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Original Article

# Comparison of Head, Neck, and Upper Trunk Postures between Patients Who Have Undergone Coronary Artery Bypass Grafting and Healthy Subjects: A pilot study

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ABSTRACT

**Background:** Coronary Artery Bypass Grafting is an effective treatment for reducing symptoms and mortality in coronary artery patients. Although patients experience post sternotomy complications such as musculoskeletal disorders. So, the aim of this study was to compare the head, neck and upper trunk postures between patients who underwent coronary artery bypass grafting and healthy individuals.

**Methods:** In this cross-sectional case-control study, twenty-one men (56.38±8.64 years) were randomly selected from among patients who had been referred to Al-Zahra Cardiac Rehabilitation Center in Shiraz and undergone coronary artery bypass grafting (CABG), and the angles of forward head, thoracic kyphosis, and rounded shoulder were measured. Twenty healthy men (51.70±10.40 years) were also evaluated and compared in terms of the above variables. This study was designed and conducted as a pilot. The angles of the forward head and rounded shoulder were assessed by placing reflective markers on the body and processing the images by Digimizer MedCalc software, version 4.6.1. Thoracic kyphosis angle was measured by a flexible ruler. The Persian version of the SF36 questionnaire was used to assess the quality of life, and the Kolmogorov-Smirnov test to verify the normal distribution of data. Independent sample t-test and Mann-Whitney test were used for between-group comparison for data with normal and non-normal distribution, respectively.

**Results:** The comparison of the forward head, rounded shoulder, and thoracic kyphosis angles showed no significant difference between post-surgical and healthy subjects (P>0.05). Patients' quality of life was significantly different from that of the control group in all aspects, except for general and mental-emotional health (P<0.05).

**Conclusion:** There was no significant difference between the case and control groups in the angles of forward head, thoracic kyphosis, and rounded shoulder. Patients who underwent CABG, however, experienced a significant reduction in their quality of life compared to the control group. Therefore, it seems necessary to pay attention to patients and find solutions to manage and improve various aspects of life, such as physical and mental health.



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## Introduction

Coronary artery disease (CAD) refers to the narrowing or blockage of all or part of the arterial duct, which is

caused by atherosclerosis, spasm, or the presence of a clot. The artery affected by this disease cannot meet the myocardial nutrient demand for oxygen, which results in angina and heart attack [1]. According to research conducted in Iran, the mortality rate is high for this disease, which is the leading cause of death in the country. To put it another way, heart disease, with more than 35%, is the most common cause of death, ranking above accidents and cancers. Interventions used to treat coronary artery stenosis include balloon angioplasty, stent placement, and coronary artery bypass graft (CABG) surgery [2]. Statistics show that approximately 416,000 CABG surgeries are performed in the United States each year due to CAD [3]. In Iran, more than 30,000 open-heart surgeries are performed annually, 50%-60% of which are CABG surgeries [4]. CABG is an effective treatment for reducing symptoms and mortality in coronary artery patients. In this procedure, the blocked coronary artery is reconstructed mainly through saphenous vein transplantation, thus restoring blood flow [5]. Median sternotomy is the most usual procedure used for CABG surgery. In this procedure, after separating the skin and the subcutaneous tissues overlying the sternum, a vertical incision is made from the manubrium to the sternal xiphoid process. No incision is made on the skeletal muscle, but an unusual force is applied to the articulations of the ribs, sternum, and spine upon the separation of the sternal halves [6].

Median sternotomy has numerous complications. One of these complications is musculoskeletal disorders that occur in the chest area and are accompanied by a decreased active and passive range of motion of the trunk, decreased rib movement, muscle imbalance, and restriction in the fascia movement. These factors cause kyphotic posture in the thoracic region on the one hand, and forward head on the other, resulting in pain in the upper vertebrae of the neck and head. These unfavorable postures cause muscle shortenings such as suboccipital, pectoralis major and minor, intercostal, and upper abdominal muscles. Increased length of the cervical and thoracic spinal erector muscles, rotator cuff, and scapular abductors are other complications of this type of poor posture [6]. Another post-sternotomy complication is pain at the surgical site, which occurs due to nerve fiber injury in the scar area. The pain starts within the first hours after surgery and persists chronically up to two months. In this case, the patient assumes an analgesic posture [7, 8]. Over time, chest pain leads to decreased quality of life, sleep disturbances, delayed return to normal activities, and detrimental effects on cardiac and respiratory function [9, 10].

