Pulse Oximetry: Instrumental Alternative in the Clinical Evaluation by the Bed for the Dysphagia

Oximetria de Pulso: Alternativa Instrumental na Avaliação Clínica junto ao Leito para a Disfagia

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SUMMARY

Introduction: The clinical evaluation by the bed is the clinical procedure utilized by the speech therapy as a screening test for established if the individual presents or not a clinical picture of dysphagia. Its achievement count with the use of the pulse oximetry that is the not-invasive measure of the peripheral saturation of O2. When it related to the dysphagia, the saturation can decline in the moment of the swallowing, suggesting a compromise of the respiratory system. Such decline is observed in individuals that aspire with sustenances of liquid and solid consistency, before during and after food, when compared to the individuals that do not aspire.

Objective: To verify the possibility of the utilization of the pulse oximetry as an instrumental alternative in the clinical evaluation for the dysphagia.

Method: Revision of literature, based in articles indexed in the bases Lilacs and Medline having as a reference the descriptors: saturation of oxygen, pulse oximetry and swallowing disorders.

Results: The association of the clinical evaluation to the pulse oximetry shows up with high sensibility in the detection of the penetration and aspiration laringotraqueal and with bass false-positive index, considering it desaturation, the indices that pierced with bigger values than 2%. Some data found are divergent as the aspiration detection possibility.

Final Comments: The studies analyzed confer to oximetria of wrist the character of practically and possibility of use in the actions by the bed, being utilized ally to the clinical evaluation for dysphagia, although certain disagreement between the same is found as regards the utilization of its results as indicator of aspiration laringotraqueal, suggesting need of subsequent researches.

Keywords: saturation of oxygen, pulse oximetry, swallowing disorders.

RESUMO

Introdução: A avaliação clínica junto ao leito é o procedimento clínico utilizado pela fonoaudiologia como um screening teste para se estabelecer se o indivíduo apresenta ou não um quadro clínico de disfagia. Sua realização conta com o uso da oximetria de pulso que é a medida não-invasiva da saturação periférica de O2. Quando relacionada à disfagia, a saturação pode declinar no momento da deglutição, sugerindo um comprometimento do sistema respiratório. Tal declínio é observado em indivíduos que aspiram com alimentos de consistência sólida e líquida, antes durante e após a alimentação, quando comparados aos indivíduos que não aspiram.

Objetivo: Verificar a possibilidade da utilização da oximetria de pulso como alternativa instrumental na avaliação clínica para a disfagia.

Método: Revisão de literatura, baseando-se em artigos indexados nas bases Lilacs e Medline tendo como referência os descritores: saturação de oxigênio, oximetria de pulso e transtorno de deglutição.

Resultados: A associação da avaliação clínica à oximetria de pulso evidencia-se com alta sensibilidade na detecção da penetração e aspiração laringotraqueal e com baixo índice falso-positivo, considerando-se dessaturação, os índices que variam com valores maiores que 2%. Alguns dados encontrados são divergentes quanto à possibilidade detecção de aspiração.

Considerações Finais: Os estudos analisados conferem a oximetria de pulso o caráter de praticidade e possibilidade de uso nas ações junto ao leito, sendo utilizada aliada a avaliação clínica para disfagia, embora se encontre certa discordância entre os mesmos quanto à utilização dos seus resultados como indicadores de aspiração laringotraqueal, sugerindo necessidade de pesquisas posteriores.

Palavras-chave: saturação de oxigênio, oximetria de pulso, transtorno de deglutição.

Introduction

Pulse oximetry is a test used to investigate the peripheral oxygen saturation, or impregnation of oxygen in the blood. It is a noninvasive test that has the oximeter as an instrument of detection.

Data collected by this instrument are measured in percentages, accurate between 80% and 100%, being considered the best indices of blood perfusion values close to 100%.

Pulse oximetry has been used as complementary test to the clinical bedside in the clinical setting of dysphagia, its results give the possibility of respiratory compromise, suggesting the likelihood of laryngotracheal aspirations.

