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Comparison of Two Imaging Methods for the Diagnosis of Pneumonia in Pediatric Patients

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ABSTRACT

Introduction: Pneumonia is an inflammation of the lung parenchyma mainly due to an infectious process, Acute lower respiratory tract infections, represent one of the main causes of morbidity and mortality in the pediatric population worldwide, so its diagnosis is of great importance for the treatment of patients; In recent years there is increasing evidence of the usefulness of ultrasound and chest radiography in the management of patients with pulmonary processes, among which pneumonia stands out.

Methodology: a bibliographic search was performed in databases, selecting original articles, case reports and bibliographic reviews from 2013 to 2021, using the documents that will deal with Pulmonary ultrasound vs radiography as a diagnostic method of pneumonia in pediatric patients, obtaining 21 articles for the realization of this document.

Results: Caiulo et al. in 2012 studied a total of 102 patients with clinical suspicion of pneumonia, who underwent RT and PE on the same day. A total of 89 patients had a confirmed diagnosis of CAP, of which PE reported a total of 88 patients and RT a total of 81 patients; in addition, PE was able to identify pleural effusion in 16 cases, while RT only detected 3 cases.

Conclusion: lung ultrasound has better sensitivity and specificity than chest radiography.

Keywords: Pneumonia; Chest X-Ray; Ultrasound; Pediatric Patients; Diagnostic Tests

Abbreviations: BTS: British Thoracic Society; RT: Reference Standard; CAP: Community-Acquired Pneumonia; NICU: Neonatal Intensive Care Unit; PUS: Findings of Lung Ultrasound; SNP: Severe Neonatal Pneumonia

Introduction

Pneumonia is an inflammation of the lung parenchyma mainly due to an infectious process, under a histological diagnosis. Clinically, it is defined as the acute presence of fever accompanied by respiratory symptoms and signs that may or may not be accompanied by radiographic findings of pulmonary parenchymal infiltrates [1,2]. Acute lower respiratory tract infections represent one of the main causes of morbidity and mortality in the pediatric population worldwide. Despite the large reduction in infant mortality in the first decade of this century, it remains high in developing countries, accounting for up to 15% of total global mortality [1]. In 2015, there were an estimated 200 million cases of pneumonia in children under 5 years of age, of which about 15 million progressed to severe clinical forms and have caused 2 million deaths. The incidence and mortality from pneumonia has an inverse relationship with age in pediatrics. The greatest burden of this disease is represented in the youngest, mainly those under 2 years of age, where pneumonia has partial mortality rates of up to 80%. Seventy percent of pneumonia mortality in children under 5 years of age occurs in developing countries [3].

Viruses are responsible for most cases of pneumonia in the pediatric age group, mainly in children under 2 years of age, with an overall prevalence of 14-62%, reaching 40% in children under 6 months of age and 30% between 6 months and 2 years of age. Streptococcus pneumoniae is the most frequent germ in bacterial pneumonias; it

affects 0.7 to 1 million children under 5 years of age living in developing countries [4,5]. Clinical ultrasound is a technique based on ultrasound that is performed at the patient's bedside, integrating in real time the ultrasound findings with the clinical information and the physical examination. Its objective is to provide an answer to a specific question, and it provides information that allows guiding the diagnosis or the initial therapeutic attitude in a short time [1,2]. Because it is a non-invasive and innocuous technique, its use in pediatrics has increased notably in recent years, especially in the emergency and intensive care areas [1,3].

In recent years there is increasing evidence of the usefulness of ultrasound in the management of patients with pulmonary conditions, most notably pneumonia. Thoracic ultrasound does not expose the child to ionizing radiation, when a specific diagnostic approach is required, obtaining capabilities is quick for the provider, and it can be performed practically anywhere in a hospital centre, without the need to move the patient [6,7]. Several studies have described the value of lung ultrasound in specific clinical situations in comparison with conventional thoracic imaging modalities, such as chest radiographs and computed tomography. [8] However, its use is not yet routine in emergency and hospital wards, leaving thoracic ultrasound for clinical indications that include, among others, dyspnea, respiratory failure, shock in any of its types, clinical pneumothorax, evaluation of pleural effusions, evaluation of the presence of alveolar consolidation, diaphragmatic function, trauma, intra-thoracic masses, as well as planning and orientation for an invasive thoracic procedure [9].