Some research has shown that postural disorders, such as thoracic kyphosis, also have a significant effect on respiratory capacity so that respiratory problems have improved in patients with postural disorders following vertebroplasty, kyphoplasty, and postural correction [11].

Other reports suggest that patients experience pain in the shoulder, neck, and chest areas three months after CABG [12]. Some studies have revealed that musculoskeletal disorders were more prevalent among men than women within the first eight weeks after surgery [13]. Other complications such as respiratory problems, feeling of fatigue, and sleep disorders have been reported by these patients [12].

Since CABG is the most common type of open-heart surgery in the community, the attention is mainly paid to the enhancement of the cardiovascular and pulmonary systems in patients, disregarding their posture and the correction of their movement disorders. As this type of surgery is more common in the elderly, the importance of posture is even greater due to its impact on performance and quality of life. Maintaining an antalgic posture reduces rib movements, causes chest deformity and respiratory dysfunction, and increases the incidence of pulmonary diseases over time. Based on previous studies, CABG causes pain in the sternum and front of the chest, which leads to musculoskeletal and neurological problems in the back, shoulders, and upper trunk over time [14]. Studies also show that following a sternotomy for thoracotomy, complications such as kyphosis and scoliosis occur in children with congenital heart disease in the short or long term [15-17].

So far, no study has investigated the posture of patients who have undergone CABG. This study was performed to compare the head, neck, and upper trunk postures between post-CABG patients and healthy individuals. For the purpose of the present study, the following two hypotheses were examined:

1- Forward head, rounded shoulder, and thoracic kyphosis are present in patients who undergo CABG surgery.

2- Forward head, rounded shoulder, and thoracic kyphosis angles are different in patients who undergo CABG surgery from healthy individuals.

## Methods

This cross-sectional case-control study was performed on twenty-one men aged 35-65 who underwent CABG surgery and twenty sex- and age-match healthy subjects (control group) [18]. The study was approved by ethics committee of Shiraz University of Medical Sciences (SUMS) (IR.SUMS.REC.1396.S323).It was designed and conducted as a pilot study. Participants were given the necessary explanations of the study methods, screened for the inclusion criteria, and signed the informed consent form before entering the study. Subjects who entered the study had undergone CABG, and two months had passed since their surgery. Exclusion criteria were: having a history of nervous system diseases (such as multiple sclerosis, spinal cord compression), the presence of rheumatic diseases or diseases affecting the musculoskeletal system such as scoliosis, and a report of neurological and mental disorder. In addition, individuals who had undergone postural correction treatment were excluded. Demographic characteristics such as age, height, weight, medical history, date of surgery, etc. were first recorded in the data collection form. Then the Persian version of the Quality of Life Questionnaire (SF-36) was completed by the subjects. This questionnaire has also been used in a study on the return to previous activities in patients who had CABG surgery [19] and

it has been proved to be a valid and reliable research instrument [20].

KIDOZ flexible ruler was used to assess the degree of thoracic kyphosis. The ruler is sixty centimeters long and made from a specific metal covered with plastic, which takes different shapes and retains its shape for a while [21]. The ruler has been proved to be a valid and reliable means to measure thoracic kyphosis [22]. To locate the spinous process of T2 vertebra, the subject was asked to assume cervical flexion and the spinous process of C7 was identified [23, 24]. Two vertebrae lower, we located the spinous process of T2. In order for the spinous process of T12 to be located, the subject was asked to place his hands on the edge of the table and bend halfway over, transferring his weight to his hands. As the spinous process of the T12 vertebra is flush with the lower edge of the twelfth ribs on both sides, the edges of these ribs were simultaneously touched with the fingertips, and their path was followed inwards and upwards until they disappeared in the soft tissue of the body. At this point, the approximate location of spinous process of T12 was marked by drawing a straight line joining the tips of the two thumbs. To measure the thoracic kyphosis, the subject was asked to stand with bare feet 15 cm apart, facing the wall and focused on a point. The tester placed the ruler on the skin and applied adequate pressure, so it took the shape of an arc. Without any change, the ruler was placed on a paper and the arc was drawn. The length obtained by connecting the two ends of the curvature was named L. Then a line was connected from the middle of the curvature to the middle of L and was named H. The kyphotic index was H to L ratio and the kyphosis angle was calculated by the formula (Θ=4 (ARC tag (2H/L)) [25-27].