This study is justified because the gold standard of objective evaluations is not the reality of services at the bedside in our society.

From this theme, we sought the *Lilacs* and *Medline,* articles published in the last 15 years, from the key words: oxygen saturation, pulse oximetry, pulse oximetry, pulse oximetry and dysphagia, pulse oximetry and clinical assessment Speech at the bedside.

Indexed articles found in the database were *Lilacs* 181 for the term oximetry. Of these, 148 had data on pulse oximetry. Not found data that relates to the relationship between pulse oximetry and the clinical for dysphagia, but 8 had to be related to respiratory disorders.

In the *Medline database* found 2893 articles on oximetry, and 1967 on pulse oximetry and 18 relating to pulse oximetry dysphagia. Among these 18 items are those relating to pulse oximetry in the clinical for dysphagia, detection aspiration, comparison of data from the gold standard examinations, review articles and other data relating to respiratory, syndromes and diseases, other than stroke.

With this survey and linking it to the publications available in the library of Methodist University Center IPA, we prepared this review.

The purpose of it is to check the possibility of using pulse oximetry as an alternative instrumental in the clinical evaluation for dysphagia at the *bedside*.

Peripheral Oxygen Saturation

The configuration of the rib cage is intended to protect vital organs and bone, through the interaction of bone and chest muscles, increase and decrease the volume of the same, generating pressure differences that allow the flow of gas into and out of the lungs, which characterizes the gas exchange, in which there is the distribution of surface oxygen exchange and discharge of carbon dioxide to the atmosphere, with the participation of $70m^2$ of alveoli (1-3).

The anatomy and physiology of the respiratory system is established by the exchange of oxygen for carbon dioxide between atmosphere and body cells, with minimal work. The system has to filter the inhaled air, your heating and humidification, making the inspired gas contact with the pulmonary capillary blood flow, exchanging, quickly and efficiently, oxygen and carbon dioxide (1).

The cycle of pulmonary respiration involves the mechanisms of ventilation, perfusion and ventilation / perfusion ratio.

Ventilation and pulmonary perfusion are transport systems specifically developed for the displacement of oxygen and carbon dioxide, serving the mechanism tissue. Pulmonary ventilation is the first step of the respiratory process, described as the result of a series of phenomena and physiomechanical complex interactions among its components, these being: controlling breathing, respiratory muscles, chest, abdomen, airflow and alveolar ventilation. These mechanisms interact so that control involuntary and voluntary respiratory function activates the respiratory muscles and causes movement of the chest and abdomen, resulting in the displacement of air in and out of the lungs, allowing alveolar ventilation. Gas exchange happens when air is blown by direct flow into the alveoli, by contacting the capillary blood and distributed to the surface of gas exchange. Diffusion is the process by which gas molecules move from an area of high partial pressure to an area of low partial pressure, making the process of gas exchange (3-4).

The transport of air through the airway depends on the permeability of the tubes, as well as the consistency of the lungs and respiratory muscle strength and transport of substances oxygen and carbon dioxide through the blood, occurs in different ways (2, 3, 5).

The oxygen (O_2) is immediately released and bound to hemoglobin in the tissues under low oxygen tension and *acidosis*. Since carbon dioxide is transported in the form of bicarbonate, mostly (6).

Hemoglobin is a protein conjugate composed of four polypeptide chains linked, whose shape determines the affinity for oxygen, i.e., the red pigment that carries O_2 in erythrocytes (5-6).

The decrease of the mass of red cells characteristic of anemia, and increased mass of red cells characteristic of polycythemia or erythrocytosis (3).