The guidelines recommend against the routine use of chest radiographs to confirm suspected community-acquired pneumonia in children not requiring hospitalization and suggest monitoring the clinical course of patients [10]. Chest radiography in an official audit by the British Thoracic Society (BTS) identified that chest radiography had been performed to confirm the diagnosis in 90 to 94% of suspected cases of community-acquired pneumonia and concluded that there was an overreliance on investigations to diagnose pneumonia [11].

Methodology

For the realization of this article a bibliographic search was performed in various databases such as Elsevier, Scielo, Medline, PubMed, ScienceDirect and Ovid, thus selecting original articles, case reports and literature reviews from 2013 to 2021, in Spanish and English language using MeSH terms: Pneumonia, chest radiography, ultrasound, pediatric patients, diagnostic tests, and the Boolean operators and and or. Thus, including all the documents dealing with Lung ultrasound vs radiography as a diagnostic method for pneumonia in pediatric patients, the data found were 30 records, thus using 21 articles for this document.

Results

In a single-centre prospective observational study, conducted in the Pediatric Emergency Department of the Hospital Universitario Parc Taulí in Sabadell between November 2015 and May 2017, they included patients under 18 years of age with suspected pneumonia, is defined as patients with respiratory symptoms plus at least one of the following symptoms: fever greater than 38 °C of more than 48 h of evolution, altered general appearance or suggestive auscultation (crackles, tubal murmur, hypophonia's). Patients with underlying lung disease (cystic fibrosis, lung transplantation, bronchopulmonary dysplasia, post thoracic surgery) were excluded. The most frequent ultrasound images in pneumonia diagnosed by PE were apparent tissue image in 10 cases (71.4%), ill-defined pleura in 9 (64.3%), underlying pattern B in 8 (57.1%), air bronchogram in 4 (28.6%) and pleural effusion in 2 (14.3%) Of the 2 pleural effusions detected by PE, 1 was not detected by RT (parapneumonic effusion < 1 cm that resolved with intravenous antibiotic treatment) The mean time required was 9 min (SD 3.5) for PE and 25 min (SD 9.2) for RT, with a difference

of 16.2 min (95% CI: 12,7-19, 6), p < 0,01. [12]. Pereda et al. conducted a meta-analysis in 2015 in which a systematic search was performed reference standard (RT). As a result, eight studies (765 children) were analysed for analysis, of which 6 were conducted in the general pediatric population and 2 in neonates. Five studies (63 %) reported the use of highly qualified sonographers.

PD had a sensitivity of 96 % (95 % CI 94-97 %) and specificity of 93 % (95 % CI 90-96 %), and the positive and negative likelihood ratios were 15.3 (95 % CI 6.6-35.3) and 0.06 (95 % CI 0.03-0.11), respectively [13]. Caiulo et al. in 2012 studied a total of 102 patients with clinical suspicion of pneumonia, who underwent RT and PE on the same day. A total of 89 patients had a confirmed diagnosis of CAP, of which PE reported a total of 88 patients and RT a total of 81 patients; in addition, PE was able to identify pleural effusion in 16 cases, while RT only detected 3 cases [14]. Luri, De Candia and Pazzochi conducted a study in Italy in 2009 in 28 patients aged between 4 months and 17 years with clinical suspicion of community-acquired pneumonia (CAP), comparing RT and EP as a diagnostic tool. The results of RT identified subpleural consolidations in 22 patients, 7 perihilar consolidations, and 8 pleural effusions, while PD found the same 22 subpleural consolidations, but did not identify any perihilar consolidation, however, it did detect a total of 15 pleural effusions, thus achieving a sensitivity of 91.67% and a specificity of 100% [15]. Esposito et al. conducted a study including a total population of 103 patients where PD was performed by pediatric residents after training in this imaging study and still report a sensitivity of 97.9% and a specificity of 94.5% of PD for the diagnosis of CAP [16]. Recently, Jones et al. performed a randomized study of diagnostic tests comparing PE and RT in patients admitted to their emergency department with a clinical suspicion of pneumonia, including a total of 191 patients ranging in age from 0 months to 21 years of age. Those who performed the ultrasound services were emergency department physicians who received 1 hour of training.

