INTRODUCTION AND OBJECTIVE: Coronary anomalies are not rare [about 1% of the general population] and may be associated with sudden death and ischemia and may cause difficulties in coronary interventions and errors in bypass surgery. The aim of this study is to demonstrate their incidence in the Sudanese patients and give a review on their classifications and clinical relevance.

PATIENTS AND METHODS: A retrospective study of 270 patients who had coronary angiography at A Gasim cardiac center from April, 2004 to August, 2005

RESULTS AND CONCLUSION: Our study showed a rather higher rate of coronary anomalies [3%] but the pattern was not greatly different from the figures in the literature. Anomalies of origin were the most common [which may give difficulties in coronary interventions]. Potentially morbid anomaly with either the left anterior descending artery [LAD] or the left main coronary artery [LMCA] originating from the right coronary sinus was seen in 3 patients [1, 1%], so this study demonstrated that coronary anomalies are not rare in our patients and potentially serious anomaly may exist.

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Coronary interventions and bypass surgery was recently established in the Sudan and as coronary anomalies may cause difficulties in coronary interventions and errors in bypass surgery in addition to their association with sudden death and ischemia, this study is carried out to demonstrate their incidence in the Sudanese patients and give a review of their classifications and clinical relevance.

INTRODUCTION and SHORT REVIEW
The right and the left coronary arteries arise from the ascending aorta on its anterior and the left posterior aortic sinuses respectively, figure 1 & 2 illustrates the course and the major branches of the two arteries[1] -

The term coronary artery anomaly refers to a wide range of congenital abnormalities involving the origin, course or termination of the coronary arteries, these abnormalities account for about 1% of general population in adults[2]. The term variation of the coronary arteries is referred to the variations that are observed frequently and are usually of no clinical significance [2].

The clinical interest in coronary anomalies is related to their association with sudden death and myocardial ischemia, they may cause difficulties in the interpretation of the coronary angiograms and in coronary interventions and may lead to errors in the surgical approach if not recognized [2].

There is no consensus about the classification of the coronary anomalies. Some researchers have suggested that the coronary anomalies...
should be classified as major or minor depending on their pathological significance. Recently, most investigators have chosen to use an exclusively anatomic definition that relegates judgments about clinical relevance to a secondary clinical classification\(^\text{(2,3)}\). The anatomic classification may be as follows\(^\text{(2)}\):

A- Anomalies of the origin:

1- Position and number of ostia:
   a- High and low take off.
   b- Multiple ostia.
   c- Origin of a coronary artery or branch from the opposite sinus of Valsalva or from the non coronary sinus.

2- Single coronary artery.

3- Anomalous origin from the pulmonary artery.

4- Origin from systemic vessels.

B- Anomalies of course:

1- Normal pattern with an intramyocardial segment [myocardial bridge].

2- Duplication of arteries.

3- Coronary artery passing between the pulmonary trunk and the aorta.

C- Anomalies of termination:

1- Abnormal termination into a cardiac chamber, great vessel or systemic vein.

2- Thebesian vein drainage.

3- Coronary arcade of Spindola-Franco.

The clinical significance of the coronary anomalies is related to their morbidity and/or procedural difficulties.

Anomalies of origin are associated with morbidity if the coronary arteries arise from the pulmonary artery or have an abnormal course. The most morbid anomaly is the origin of the coronary arteries from the pulmonary artery as this usually results in death during infancy specially if both coronary arteries are involved\(^\text{(4,5)}\).

Other serious anomalies include origin of the LMCA or the LAD from the right coronary sinus, in this case the morbidity is related to the course of the artery, as each artery may courses either between the aorta and the pulmonary artery or anterior to the pulmonary artery and rarely it may have a retroaortic course. The course between the aorta and the pulmonary artery carries the highest risk of sudden death\(^\text{(6, 7, 8, 9, and 10)}\).

A similar morbidity may arise from a single coronary artery if a major branch courses between the aorta and the pulmonary artery, in addition a proximal stenosis of a single coronary artery may be devastating because of the inability to develop collateral channels\(^\text{(11, 12)}\).

Anomalous LAD from the right coronary sinus may be associated with other congenital heart diseases e.g. tetralogy of Fallot\(^\text{(9, 10)}\).

Anomalies of termination may cause left to right shunt but usually they are not significant and the most frequent one is the coronary fistulas\(^\text{(13)}\).

Technically anomalies of origin may cause difficulty in cannulation and guiding catheter support in coronary interventions while anomalies of course and variation may cause errors in surgical approach if not recognized.
Figure (1): The right coronary artery and its branches.

Figure (2): The left coronary artery and its branches.
Material and Methods
This is a retrospective, cross-sectional study performed at Ahmed Gasm cardiac center from April 2004 to August 2005. 270 patients who underwent routine coronary arteriography were included, their angiogram reports were reviewed. The angiograms of those patients who had coronary anomalies were cross checked by another interventionalist. High and low “take off” anomalies, coronary variations as well as children with congenital heart disease who had aortograms to delineate the origin and course of their major coronary arteries before surgery were excluded.