To assess posture of the head, neck, and shoulders, the photographic technique was used in a standing position and without clothes. The validity and reliability of this method have been reported in previous studies [28, 29]. In order to measure the angles, white markers were placed on standard landmarks. To measure the forward head, the landmarks were placed on the spinous process of the seventh cervical vertebra and the right tragus [30, 31]. In order to locate the spinous process, the subject was first asked to put their head forward to make the spine prominent and palpable, and then to bring the head back so that the spine is no longer prominent. To measure the forward shoulder, the marker was placed on the midpoint of the humeral head, and then a photo was taken from the lateral and frontal view in a standing position, using the Samsung ST 150 camera (Figure 1). For all subjects, the camera was placed at a distance of 1.5 m. The anatomical angles of head, neck, and shoulder posture were calculated using Digimizer MedCalc software, version 4.6.1 as follows:

Head forward: The angle formed between the line joining the seventh cervical vertebra to the ear tragus and the horizontal line (when the subject is staring at the horizon). This angle shows the degree of forward head (angle b, Figure 2) [32].

Forward shoulder: The angle formed between the line joining the midpoint of the humeral head to the spinous process of the seventh cervical vertebra and the horizontal line. This angle is 52 degrees in healthy people. A smaller angle indicates the forward shoulder (angle c, Figure 2) [33]. Statistical analysis was performed using SPSS software, version 16.00, with a significance level of 0.05. The normal distribution of data was examined for each group, using the Kolmogorov-Smirnov test. Independent sample t-test and Mann-Whitney test were used for between-group comparison for variables with normal and non-normal distribution, respectively.

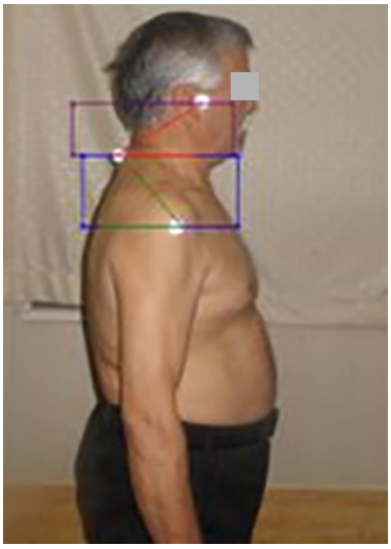

**Figure 1:** marker set for postural assessment of head, neck, and shoulder

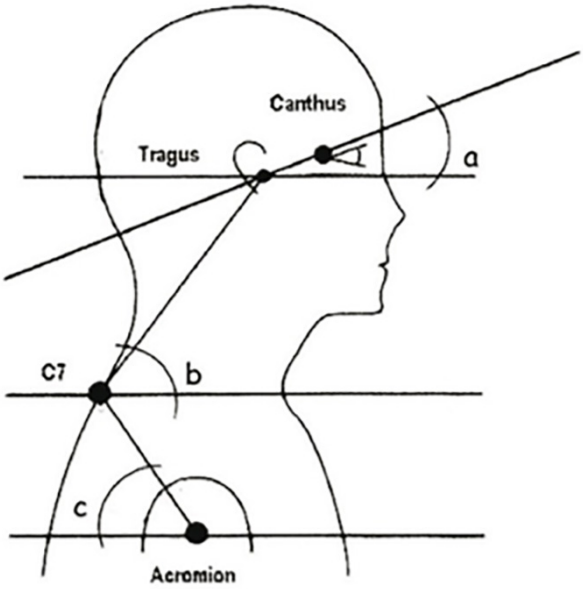


**Figure 2:** Forward head and shoulder angles

## Results

Twenty-one men aged 35 to 65 who underwent CABG surgery and twenty healthy individuals participated in this study. The comparison of the demographic characteristics of participants showed no significant difference between the two groups (P>0.05) (Table 1).

