Respiratory examination for physiotherapy students. Part 2: Forced spirometry

Available at: https://youtu.be/GikvFiZ1fr8?si=9oKeZQXBuki5GCBd

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In our previous video we explained simple spirometry and now we will see what forced spirometry is and how it differs from simple spirometry.

First of all, it should be remembered that spirometry is a functional test that not only allows us to detect alterations in respiratory function and monitor them, but also to optimize functional activity, such as when performing physical exercise.

Let us remember that in simple spirometry the patient performs a maximum inspiration followed by a maximum expiration, taking the time that they need. However, in forced spirometry, the maximum expiration after maximum inspiration must take place in the shortest possible time. In other words, the aim is to measure how quickly air leaves the lungs.

Whereas in simple spirometry the values we obtained were volumes of air, in forced spirometry, by taking time into account, we will also obtain flow measurements. Forced spirometry has greater diagnostic value.

In this test we can obtain two types of curves: volume-time and flow-volume.

For the volume-time curve, we have the time in seconds on the "x" axis and the volume in litres on the "y" axis. A healthy person, when carrying out the test, generates a curve that has a rapid rise followed by a plateau, which represents the sustained effort of the person to continue to breathe out.

The test ends when no changes greater than 25 ml per second are found in this plateau.

For the flow-volume curve, we have the volume in litres on the "x" axis, and the flow in litres per second on the "y" axis. The lower part, which is in the shape of a semicircle, indicates the inspired volume, while the upper part refers to expiration. The part of the curve corresponding to expiration has a triangular shape with a sharp incline that reaches a peak that indicates the maximum flow and then progressively decreases to the value of flow 0, which must obviously coincide with the forced vital capacity.

The parameters obtained from forced spirometry are:

• The forced vital capacity (FVC)

• The maximum expired volume in the first second (forced expiratory volume in one second, FEV1)

• The maximum expiratory flow or peak expiratory flow (PEF)

• And the FEV1/FVC ratio

The forced vital capacity is the maximum volume of air that the patient can mobilize in a respiratory cycle and in the shortest possible time.

The maximum expired volume in the first second (FEV1) is the volume of air that the person can exhale in a forced expiration after a maximum inspiration. Although it is measured in litres, it refers to the volume expired in the first second, therefore it is a measure of air flow.

The maximum expiratory flow is the value of the peak or maximum value of the expired air flow.

The FEV1/FVC ratio is the relation between these two parameters and represents the forced vital capacity that is expelled in the first second.

We can use the vital capacity obtained in the simple spirometry, instead of the forced vital capacity. The relationship between FEV1 and vital capacity is called Tiffeneau index.

The vital capacity obtained in simple spirometry should coincide with the forced vital capacity, since the volume of air that the person can mobilize is the same, regardless of the speed with which the air is expelled.

Both the forced vital capacity and the FEV1 should be equal to or greater than 80% of the ideal value calculated for each patient depending on their characteristics, such as age, height, weight, sex, etc., as we explained in our previous video.

The FEV1/FVC ratio should be equal to or greater than 70%

Now let's see it with a real example:

The patient should empty their lungs as much as they can, and then we ask them to take a deep breath in and then expel all the air as quickly as possible.

Come on, take a deep breath, as much as you can.

Keep going, keep going, keep going... Ok and now, breathe out, keep, going, keep going. Empty your lungs! Well done!

Let's see the results.

The ideal forced capacity for this person is 3.76 litres. She has managed to mobilize 3.42 litres in the real test, which is 91% of the ideal value.

For the FEV1, the ideal value was 2.94 litres and she has mobilized 2.77, which represents 94%. If we calculate the FEV1 and forced vital capacity ratio as a percentage, we will obtain 81% for this person.

If we take the vital capacity obtained in simple spirometry, which gave us 3.58 litres, we can then calculate the Tiffeneau index, which is in this case 77%. Therefore, the results show a normal pattern.

What can we learn from this examination of respiratory function?

With the percentages of vital capacity, FEV1 and Tiffeneau index we can obtain diagnostic indicators of an obstructive or restrictive disorder.

In a pure obstructive disorder, the vital capacity is not affected, but the FEV1 is less than 80% making the Tiffeneau index also low.

This graph shows the volume-time and flow-volume curves of an obstructive disorder and the parameters that are decreased.

In a pure restrictive disorder, the vital capacity decreases: the lower the amount of air that enters, the lower the amount of air that will leave in the first second, so the FEV1 is expected to be lower than the reference value for such patients.

With regard to the Tiffeneau index, it may not change or it may even have a higher value than expected, because in a restrictive disorder, the decrease in vital capacity is usually more pronounced than that of FEV1.

These graphs show the volume-time and flow-volume curves of a restrictive disorder and the parameters that are affected.

In mixed disorders, it may be that all the parameters are decreased. For example, it may be that a patient with chronic obstructive pulmonary disease (COPD) has a complication leading to a restrictive disorder and therefore a decrease in vital capacity. In these patients, the drop in FEV1 is usually greater than that of the vital capacity and consequently the Tiffeneau index remains low. However, depending on the pattern that predominates the Tiffeneau index could also be higher or even normal.

For physiotherapists, beyond the diagnostic value of spirometry, this technique, together with other pulmonary function tests, allows them to assess the patient's respiratory function.

In relation to physiotherapy treatment, this test is useful for monitoring and evaluating the effectiveness of respiratory physiotherapy.