ORIGINAL RESEARCH ARTICLE

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# Is Measurement of Beta Angle in Flow Volume Loop Useful for Diagnosis of Airways Obstruction?

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## ABSTRACT

***Background***: *Spirometry is the most common method for evaluation of lung function, and the shape of flow-volume loop is very helpful for recognition of pulmonary disease pattern particularly, the site and severity of airway obstruction. The slope of descending arch of expiratory curve is one of the criteria which determine the severity of lower airways obstruction. Measurement of Beta angle is one of the methods for determination of this slope. Beta-angle is characterized by determination of three points on the flow-volume loop. Its vertex is maximum flow in the middle of vital capacity (V.max 50%). Its other points are the outset of residual volume (RV) on the volume axis and the peak flow on the flow axis.*

***Materials and Methods***: *This is a cross-sectional descriptive study. To determine the measurement of Beta- angle, the flow-volume curve was examined in 325 patients, (smokers and non-smokers) randomly. These patients were referred for pulmonary function tests to our hospital. All the patients underwent standard spirometry and used SPSS package for calculating the results.*

***Results***: *Following results were obtained: The size of Beta-angle decreased with the increase of age, from the third decade of life and onward. There was a significant difference in the mean Beta-angle between the smokers that consumed more than 20 pack-year and the non-smokers. The size of Beta-angle decreased with obstruction of peripheral airways, but it had no correlation with restrictive lesions. The size of this angle decreased with the reduction of different pulmonary measures such as FEV1, FEV1/FVC, and FEF25-75%.*

***Conclusion***: *The size of Beta-angle is useful for detecting patient with obstructive lung disease.* ***(Tanaffos 2003; 2(5): 37-42)***

***Abbreviations***: *FEV1= forced expiratory volume in second one*
*FVC= forced vital capacity*
*FEF25-75= forced expiratory flow in mid-portion of vital capacity.*

***Key words***: *Flow-volume loop (curve), Beta angle, Obstructive pulmonary disease, Cigarette smoking*

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## INTRODUCTION

Spirometry is the most common method for evaluation of lung functions. In spirometry, in addition to pulmonary volumes and capacities, flow-volume loop is used to recognize the pattern of pulmonary diseases, in general restrictive or obstructive. Recognition of pattern of obstructive airway diseases is one of the important applications of the above-mentioned loop. In this view, according to the shape of the curve the point of the obstruction either upper or lower and its severity could be assessed. The slope of expiratory descending arch of the flow-volume loop changes in the presence of peripheral airways obstruction. Measurement of the Beta-angle is one of the methods to determine the slope of expiratory loop (1).

It is shown as in figure-1 that beta-angle is drawn by determination of three points on the expiratory loop. A point is at the end of loop on the volume axis, and the other just is in the point of the peak expiratory flow rate (PEFR). The third one which constitutes its vertex is located in the point of PEFR in the middle of vital capacity (V max 50%) (2). The size of loop in a normal individual is about 180 degrees and less than 180 in obstruction (2). The purpose of the present study is to measure Beta-angle in the patients and to find its relation with the age, cigarette smoking, airways obstruction, restrictive disease and different pulmonary volumes.

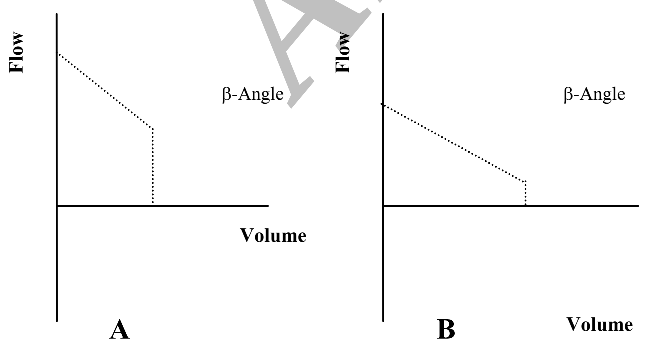


**Figure 1**. The size of beta angle in (A) normal flow volume loop, and (B) in airway obstruction

## MATERIALS AND METHODS

A total of 450 cases of spirometry was carried out in the department of spirometry of Hazrat Rasool-Akram Hospital in 2001. Of these, 325 cases showed acceptable and standard spirometries. These individuals were patients who were presented due to pulmonary complaints or for clinical consultation for spirometry. Some of these patients were smokers and others were non-smokers. After determination of the shape of flow-volume loop, according to the procedure explained in the introduction, Beta-angle was drawn and its size was determined. Then, this angle was studied according to the patient's age, smoking, disease pattern, and different pulmonary volumes. Spirometer used in the Spirometry department of the hospital was a computer device, type Chestage, model 55V, made in Japan. This was a cross-sectional descriptive co-relational study and samples were all the patients referred for pulmonary function study and had a standard spirometry. The results analyzed by SPSS package and we used descriptive statistical analysis to analyze the results.