The transport of O_2 depends crucially on the hemoglobin concentration and a quality of hemoglobin present. The dependence of the cell when oxygen is justified, because the survival of that depends on the presence of oxygen in the blood and the function of carbon dioxide is to control the acid-base status of the organism. Such a relationship is perceived by arterial blood gases. The pressure of atmospheric O_2 *(PO_2)* is normal to 150mmHg or 20kPa, decreasing to 120 mm Hg or 16Kpa into the socket. The pressure of arterial O_2 *(PaO_2)* is generally around 105mmHg or 14Kpa in a healthy individual. What is important for the cell is the amount of O_2 that it receives (3, 6).

The transport of oxygen to the tissues is subject to such factors as amount of hemoglobin, degree of saturation with O_2 and the speed with which the oxygenated blood is delivered to tissues. Since hemoglobin and normal cardiac function, measurement of O_2 saturation of hemoglobin is more relevant to the distribution of O_2 than PaO_2 (6).

PaO_2 is related to O_2 saturation in a complex way determined by the properties of hemoglobin, known as dissociation curve of O_2. This relationship shows that when the PaO_2 *reaches* 60 mmHg or Kpa 8, under most conditions, the hemoglobin is completely saturated and can no longer carry O_2 (6).

Saturation is the measure regarding the proportion of hemoglobin that is available actually carrying oxygen. It is calculated as the ratio of oxyhemoglobin - HbO_2 - (content) relative to total hemoglobin *(capacity)*. Calculation of oxygen saturation (SaO_2) is given by the following formula:

$$SaO_2\ (\%) = \frac{[HbO\ 2]}{[Hb] + [HbO_2]} \times 100$$

And $[HbO_2]$ the content of hemoglobin, [Hb] content and deoxygenated hemoglobin [Hb] + $[HbO_2]$ The total content of hemoglobin. Oxygen saturation (SaO_2) is given in percentage (%) of available hemoglobin that carries oxygen, leaving the remaining deoxygenated (5).

Pulse oximetry is a noninvasive measurement of O_2 saturation (SpO_2), introduced for clinical use in mid-1980. This works by transcutaneous examination of the color spectrum of hemoglobin, which changes with the degree of saturation (5-7).

The operating principle the oximeter is caused by change of color between arterial blood, bright red, and venous and cyanotic. This feature changes the light transmitted through a thin layer of blood, defined by special buckets located in the lines of cardiopulmonary bypass. The equipment consists of optical sensors connected in these buckets, an electronic unit conditioning analog signal corresponding to light transmitted, and a unit of digital signal processing (8).

To calculate the oxygen saturation using an equation of a bivariate degree, whose coefficients are obtained from the correlation between light intensity values and measures of SaO_2, blood gas analysis obtained with commercial equipment calibrated (8).

The extent of saturation provides information on the impregnation of oxygen and this is related to ventilation only if the inspired oxygen level is normal. Monitoring of oxygen saturation does not detect hypoventilation and increased pressure of carbon dioxide. Saturation levels below 60 mmHg affect saturation and oxygen delivery (5-7).

Oxygen saturation is measured continuously by pulse oximetry given by a sensor on the finger or earlobe. The overruns are generally accurate between 100% and 80% and there are factors that can interfere with the measurement of arterial oxygen pressure, ie a poor peripheral perfusion, nails painted or stained by nicotine, pierced ears, intravenous contrast medium injected dyes (2).

The relationship between the level of oxygen saturation and aspiration during food intake is established, since, compared to the aspiration, there is a decline in the level of oxygen saturation and this is measured by pulse oximeter, as reported by Sherman *et al* (9)

Ventilatory dysfunction may occur in any of the steps of these mechanisms. The function of respiratory muscles can be affected by diseases, acting directly or indirectly in the muscle through the motor pathway of the central nervous systems and / or peripheral. The pathologies that act directly on muscle include the categories of muscular dystrophies and myopathies. Those that indirectly affect muscle, including spinal injury, polio and / or neuropathy (4).

Results of pulse oximetry and swallowing disorders

The saturation level or variations thereof in more than 2% is considered clinically significant for the diagnosis of aspiration (10-11) and the combination of the assessment

of swallowing at the bedside and monitoring by pulse oximetry, compared penetration and aspiration laryngotracheal, offers a positive predictive value of 95% (10).

