax can be calculated (in per cent) using the following equation:[5]

$$100-\left[\left(\frac{\text{average diameter of lung}^3}{\text{average diameter of hemithorax}^3}\right)\times 100\right]$$

In common practice, these diameters are measured at the hila.[6] This method has the advantage of not being reliant on absolute measurements on an X-ray film unlike other methods.[7] Its proportional nature particularly suits its use in digital radiology, where screens may be of different sizes.

Another method for estimating the volume of a pneumothorax on a chest radiograph using volumetrics derived from helical CT was described by Collins.[8] The so-called Collins formula uses interpleural distances at specified points to estimate the

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size of pneumothorax and showed excellent correlation (r = 0.98) to CT-measured volumes.[8]

The aim of this study is to compare the estimated size of spontaneous pneumothoraces using the CT-derived Collins method with the Light index.

METHODS

This retrospective study was conducted at Western Hospital in Footscray, Australia. It was a secondary analysis of radiographs from a database of pneumothoraces in adults treated conservatively. We excluded partial pneumothoraces (defined as the absence of separation of the parietal and visceral pleura at the hilum) as the Light index method is not applicable to this group.

Radiographs were reviewed independently by two researchers and measured according to the methods described by Collins[8] and Light.[5] The average of the measurements by the two observers was taken as the 'true' measurement and used in the calculation of pneumothorax size using the two formulae for estimation. Expiratory films were preferred, but if none was available, inspiratory films were included.

The primary outcome of interest was agreement between pneumothorax size (as per cent with 95% confidence interval (CI)) between the two methods. Data were analysed using bias plot (Bland–Altman) analysis using Analyse-IT (Leeds, UK). We also analysed correlation using Pearson's correlation and inter-observer correlation for both methods. As in clinical practice, pneumothoraces are banded into small, medium and large; we also analysed agreement in subgroups with small defined as less than 20%, medium as 20–50% and large as greater than 50% (taking the Collins method calculation as the 'true' estimation of size).

The study was approved by the relevant institutional ethics committee.

RESULTS

Sixty-one radiographs were analysed, of 27 patients with a median age of 21 years (range 16–43 years). Of the 27, 21 (76%) were men. Average pneumothorax size as estimated by Collins formula was 33% (median 31%, range 11–88%).

Agreement between pneumothorax estimated using the Light index and the Collins method was poor. Agreement is shown in Figures 1 and 2. Correlation was good (0.87, 95%CI 0.79–0.92). The average difference between methods was 7.3%, with the Light index underestimating size compared with the Collins' method. The 95% limits of agreement were wide (24% underestimation to 17% overestimation of size).

Correlation between observers was 0.96 for the Collins method and 0.92 for the Light index. The 95% limits of agreement between observers were narrower for the Collins method (−11 to +3%) compared with the Light index (−16 to +16%).

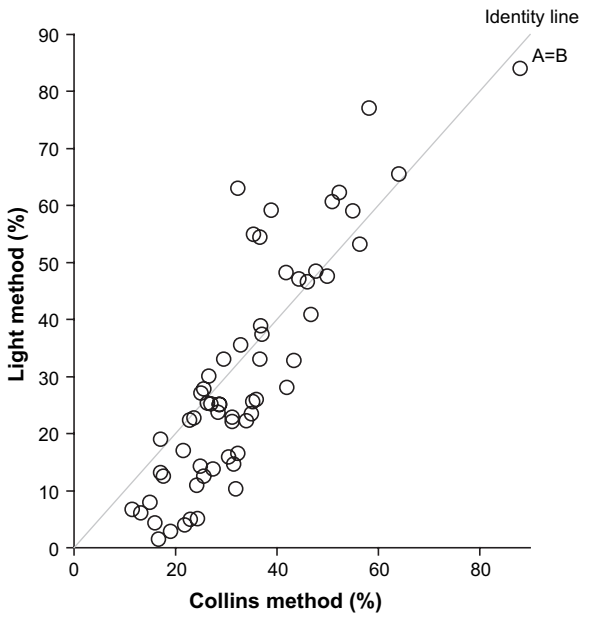

Fig. 1. Scatter plot of agreement between methods.

