Standardizing Bilateral Ultrasound Images Comparison for the Diagnosis of Pneumothorax: A Pilot Study

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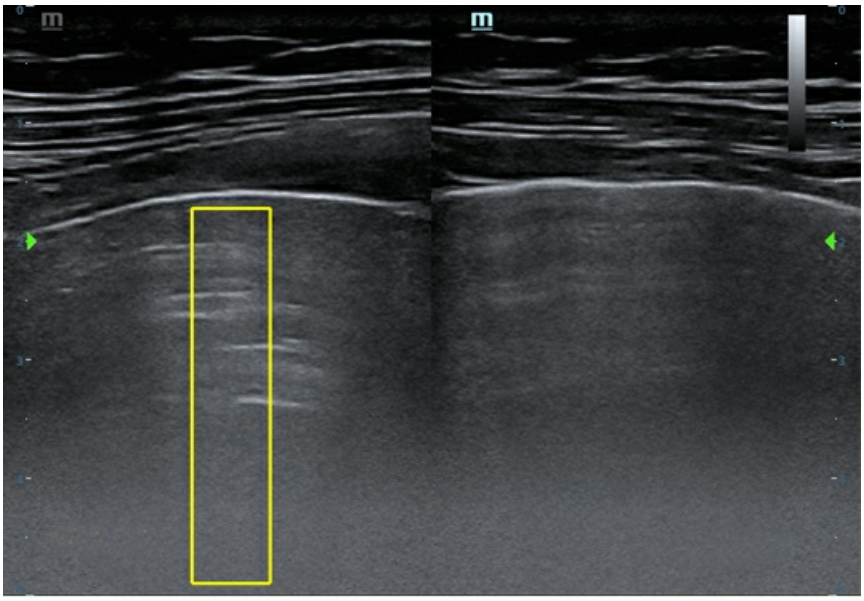
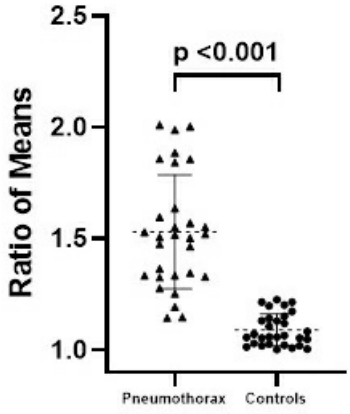
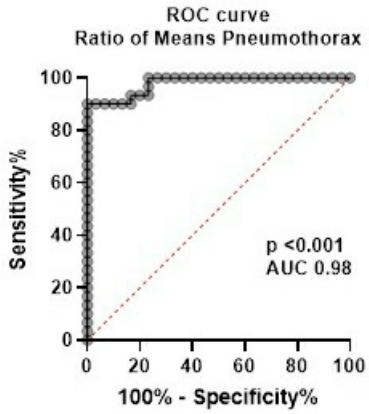
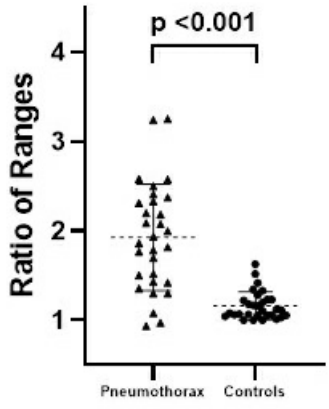
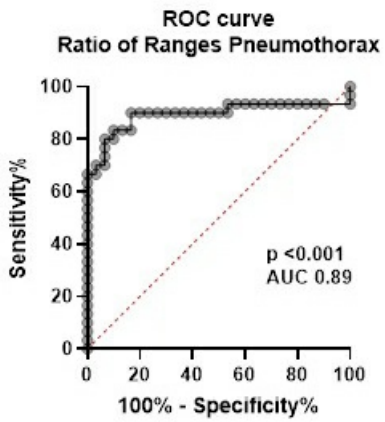
The use of ultrasound (US) for the diagnosis of pneumothorax is well-established; nonetheless, this condition's potentially deadly outcome leads clinicians to find new US signs of pneumothorax to obtain a much more confident diagnosis. We designed a prospective case-control pilot study to assess the diagnostic yield of a potential new US sign for pneumothorax diagnosis. We enrolled 60 patients, divided into 30 cases affected by pneumothorax and 30 healthy controls. All patients were evaluated in supine position, with the chest inclined by 30°. We collected a double-view frozen image through the anterior second intercostal space, containing two frames: one from the left lung and one from the right lung. All images were collected with the same machine, using the same probe at the same depth and gain. The images underwent a subjective and objective analysis. The subjective analysis was conducted by 10 different physicians divided by specialty into five groups (8 physicians were blinded to the diagnosis): they evaluated the images randomly, answering whether the two sides differed by greyscale and/or horizontal artifacts (a positive result was considered whether one of the two or both differed). The objective analysis relied on an image-editing program (Adobe Photoshop®), which compared selected areas of 100-pixel width on both sides. No significant differences were observed among the 5 different groups of physicians, even though the diagnostic accuracy almost reached a significant p-value. The objective analysis confirmed the hypothesis that there is a significant difference between the pneumothorax side and the contralateral one, as opposed to the control group. We built several ROC curves, focusing on the ones with the higher area under curve (AUC). We identified 3 specific parameters with a potential diagnostic value: mean ratio (AUC 0.98, $p<0.001$, cut-off 1.25, LR 27), range ratio (AUC 0.89, $p<0.001$, cut-off 1.52, LR 21) and median ratio (AUC 0.95, $p<0.001$, cut-off 1.32, LR 27). The combination of these three ROC curves resulted in a perfect curve (AUC=1.0, $p=0.02$). Our study results suggest that the comparison of US images of pneumothorax with images obtained from the contralateral side is a potential new tool for diagnosing pneumothorax. We think it may lead to new US software development, allowing the physician to obtain a much more confident diagnosis. Further studies are needed in order to validate this diagnostic tool in real-life clinical practice.

