Case Series

Transcatheter Coil Embolization

in 17 Patients with 22 Coronary Artery Fistulas

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Coronary artery fistulas are rare anomalies that often become symptomatic with age. They are typically diagnosed incidentally during coronary angiography. The chief nonsurgical treatment is transcatheter coil embolization. We evaluated the outcomes of this procedure in 17 symptomatic patients who had 22 fistulas in total.

The 9 men and 8 women (mean age, 52 ± 16.5 yr; range, 27–74 yr) presented at 4 Turkish hospitals from October 2008 through March 2015. Three patients had multiple fistulas. Twelve fistulas originated from the right coronary artery and 10 from the left coronary artery, draining into the pulmonary artery in 18 instances. We evaluated results postprocedurally and after 2 to 5 months, defining angiographic success as a flow better than Thrombolysis in Myocardial Infarction grade 2 in the treated artery.

Twenty-one of the 22 procedures immediately produced the targeted flow. We observed 2 minor and no major complications. On follow-up, 3 symptomatic patients underwent successful repeat treatment of one fistula each. We found that transcatheter coil embolization afforded good success rates with few complications in closing coronary artery fistulas. We share our experience to add to the data on treating patients with coronary artery fistulas, and to raise awareness among clinicians. ***(Tex Heart Inst J 2020;47(2):135-9)***

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Coronary artery fistulas (CAFs), first described by Krause[1] in 1865, are created when a coronary artery abnormally ends in a cardiac chamber, the pulmonary artery (PA), or a systemic vein. Their frequency ranges from 0.05% to 0.25% in angiographic series,[2] and their prevalence in the general population is approximately 0.002%.[3]

Most CAFs are congenital; however, they can develop after trauma or procedures such as ablation,[4] coronary artery bypass grafting,[5] or stent implantation.[6] In 50% of cases, the CAF originates from the right coronary artery (RCA); in 42%, from the left coronary artery; and in 5%, from both.[2] Fistulas typically drain into the right-sided cardiac chambers or the PA.[7]

Whether coronary steal causes ischemic symptoms in CAF has been debated.[8] Except for a continuous murmur, hemodynamically small fistulas can be silent until patients age or a fistula expands with an increased left-to-right shunt ratio; in either circumstance, dyspnea or angina may be reported.[2] Ruptured CAFs may lead to myocardial ischemia, infective endocarditis, pulmonary hypertension, or sudden death.[9]

Most CAFs are discovered incidentally during coronary angiography, and even more are revealed on computed tomographic (CT) angiograms.[8] Results of exercise tests, stress echocardiography, and myocardial perfusion scintigraphy help to determine decreases in coronary flow.[9] Echocardiography is useful for identifying related hemodynamic changes, shunt ratios, concomitant congenital anomalies, and possible ischemic complications.[10] High-resolution multislice CT reveals a fistula's course and drainage region.[10]

Percutaneous closure or surgical ligation can prevent fistula-related complications and alleviate symptoms.[2] Small and medium-sized fistulas are typically accessible and are candidates for percutaneous closure when they originate as a single root from a proximal arterial segment and drain into one narrow area.[11] The predominant percutaneous closure method is transcatheter coil embolization (TCE) (Fig. 1); closure devices may also be used,[11] and stent-grafts may suffice when a coronary lesion and fistula occupy the same arterial segment.[12] Surgical ligation is preferable when fistulas are tortuous, aneurysmal, or complex, or when patients need other coronary surgery.[13]