## RESULTS

From these 325 patients in this study, 104 cases (32%) were smokers, and 221 cases (68%) were non-smokers. Smokers divided into 4 groups according to their smoking habits:

1) lower than 10-pack-year, 15 cases (14.5%)
2) between 10-14-pack-year, 38 cases (36.5%)
3) between 15-19-pack-year, 17 cases (16.5%)
4) 20-pack-year or more, 34 cases (32.5%)

The mean age of the patients was 33 years old (maximum age 72 and minimum age 6). In individuals with standard spirometry, 260(80%) had normal spirometry. From 65 remaining, 29 (8.9%) had dominant obstruction, and 36 (11/1%) showed restrictive pattern. Mean Beta-angle in all smokers was 180.97 degrees. Mean Beta-angle in smokers of first and second groups was 185 degrees, in third group 186 degrees, and in forth group 172 degrees. In non-smokers mean Beta-angle was 179 degrees. Comparison between smokers and non-smokers indicates that mean Beta-angle in smokers and three first groups of none smokers, namely those with a smoking history of less than 20-pack-year, lacks significant difference (p=0.24), but comparison of mean Beta-angle between the non-smokers and the smokers in the forth group has shown that there is a significant difference in terms of mean Beta-angle (p=0.05).

As shown in figure 2, in individuals with normal pulmonary volumes, FVC and FEV1 were higher than 80%, FEV1/FVC> 70%, PEF>80, and mean Beta-angle was higher than 180 degrees. With decrease of above volumes, Beta-angle became less than 180 degrees gradually. In individuals with dominant airways obstruction, i.e. those with FEV1<80 and FEV/FVC<70, mean Beta-angle was 166.6, and in individuals without obstruction, this mean was 179.7 (figure 2). The difference of this angle between the two groups was statistically significant (p<0.05) (table1).

**Table 1**. Comparison of Beta- angle in patients with and without airways obstruction

| Groups | No. | Minimum Beta-angle (degree) | Mean Beta-angle (degree) | Maximum Beta-angle (degree) | p-value |
|---|---|---|---|---|---|
| With obstruction | 29 | 135 | 166.67 | 196 | <0.05 |
| Without obstruction | 286 | 135 | 179.72 | 210 | |

In patients with restrictive pattern i.e. those with FVC<80% and FEV1/FVC>70%, mean Beta-angle was 178.9, and in individuals without restrictive pattern, mean Beta-angle was 179.7. The difference of this angle in the two groups was not statistically significant (p<0.05)(table 2).

**Table 2**. Comparison of Beta-angle in patients with or without restrictive disease

| Groups | No. | Minimum Beta-angle (degree) | Maximum Beta-angle (degree) | Mean Beta-angle (degree) | p-value |
|---|---|---|---|---|---|
| With restriction | 36 | 158 | 198 | 178.92 | >0.05 |
| Without restriction | 289 | 135 | 210 | 179.71 | |