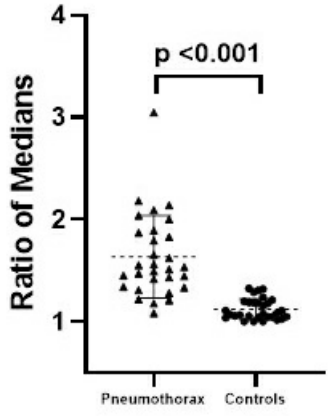


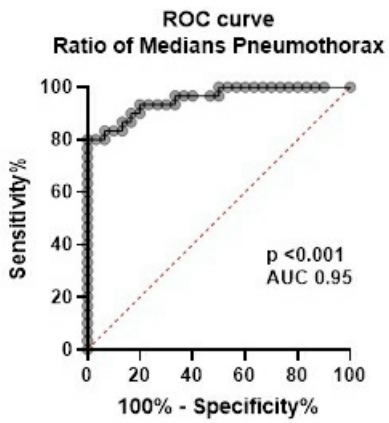

p <0.001
Ratio of Means
2.5
2.0
1.5
1.0
Pneumothorax
Controls


ROC curve
Ratio of Means Pneumothorax
Sensitivity%
100
80
60
40
20
0
0
20
40
60
80
100
100% - Specificity%
p <0.001
AUC 0.98


p <0.001
Ratio of Ranges
4
3
2
1
Pneumothorax
Controls


ROC curve
Ratio of Ranges Pneumothorax
Sensitivity%
100
80
60
40
20
0
0
20
40
60
80
100
100% - Specificity%
p <0.001
AUC 0.89


p <0.001
Ratio of Medians
4
3
2
1
Pneumothorax
Controls


ROC curve
Ratio of Medians Pneumothorax
Sensitivity%
100
80
60
40
20
0
0
20
40
60
80
100
100% - Specificity%
p <0.001
AUC 0.95

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