The comparison of the forward head, rounded shoulder, and thoracic kyphosis angles in post-surgical patients and healthy individuals is presented in Table 2. The comparison shows that the mean values of forward head and thoracic kyphosis angles are higher in patients

**Table 1:** Comparison of statistical indicators for demographic characteristics in case and control groups

| Group | Patient (21 subjects) | Healthy (20 subjects) | P value |
|---|---|---|---|
| Variable | Mean(SD) | Mean(SD) | |
| Age (year) | 56.38±10.40 | 51.70±10.40 | 0.19 |
| Weight (kg) | 75.04±13±18 | 78.30±11.74 | 0.63 |
| Height (cm) | 171±8.70 | 163±7.70 | 0.20 |
| BMI (kg/cm$^2$) | 27.07±3.20 | 26.88±3.31 | 0.81 |

*Significance level<0.05, BMI: Body mass index

**Table 2:** Comparison of the mean value for the forward head, rounded shoulder, and thoracic kyphosis angles in case and control groups

| Group | Patient (21 subjects) | Healthy (20 subjects) | P value |
|---|---|---|---|
| Variable | Mean(SD) | Mean(SD) | |
| Forward head angle (degree) | 40.59±6.06 | 40.45±6.72 | 0.79 |
| Rounded shoulder angle (degree) | 53.33±7.42 | 51.18±11.65 | 0.28 |
| Thoracic kyphosis angle (degree) | 43.23±12.13 | 44.96±10.32 | 0.36 |

*Significance level<0.05

**Table 3:** Comparison of the scores of different aspects of quality of life in the case and control groups

| Group | Patient (21 subjects) | Healthy (20 subjects) | P value |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| Different aspects of quality of life | | | |
| Physical function | 69.28±18.79 | 83.75±14.86 | *0.01 |
| Functional limitations for physical reasons | 28.57±39.84 | 64.10±38.20 | *0.004 |
| Functional limitations for emotional reasons | 39.88±40.62 | 77.50±32.34 | *0.002 |
| Physical pain | 62.86±28.84 | 83.87±18.47 | *0.02 |
| Social performance | 64.62±29.85 | 83.00±26.45 | *0.02 |
| Energy and freshness | 43.80±20.30 | 57.75±18.24 | *0.04 |
| Mental health | 61.57±19.92 | 63.40±19.74 | 0.98 |
| General health | 60.48±18.30 | 66.75±14.98 | 0.27 |

*Significance level<0.05

than in healthy individuals, but this difference was not significant (P>0.05). Also, the mean value of the rounded shoulder angle was higher in healthy individuals than patients, although this difference was not significant (P>0.05) (Table 3).

## Discussion

This study aimed to compare the forward head, round shoulder, and thoracic kyphosis angles between patients who underwent CABG and healthy individuals. Studies have shown that the mean value of the forward head and thoracic kyphosis angles were higher, and the average value of the forward shoulder angle was lower among patients than healthy individuals. But these differences were not significant. No similar study was found on the comparison of the angles of forward head, rounded shoulder, and thoracic kyphosis between patients who have undergone CABG and healthy subjects so that we could compare its results with those of the present study.

According to the World Health Organization, CAD is the leading cause of death in developing countries, which is on the rise due to lifestyle behaviors such as reduced daily physical activity, smoking, and unhealthy diet. An unhealthy lifestyle is associated with risk factors for coronary artery diseases, including high blood pressure, diabetes, and obesity [34]. CABG surgery is an effective treatment for reducing the symptoms and mortality from CAD. Procedures involved in this surgery include cardiopulmonary bypass, manipulation of chest contents, and postoperative rest [35]. In this type of surgery, the sternum is split in half and pulled back with a retractor to provide adequate access to the heart and surrounding arteries [34]. This procedure, like other surgical procedures, has several complications, with some patients having early and some having late complications. One of the problems after surgery is the post-sternotomy pain syndrome which usually lasts up to two months after the procedure. Several hypotheses have been proposed to explain this, including nerve entrapment by the suture or scars forming at the incision site, rib fractures during surgical procedure; damage to the brachial plexus injuries during surgical positioning, costosternal syndrome, or showing allergy to the metal suture [9]. In such cases, the patient assumes an antalgic posture that can affect lung function [36].