The desaturation is referred to as related to dysphagia, because there is an impairment of the respiratory system in dysphagic individuals and as such, is a decline in the levels of O_2 saturation in those who aspire to consistency of food and liquid, before during and after feeding, compared with individuals without aspiration (12).

The efficiency of the use of pulse oximetry as a tool for examining and / or evaluate dysphagia is argued in the study of Colodny (12), which reports that many studies propose the use of pulse oximetry as an alternative instrument for the examination or assessment swallowing, as well as other assessment instruments, and that their findings support this alternative assessment, when it is used in conjunction with clinical assessment of swallowing, in order to discriminate against individuals with normal swallowing of dysphagia.

In another study, Colodny (13) found that the saturation level is not significantly altered by the aspiration of liquids and / or solid foods. However, he emphasized that dysphagic individuals showed a decrease in the level of oxygen saturation when compared with individuals with normal swallowing, before, during and after oral feeding. In addition, the author observed that individuals who aspired to have their respiratory status compromised, as evidenced in the fall of representative saturation levels when compared with individuals with normal swallowing food or that have penetrated.

Studies like that of Sherman *et al.* (9) to support data Colodny (13) for the presence of a drop in saturation levels about aspiration.

Literature is the result of falling levels of saturation front of aspiration, although each study researched denote a limitation of influence on their results, but state that dysphagic individuals who aspire to or that have penetrated the food, had a lower level of oxygen saturation than subjects with normal swallowing, lying as factors that may influence the results of oxygen saturation in these patients: age, gender, clinical diagnosis and should multisensory disorder (13-15).

Collins and Bakheit (14) showed these factors to find a higher rate and significant data for the desaturation and aspiration in men and individuals older than 65 years.

At the same time, the study by Sherman *et al.* (9) shows no relationship between dysphagia in patients with desaturation related to age, gender or diagnosis, but reports aspiration or penetration without the occurrence of laryngotracheal *clearance* with a significant decline O_2 saturation, and those who had penetrated the food, but carried out the *clearance*.

Colodny (12) and Smith *et al.* (10) conclude that pulse oximetry can be used as an adjunct element of discrimination of the presence of dysphagia and non-dysphagia, as confirmed these data while exposing patients to pulse oximetry and videofluoroscopy, respectively, whose combination of bedside clinical assessment with pulse oximetry resulted in a value of 95% of positive data on the presence of aspiration.

The results of Smith et al. (10) indicate that, when combined, pulse oximetry and the clinical assessment by the bedside, show oxygen desaturation on swallowing, with a low false-positive.

In the review about the clinical bedside, combined with pulse oximetry performed by Lim *et al.* (11), in order to identify patients who were at risk of aspiration through the use of fibroscopy, enabled them to identify three groups of patients: group A - patients who aspired to open signs of aspiration such as coughing and choking, but no signs of desaturation, group B - patients who showed signs of aspiration and also open desaturation on swallowing, group C - patients without signs or silent open, but with desaturation.

Smith *et al.* (10) and Lim *et al.* (11) conclude that the saturation level or variations thereof in more than 2% is considered clinically significant for the diagnosis of aspiration.

Studies are found to differ with regard to drop in front of the saturation level of aspiration as Sellars, Dunnet and Carter (16), De Groof, and Dejaeger Goeleven (17) and Wang *et al.* (18). These last reviewed the results of the comparison of pulse oximetry in the identification of aspiration with swallowing evaluation by videofluoroscopy (VFSS), noted the rate of 3% as desaturation and found no significant correlation between desaturation and aspiration as detected by VFSS. Their results showed negative predictive values, and concluded there is no possibility to predict the aspiration through the fall in SpO_2 monitored by pulse oximetry.

The use of pulse oximetry as an alternative examination for individuals with dysphagia, involves no radiation exposure, although its validity front of silent aspiration has not been fully examined.