These patients were randomly assigned to initially undergo PD or RT. Patients who were assigned to RT subsequently underwent

PD, whereas those who initially underwent PD could undergo RT if deemed appropriate by the medical team or the patient's family. Of the 103 patients who started in the PD group, 61 % subsequently underwent RT; of these in 29 cases (28 %) were requested from admission, by the family or by the physician after performing PD, and yet none of the RTs showed different results from PD. On the other hand, no diagnosis of CAP was missed in either group [17]. In 2014 in Beijing, they conducted an observational study with the aim of investigating the findings of lung ultrasound (PUS) in severe neonatal pneumonia (SNP) in order to evaluate its diagnostic ability for this disease. Forty neonates diagnosed with SNP according to their medical history, clinical manifestations and chest X-ray findings participated and 40 neonates without lung disease formed the control group, all of them admitted to the neonatal intensive care unit (NICU). They were excluded if there was no definitive evidence of infection or if they had serious complications that could affect the findings of the EchoP, which was performed by a single investigator, unaware of the diagnosis. The main sonographic findings in patients with NSN were respectively: pulmonary consolidation and interstitial syndrome in 100 %; pleural line abnormalities in 90 %; disappearance of pulmonary sliding in 75 %; dynamic air bronchograms in 52.5 %; pulmonary pulse in 30 %; pleural effusion in 20 %. The only finding in the subjects belonging to the control group were some B lines in 30 %. This being so, the p value <0.001 the data obtained. Large areas of pulmonary consolidation with irregular margins demonstrated a sensitivity and specificity of 100% for the diagnosis of NNS [18].

Discussion

In the study performed by Gelman and collaborators, they included 37 patients of which 17 of them were diagnosed with pneumonia, most of them were in a mean age of 3 years old and > 50% were girls, of these 17 patients the ultrasound was positive in 14 of them and the remaining 3 were negative to ultrasound.50% were girls, of these 17 patients in 14 of them the ultrasound was positive and in the remaining 3 were negative to ultrasound, The most common ultrasound images in the lung ultrasound diagnosis of pneumonia were evident tissue images in 10 cases (71,4%), unclear pleural border in 9 cases (64.3%), latent type B in 8 cases (57.1%), bronchial air in 4 cases (28.6%) and pleural effusion (14.3%), likewise, EP is an excellent test for the diagnosis of pneumonia in childhood, based on the improvement of quality of care and patient safety, which is why the use of EP is recommended as the first line test for the diagnosis of pneumonia in childhood, however, the results of this study support the usefulness of EchoP as the technique of choice for the diagnosis of pneumonia in children, with a high accuracy, slightly higher than RT, and less time consumption, results consistent with the existing literature [19]. In pneumonia, due to its frequency in clinical practice and its frequent occurrence in children, chest ultrasound is most useful in primary care (if the lesion is > 1 cm, the changes are important; the clinical relevance of lesions < 1 cm is not completely known).

Dynamic bronchial images, air or liquid (depending on time of evolution) and dendritic, hepatic, lamellar atelectasis. If it is not a large sheet, the border is irregular. B lines appear behind the lesion. Fragmented and thickened pleural line Basal parapneumonic effusion. Doppler: increased vascularization [20] According to a study conducted by Molina and Ortega, where eight studies were evaluated with a total of 765 subjects, the result was that ultrasound proved to be useful and effective for the diagnosis of pneumonia, with an S of 96% (CI 95: 94 to 97), where For every eleven ultrasounds that were performed in these patients, ten of these patients were diagnosed with pneumonia; although in various studies they conclude that there is no high relevance between the use of ultrasound vs. chest radiography and despite the heterogeneity in the studies and the skill of the sonographers, lung ultrasound is recommended and is a good tool for the diagnosis of pneumonia in pediatric patients and this can be considered a viable alternative for the timely diagnosis of pneumonia in children.

Conclusion

Among the imaging tests performed for the diagnosis of pneumonia in pediatric patients we have among others, pulmonary ultrasound and chest radiography, where according to the results of multiple studies ultrasound has better results in the diagnosis of pneumonia showing a high sensitivity and specificity, also proved better in identifying pleural effusion in patients compared to chest radiography, because this manages to identify effusions when these are of greater content; Nevertheless, chest radiography is a good diagnostic option for the identification of this pathology, having specific radiological signs of pneumonia such as air bronchogram that are of great help in the imaging diagnosis.

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