One of the complications of CABG is musculoskeletal disorders that result from immobility and adaptation to the kyphotic posture because of pain at the incision site in the sternum, which puts a severe load on the surrounding muscles. Sternal pain reduces the cervical range of motion, induces kyphotic posture, and causes problems in the surrounding muscles [37]. Few studies have been conducted on the prevalence of spinal deformities following median sternotomy. Some of these studies have shown the prevalence of spinal deformities in the frontal plane after sternotomy among patients with congenital heart diseases [16] and a study has reported kyphosis in

21% of patients following sternotomy and thoracotomy in CABG surgery [15].

Another complication is upper-crossed syndrome. There is not a great deal of information about the epidemiology of this disorder, but it can be seen as a result of poor sitting or standing posture after CABG surgery. This disorder occurs in the upper quarter of the trunk and affects the shoulders, neck, and head. The main risk factors for this disorder include bad postures, long surgeries, disability, physical weakness, and old age. In addition, the antigravity muscle endurance is reduced and the patient's ability to maintain the body posture decreases after surgery. Therefore, the correct body alignment changes, and the patient is prone to maintaining a forward head posture. Reduction of the cranio-vertebral angle leads to increased torque of the cervical extensor muscles whose strong isometric contraction is necessary for counteracting the force of gravity. The increased activity potentially causes muscle pain and discomfort. The curvature of the upper part of thoracic region increases the tension in the neck and lower back muscles. Forward head posture is associated with increased kyphosis angle and rounded shoulder, these conditions cause a relative increase in protraction, elevation, downward rotation, and anterior tilting of the scapula. Biomechanical changes in the glenohumeral joint can cause shoulder dysfunction by disrupting the scapulohumeral rhythm. Therefore, assuming bad postures after CABG surgery causes chain reactions throughout the spine. Upper crossed syndrome causes abnormal kyphosis, biomechanical changes in the glenohumeral joint, chest, and shoulder pain. Therefore, doing chest strengthening exercises to improve the postures can lead to a corrected kyphosis [38, 39].

Problems have been reported in other areas of the body, such as the shoulder. Evidence has shown that unilateral or bilateral shoulder pain and frozen shoulder syndrome occurs in patients 6-9 months after CABG surgery [40]. Other possible causes of musculoskeletal and neuromuscular disorders resulting from this procedure are the position of the patient during surgery, internal jugular vein cannulation, and a relative decrease in blood supply to sternum due to the cutting off the main blood supply [34].

As mentioned, various studies have reported a high prevalence of musculoskeletal disorders following open-heart surgery, which are often regarded as unavoidable complications of this type of surgery. These complications affect patients' comfort levels and functional ability to return to work and daily activities [14]. The present study is the first work reporting the effect of CABG surgery on postural abnormalities in Iran. Therefore, it is necessary to pay special attention to musculoskeletal complications after CABG surgery. Our study revealed that the quality of life is significantly reduced in patients who have undergone CABG surgery. This is manifested in all aspects of life except for general and mental health, which indicates that people around the patient should treat them with more love and care. Vitality (energy and freshness), social functioning, and physical pain, among other aspects, were significantly reduced, which are in line with previous study. Based on previous findings, it can be concluded that heart surgery may not necessarily reduce pain, improve the patient's physical function, and thus enhance the quality of life [19]. The result of the present survey is in compliance with the study of Montazer Ghaem et al. conducted in Bandar Abbas. These researchers found that the patients' quality of life would not necessarily improve after open-heart surgery [41]. It seems that patients with low quality of life are more likely to be repeatedly hospitalized because their symptoms worsen over time, and hospitalization is more necessary [42]. Our study also had some limitations. Among other things, the forward head, rounded shoulder and thoracic kyphosis angles were not measured in female subjects, so we suggest that future studies be carried out on females and other age groups.

## Conclusion

The results of the present study showed that there was no significant difference in the forward head, rounded shoulder, and thoracic kyphosis angles between post-CABG patients and healthy subjects. Patients who underwent CABG surgery experienced a significant reduction in all aspects of quality of life, except for general and mental health, compared to the control group. Therefore, it is necessary to pay attention to patients and find solutions to manage and improve various aspects, such as physical and mental health.

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**Conflict of Interests**: None declared.

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