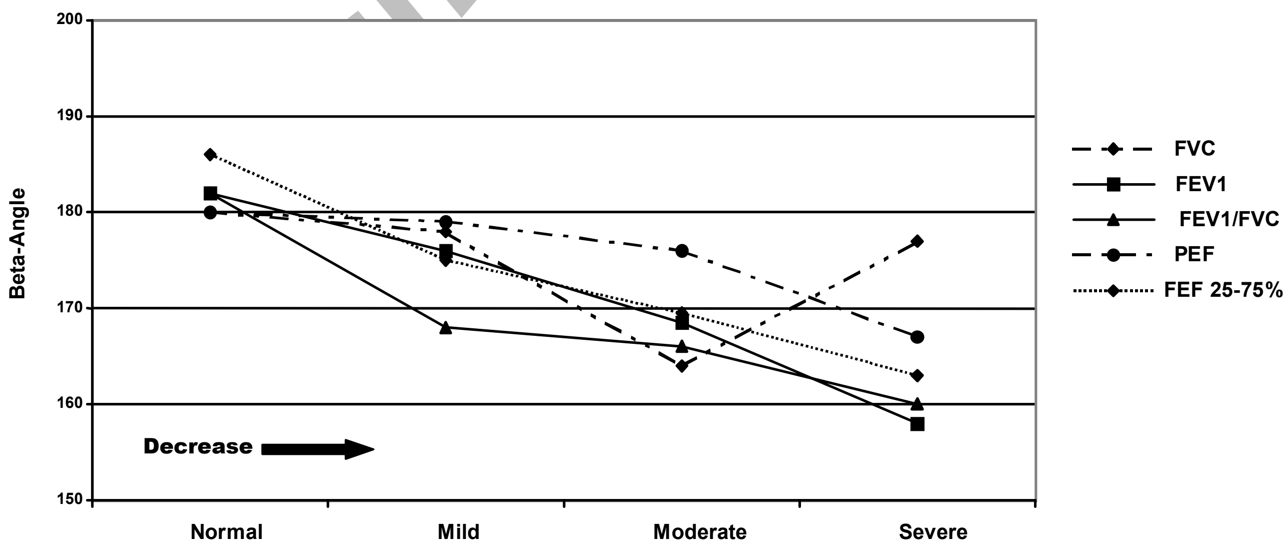


**Figure 2**. Relationship of Beta-angle with different pulmonary volumes

Figure 3 reveals the link of Beta-angle with the age of individuals. As it is shown, Beta-angle is increased initially with increasing of age up to about 20. From the age of 30 and above, this angle begins to decrease and the higher the age, the narrower will be this angle.

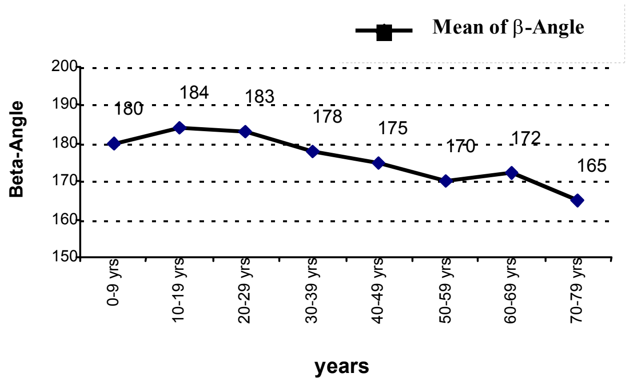


**Figure 3**. The relation of Beta-angle with aging

## DISCUSSION

The inflammation and contraction of smooth muscles of the airways along with decreased elastic recoil of lung parenchyma cause obstruction and increase resistance of the airways (3,4). These all result in decrease of peak expiratory flow and sudden loss of air flow in the mid-expiratory and end expiratory sections. As a result, they cause increase of expiration time. This process makes a sharp increase of slope in the expiratory curve immediately after vertex of loop in the region of peak flow and then severe decline happens until the end expiratory phase. Consequently, the loop concaves toward the upper part. In this state, the size of Beta-angle is lower than 180 degrees. In other words, as the obstruction is higher, the Beta-angle is smaller (5).

In a study, Schachter et al. demonstrated that there is a clear correlation between the airways obstruction and the decrease of Beta-angle (6). In our study, this point was confirmed, too. In figure 2 individuals with normal spirometry had the mean of Beta-angle higher than 180 degrees. In addition, by decreasing of FEV1, FEV1/FVC, and PEFR, Beta-angle decreased gradually to less than 180 degrees. There is another study, which indicates that the size of Beta-angle has a link with the years of cigarette consumption and this angle becomes 10 degrees smaller with 10 years of smoking (1,5).

In our study, there was no significant difference between the mean Beta-angle in the non-smokers and the smokers less than 20-pack-year. However, there was a difference between smokers of 20-pack-year or more and non-smokers. This difference is meaningful because smoking less than 20-pack-year is less likely to cause obstructive airway disease so it does not affect on Beta angle. In another word, light smokers are younger and their pulmonary function has not been affected by smoking yet.

Beta-angle has no correlation with the restrictive disease, and this has proved Kapp's study, too (5). In our study there was no significant difference in mean Beta-angle in patients with or without restrictive disease.

In the present study, a clear correlation was obtained between the volumes of FEV1, FEV1/FVC, PEF and FEF25-75% with Beta-angle, but there was no distinct link between the size of Beta-angle and FVC. This is the reason for declining of FVC level both in obstructive and restrictive patterns.

In our study, age is one of the factors that did not affect on Beta-angle size until around 20-25 years old. As a matter of fact, even to some extent resulted in its increase, but from the age of 30 and over, the angle became smaller, gradually. The reason is the increase of elastic recoil of lung until the age of 20-30 and then it gradually decreases thereafter (3).

## CONCLUSION

Measuring Beta-angle in flow volume loop could be useful for detecting patients with obstructive airway diseases, but according to our study, this finding is not specific.

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