We studied 17 patients diagnosed with CAF. We noted the characteristics of the

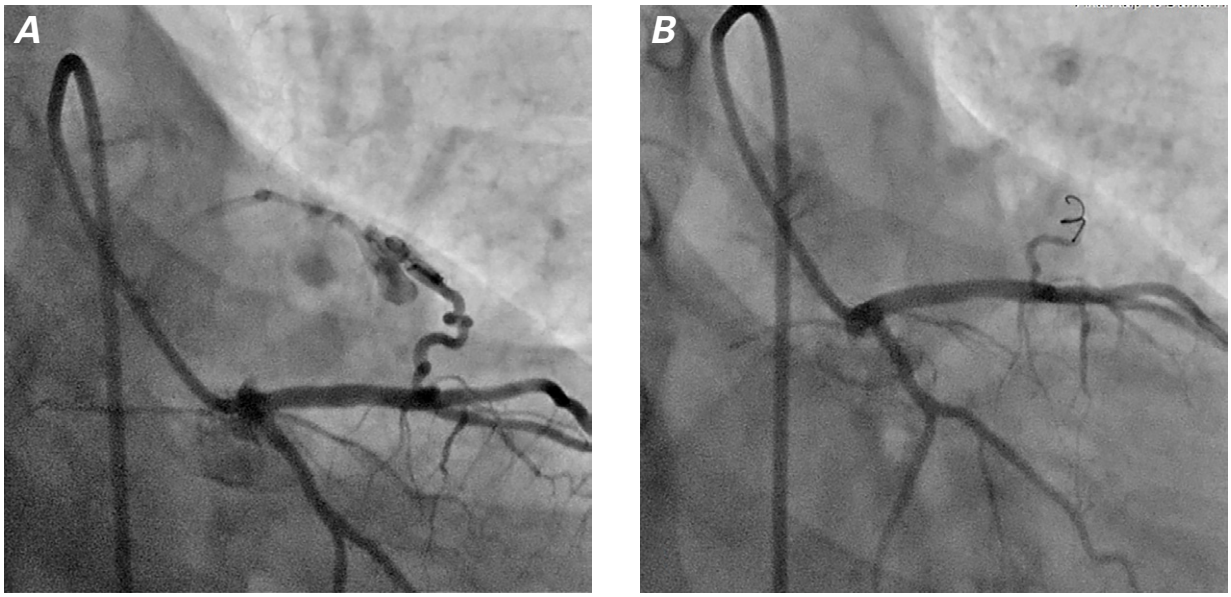

Fig. 1 *Patient 9. Representative angiograms show* ***A****) a fistula originating from the left anterior descending coronary artery and* ***B****) successful closure after transcatheter coil embolization.*

fistulas and evaluated the postprocedural and short-term outcomes of TCE. We present our findings to raise awareness about the topic.

Patients and Methods

We retrospectively evaluated 22 TCE treatments of CAF in 9 men and 8 women (mean age, 52 ± 16.5 yr; range, 27–74 yr) at 4 Turkish hospitals from October 2008 through March 2015.

From hospital records, we obtained the patients' demographic characteristics, symptoms, lengths of hospital stay, and procedural complications. For each CAF, we recorded the arterial segment (proximal, mid, or distal) where it originated and its diameter at the proximal and distal point of origination, the largest width of the CAF, and the regions where coils were placed. (Because TCE was performed in different centers at different times, we did not evaluate brands or types of microcatheters or coils.) We considered TCE successful when flow was Thrombolysis in Myocardial Infarction (TIMI) grade 1 or better, and unsuccessful when flow was TIMI grade 2 or worse.[14]

All patients provided written informed consent for the study, which conformed with institutional and national ethical standards and the Declaration of Helsinki.

Statistical Analysis. We used SPSS 15.0 (SPSS, an IBM company) for statistical analysis. Variables with normal distribution were expressed as mean ± SD.

Results

The main symptoms at presentation were chest pain and dyspnea. Seven patients (41%) had hypertension. Angiograms showed critical coronary artery stenosis (>50%) in 3 patients (18%). Effort stress testing, myocardial scintigraphy, or both revealed ischemia in 9 patients (53%). One patient was scheduled for TCE because a fistula had developed after a surgical ligation.

The 17 patients had 22 CAFs (Table I); 14 had only one. One patient had 2 CAFs; 2 patients each had 3 CAFs (Fig. 2). Twelve CAFs (55%) originated from the RCA, 7 (32%) from the left anterior descending coronary artery (LAD), and 3 (14%) from the left circumflex coronary artery. Eighteen CAFs (82%) drained into the PA.