Results
Out of the 270 patients, 162 patients [60%] were males and 108 patients [40%] were females. The mean age of the study population was 60 years, with a range of 42 years to 78 years. Eight patients (3%) were found to have coronary anomalies [Table 1, Fig 3 & 4]. The most common anomaly in this study was that of the origin of the left anterior descending coronary artery [LAD], which was seen in 4 patients i.e. 50% of the anomalies and in about 1.5% of the total population studied.

Table (1): Shows the incidence of the coronary anomalies in the study population:

<table>
<thead>
<tr>
<th>Sex &amp; Age</th>
<th>Coronary anomalies</th>
<th>Number of patients</th>
<th>Incidence %</th>
<th>% 0ut of the 270 Pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-55 yrs</td>
<td>LAD and LCX, arising from RCS</td>
<td>1</td>
<td>12.5</td>
<td>0.4</td>
</tr>
<tr>
<td>F-42 yrs</td>
<td>LAD arising from RCS</td>
<td>1</td>
<td>12.5</td>
<td>0.4</td>
</tr>
<tr>
<td>M-78 yrs</td>
<td>LMCA arising from RCS</td>
<td>1</td>
<td>12.5</td>
<td>0.4</td>
</tr>
<tr>
<td>M-58 yrs</td>
<td>LAD arising from the conus artery</td>
<td>1</td>
<td>12.5</td>
<td>0.4</td>
</tr>
<tr>
<td>M-60 yrs</td>
<td>LAD has muscle bridge</td>
<td>1</td>
<td>12.5</td>
<td>0.4</td>
</tr>
<tr>
<td>M-63 yrs M-53 yrs</td>
<td>RCA arising from LCS</td>
<td>2</td>
<td>25</td>
<td>0.74</td>
</tr>
<tr>
<td>F-55 yrs</td>
<td>RCA absent</td>
<td>1</td>
<td>12.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>8 out of 270</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

LAD = left anterior descending. LCX = left circumflex. LCS = left coronary sinus. LMCA = left main coronary artery. RCA = right coronary artery. RCS = right coronary sinus.
Figure (3): LAD, RCA and CX arising from LCS
LAD= Left anterior descending
RCA= Right coronary artery
RCS= Right coronary sinus

Figure (4): The left coronary artery (LCA) arises from the right coronary sinus (RCS).
RCA=right coronary artery. LAD= left anterior descending artery. Cx=circumflex artery
Discussion

Although coronary anomalies may be detected non invasively by the new methods like multi-slices computed tomography, this difficult to be used as screening test and they are usually detected at coronary angiography.(13)

There are many reports describing coronary anomalies. The largest series is by Yamanaka et al, where he analyzed 126,595 angiograms and found 1,686 patients with anomalous coronaries with an incidence of 1.6%, while in northern India the incidence was 0.95%. In the series studied by Topaz et al; The incidence was 0.61%. In our study the incidence was rather high [3%] (14, 15,16).

The most common anomaly in our study was of the origin of the LAD [about 50% of the anomalies and 1.5% of the patients studied] . Yamanaka et al Found that 30.4% of the anomalies were contributed to by a separate origin of the LAD and the LCX. This anomaly usually causes no hemodynamic impairment and is generally considered to be benign. In the series by Topaz et al; Among 20,332 adult patients, 83 (0.4%) were found to have separate origins of the LAD and LCX but they found an increased incidence of myocardial bridging (1.5%) (14, 15).  

Occasionally this anomaly may not be recognized at the time of coronary angiography. The LAD or the left circumflex artery [LCX] may be misinterpreted as totally obstructed or congenitally absent. The appearance of an avascular area in the distribution of either artery (a pseudo "no perfusion" sign) should raise the possibility of this anomaly(15).

Potentially morbid anomaly was seen in three patients in our study. In the first patient, the origin of the LAD was from the right coronary sinus, in the second there was separate origin of the three major coronary arteries from the right coronary sinus, such anomaly has been reported by Fineschi et al, (17), while in the third the left main coronary artery is originating from the right aortic sinus [0.4%]. Twenty-two cases with a similar anomaly were described by Yamanaka et al (14). Origin of the left anterior descending from the conus artery is a rare anomaly which was seen in one patient in our study.

The next commonly encountered anomaly in our study was the right coronary artery arising from the left coronary sinus (25% of the anomalies). In this anomaly, the right coronary artery originated from an orifice located anterior to the left main ostium in the left coronary sinus. This anomaly is suspected when the right coronary ostium is not located in the right coronary sinus and collaterals are absent. This ectopic right coronary artery is difficult to cannulate because of its slit-like orifice and odd angulation. This was the most common of the coronary anomalies (42%) in the series described by Garg et al (18).

The anomaous of the left circumflex arising from the right coronary cusp was seen in one patient in our study (12.5%), this agreeing with the studies by Yamanaka et al, Topaz et al and Garg et al (14,15,18).

Conclusion

Although this study is limited by the small number of patients, it demonstrated a rather higher incidence of coronary anomalies in our patients but the pattern appears not to be greatly different from the reports in the literature, with anomalies of origin as the most common [75%] especially anomalies of the origin of the left anterior descending artery which constituted 50% of the anomalies detected.

Potentially morbid anomalies with the origin of either the LAD or the LMCA
from the right coronary sinus were detected in three patients [37%].

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