In the analysis of subgroups by pneumothorax size, for small pneumothoraces the average difference between the methods was −10% (Light index underestimating size) with 95% limits of agreement from −20 to 0%. For the moderate pneumothorax group, the average difference between methods was −8% (Light index method underestimating size) with 95% limits of agreement from −35 to +19%. For the large pneumothorax group, the average difference was 4% (Light index method overestimating size) with 95% limits of agreement from −11.5 to +20%.

DISCUSSION

Management guidelines and contemporary texts advise that the size of a pneumothorax is an important determinant of

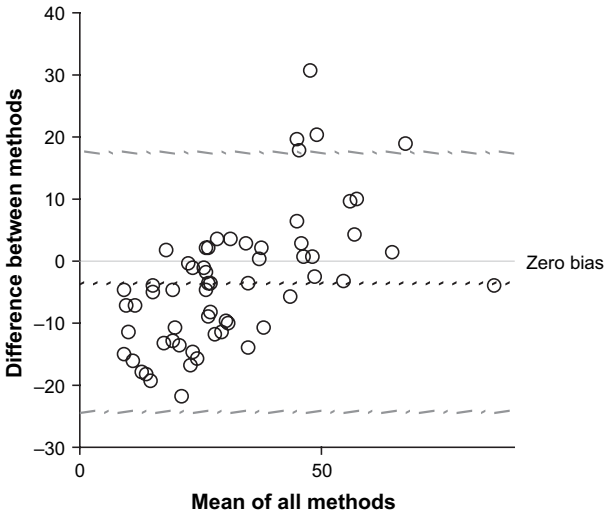

Fig. 2. Bias plot of agreement between methods.

therapy.[1–3] Some guidelines base size cut-offs on maximal interpleural distance at the apex as a surrogate for calculation/estimation of size,[1,2] whereas others recommend more formal estimation of size.[3] There are currently three methods described for calculation of pneumothorax size: the Rhea method,[7] the Light index method[5] and the Collins formula.[8]

A comparison of the Rhea and Collins methods was reported recently and concluded that the Rhea method is acceptably accurate for smaller pneumothoraces, but may significantly underestimate the size of larger pneumothoraces.[9] However, both the Rhea and Collins methods are reliant on absolute measurements on standard X-ray films and have not been validated with digital radiology.

The Light index is based on the proportional correlation between the lung and the hemithorax and thus, if accurate, would be applicable to a variety of screen sizes.[5] It has been reported to accurately estimate the size of pneumothorax.[10] This validation was, however, based on a very small sample (18 patients) who underwent aspiration of primary pneumothorax. Thus the sample is probably biased towards moderate and large pneumothoraces as small pneumothoraces are often treated without drainage. The study correlated the size of pneumothorax as evidenced by volume of gas aspirated against Light index estimation of size. It is important to remember, however, that correlation only measures association between two variables, not necessarily agreement between them. This study did not attempt to measure or estimate hemithorax volume, so agreement between the aspirated volume and true size cannot be calculated.

Our study found that agreement between pneumothorax size estimated using the Light index was poor, particularly for small pneumothoraces. Agreement was somewhat better for moderate and large pneumothoraces, but 95% limits of agreement were still very wide. The likely reason is that the assumptions underlying the Light index (i.e. that the thorax and lung approximate spheres) is less robust than the CT volumetrics-derived Collins method.

Although assessment of methods for accurately estimating the size of pneumothorax is an interesting academic exercise and may be useful for research purposes, the clinical relevance of accurate size estimation can be questioned. Some management algorithms are moving away from size as the primary determinant of management option, taking more account of the patient's clinical status.[1,6] Where size is still regarded as important, there seems to be a move towards classification as small, moderate or large depending on less absolute criteria.[1,6] If this is the case, all of the methods used for this classification (Rhea, Light, Collins and physician estimate) are probably of acceptable accuracy.

Our study has some limitations that should be considered when interpreting the results. It is a secondary analysis with all the well-known limitations this method. The sample includes a relatively small number of patients. Also, both of the methods compared in this study have not been externally validated. The subgroup analyses have small sample sizes in the subgroups, which may distort the agreement between methods.

CONCLUSION

The Light index as described does not accurately estimate the size of pneumothorax and is probably unsuitable as a quantification method. New methods, based on proportional correlations or using new technology are needed if accurate quantification of pneumothoraces is required clinically.

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