Among the possible health consequences, is that

the aspiration is one of the most critical signs of oropharyngeal dysphagia (19).

In relation to clinical assessment by the bedside, it is observed that the challenge is to develop a diagnostic test that can be used easily, which is noninvasive, it does not cause pain or distress to the patient and giving reliable results and pulse oximetry following being questioned as to its reliability, but argue that this is available at hospitals and health professionals are familiar with its use (20).

Pulse oximetry can be used as an adjunct element of discrimination of the presence of dysphagia and swallowing normal because studies confirm that the data collected in surveys, by exposing individuals to pulse oximetry and videofluroscopia, respectively, and by combining such results to the clinical assessment at the bedside with pulse oximetry, resulted in a value between 86% and 95% of positive data to the presence of aspiration (10, 12).

The blood desaturation observed in the decrease of pulse oximetry, is when the aspiration of food and liquids into the airways and pulse oximetry enables the identification of patients with aspiration and may be the alternative technique to instrumental evaluation of dysphagia (15).

In normal situation, no significant effects between food and the level of oxygen saturation measured on pulse oximetry, but is an association between altered arterial oxygenation and oral feeding in dysphagic individuals (16).

When combined with pulse oximetry and clinical assessment at the bedside revealed oxygen desaturation during swallowing, with a low false-positive (10).

The detection of aspiration is only one aspect of a non-instrumental examination of swallowing function (19).

The accidental loss of food or liquid by the airways during the feeding process is perhaps the most significant clinical consequence of dysphagia. The invasion of the airways is described as penetration, when the material does not exceed the vocal folds and aspiration when the material goes beyond the vocal cords, entering the trachea (21).

The picture of aspiration differs on the type of material aspirated in: particulate obstruction due to large food particles that cause complete obstruction and are not forwarded to the stomach, "cafe coronary", i.e., partially chewed food and that is sucked during swallowing, disabling the patient to breathe or talk and became cyanotic, for partial tracheal or bronchial obstruction, gastric aspiration due to particles of intermediate size, leading to symptoms common to any foreign body aspiration; particulate non-obstructive: aspiration of gastric material neutral, not-large enough to obstruct the airway and cause tachypnea, cyanosis, wheezing, cough, sputum production and may lead to shock, liquid acid, inhalation of liquid with a pH below 2, 5 and may damage the lung tissue extensively, and their initial signs tachypnea, cyanosis, wheezing, and hypotension, and after a few seconds, hypoxemia occurs with a concomitant decrease in lung compliance; aspiration of water or drowning due to injury lung caused by drowning, depending on the amount of water aspirated; blood with an increased frequency of pulse and breathing, may become cyanotic after this aspiration, hydrocarbons, compared to kerosene, furniture polish, lighter fluid, gasoline , solvents, petroleum products (21).

A wide distribution of grades of material penetrated or aspirated, in selected subjects in two groups known to be suffering from dysphagia, or post-accident brain injury and head and neck cancer was described in eight points, observed during the evaluation of by video fluoroscopic swallowing, which are considered: no penetration or aspiration, such as Grade 1 and is defined because of the contrast does not enter the airways, penetration, grade 2, in which contrast enters the airways and remains above the vocal voice, with no residue, penetration, Grade 3, contrast enters the airways, remaining visible residue, penetration, grade 4, where the contrast contacts the vocal folds, without the presence of residue, penetration, grade 5, the contrast contacts the vocal folds, visible residue remains, aspiration, grade 6, where the contrast exceeds the glottis, without visible residue sub-glottis, aspiration, Grade 7, the contrast beyond the glottis, while the visible sub-glottis residue, although patient's response, and aspiration, grade 8, where the contrast exceeds the glottis, there is visible sub-glottis residue, with no response from the patient (22).

Although the data of Chan and Lo (23), as the fall in SpO_2 during meals, do not reveal early indication of aspiration pneumonia, those of Isola (24) are that oropharyngeal dysphagia predisposes individuals to bacterial pneumonia, as there is a constant and massive aspiration, which overlaps the defense capacity of the lung.

The picture of dysphagia are common in brain vascular disease and individuals who aspire to have a 20 times greater chance for developing pneumonia compared with those who do not aspire or 6.95% higher for normal swallowing and dysphagia (10, 25) .

Studies for the concomitant use of pulse oximetry and clinical assessment at the bedside have been confirmed as its sensitivity and specificity by investigations of the gold standard, as videofluroscopia *(VFSS)* and fibronasoscopia

(FEES), ranging from percentage for sensitivity of 58.3% to 100% and specificity of 62% and 76% (10, 11, 18, 25, 26) and considered a moderate sensitivity and specificity in the findings of Morgan Omahoney and Francis (27).

Pulse oximetry, when the joint use of clinical assessment by the bedside *(bedside assessment of Dysphagia),* allows predicting aspiration or his predisposition in 81.5% of cases of neurogenic dysphagia due to stroke and establishes a high correlation between oxygen desaturation and aspiration during the two minutes after ingestion of food (14).

Discussion

Dysphagia remains the most common difficulty facing the neuropathy and its clinical complications involving malnutrition, dehydration, aspiration, suffocation, pneumonia and death of the individual affected by this disorder.

Overlooking the need to establish baseline data based on clinical practice, we see every day, more research involving the clinical bedside associated with different objective diagnostic techniques in order to demonstrate its effectiveness and to specify a valid protocol.

In this sense, the clinical evaluation for dysphagia varies its protocols with different amounts of material to be ingested by the patient (between 5 and 100 ml) at different consistencies.

Given the reality of not infer the individual other damage, we were faced with the necessity of our joining with other forms of assessments, less invasive, although we of course exams and *VFSS FEES* continue to be the gold standard for diagnosis of dysphagia , regarding the establishment of penetration and tracheal aspiration.

Due to the quality standard of these examinations, clinical evaluation has been analyzed and compared to them, as well as clinical evaluation associated with pulse oximetry, exhaustively.

Pulse oximetry is a method of measuring O_2 saturation, which can be used as a criterion of an alleged prior detection of laryngeal penetration and aspiration of sub-glottis, considering a variation of 2% or more in patients with neuropathies.

The data published so far show the use of pulse oximetry related to clinical bedside with controversy, first reported as being efficient and facilitates the diagnosis and treatment of dysphagia and has a high sensitivity for detection of penetration and tracheal aspiration and with low false-positive and the other, without the possibility of establishing frameworks for silent dysphagia, in which there is no sign or symptom of penetration or tracheal aspiration, or even indication of aspiration pneumonia.

Our clinical findings make possible a grouping proposal involving themselves in the clinical signs and symptoms found in clinical assessment towards the cause of neurogenic dysphagia bedside indices of oxygen saturation obtained by pulse oximetry, with the variation these indices and, considering them as desaturation above 2% in the following groups:

- Group A - those individuals who show signs of normal swallowing and no data desaturation;
- Group B - those individuals who have specific signs, oromiofuncionais, oropharyngeal dysphagia, but no signs of desaturation;
- Group C - those with specific signs, oromiofuncionais, oropharyngeal dysphagia, with signs of desaturation;
- Group D - those that do not have specific signs, oromiofuncionais, oropharyngeal dysphagia, but with signs of desaturation.

We believe that front dysphagia are the data of impaired arterial oxygenation and believe in the use of pulse oximetry, combined with clinical evaluation for dysphagia, as a possible diagnostic tool because of its convenience and availability.

Final Comments

The studies analyzed of pulse oximetry gives the character of practicality and usability in action by bed, as well as considering as desaturation variations above 2%. Although there is some disagreement between them regarding the use of results as indicators of laryngotracheal aspiration, this tool has been used together with clinical evaluation for dysphagia by bed, and its results are being compared to instrumental evaluations of the gold standard. There is a consensus that further studies should be hired.

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