The fistulas most often originated from proximal arterial segments. Those arteries had larger diameters proximal to the fistulas than distal to them (mean, 3.62 ± 0.5 vs 3.1 ± 0.42 mm). The largest fistula's diameter was 3.5 mm (total mean diameter, 2.17 ± 0.67 mm), and the mean diameter of the segments where coils were implanted was 1.74 ± 0.45 mm. Up to 5 coils were used per CAF and up to 8 per patient (mean, 2.26 ± 0.99 coils).

The postprocedural success rate for TCE was 95% (21 of 22 CAFs). The failed procedure left symptomatic residual shunting with TIMI grade 2 flow, and that patient underwent successful repeat TCE. All patients survived without stroke, myocardial infarction, major bleeding, or transient ischemia or arrhythmias. Two patients had minor procedural complications (12%): one was allergic to the contrast medium[15]; another had a hematoma (<5 cm) at the intervention site,[16] which was controlled with compression during the procedure. Coil embolization outside a fistula, the chief technical complication of TCE,[17] did not occur. The mean postprocedural hospital stay was 1.5 ± 0.7 d.

TABLE I. Characteristics of the 17 Patients with 22 Coronary Artery Fistulas

Pt.	Age (yr), Sex	Presenting Symptom(s)	CAF Features			No. of Coils	TIMI Grade	
			No.	Course	Max. Diam. (mm)		After Procedure	Follow-Up
1	65, M	Chest pain	1	RCA–PA	2.5	2	1	1
2	51, M	Chest pain and dyspnea	1	RCA–PA	2.7	3	0	0
3	55, F	Chest pain and dyspnea	1	LCx–PA	2.0	2	0	0
4	54, M	Fatigue	1	LAD–RA	2.8	3	1	1
5	48, F	Dyspnea	1	RCA–PA	2.1	2	0	0
6	65, M	Dyspnea	1	LAD–PA	1.8	2	0	0
7[a]	56, F	Chest pain and dyspnea	2	RCA–PA	3.3	3	0	0
				LAD–PA	2.7	2	0	0
8[b]	40, M	Chest pain	1	LAD–PA	1.3	2	2	2
9	74, F	Chest pain	1	LAD–PA	1.5	1	0	0
10	43, M	Fatigue	1	RCA–PA	1.4	2	0	0
11	59, M	Chest pain	1	RCA–PA	2.4	2	1	0
12	74, F	Dyspnea	1	LCx–PA	1.5	1	1	2
13	60, F	Chest pain	3	RCA–PA	2.5	3	1	0
				RCA–PA	2.1	2	0	0
				RCA–PA	1.8	1	0	0
14	32, F	Dyspnea	1	RCA–RA	1.5	1	0	0
15[c]	27, M	Chest pain	1	LAD–PA	3.5	5	0	0
16	49, F	Chest pain	1	LAD–PA	2.0	3	0	0
17	33, M	Chest pain and dyspnea	3	RCA–RA	1.9	3	1	0
				RCA–RA	1.7	2	0	0
				LCx–PA	2.7	3	0	2

CAF = coronary artery fistula; F = female; LAD = left anterior descending coronary artery; LCx = left circumflex coronary artery; M = male; Max. Diam. = maximal diameter; PA = pulmonary artery; Pt = patient; RA = right atrium; RCA = right coronary artery; TIMI = Thrombolysis In Myocardial Infarction

[a] Patient 7 had a minor hematoma.

[b] Patient 8 underwent successful repeat TCE after a procedure failed and left symptomatic residual shunting.

[c] Patient 15 was allergic to the contrast medium.

Within 2 to 5 months (mean, 3.5 ± 1.4 mo), all patients underwent follow-up angiographic evaluation. Three had symptomatic residual shunting with TIMI-2 flow and underwent TCE again in one CAF each, with good results. The overall short-term procedural success rate was 86% (18 of 21).

The rate of procedural failure was too low for statistical comparisons in terms of the other variables evaluated, so we present only our numerical and observational results.

Discussion

Our patient population was similar to those in other reports.[18] Diagnoses of CAF were distributed almost equally between women (47%) and men (53%). Fistulas typically become symptomatic in individuals who are 50 years of age,[19] as was the case in 10 of our patients. More than 90% of the CAFs originated from the proximal RCA or LAD,[2,20] and 82% drained into the PA, consistent with a 90.9% PA drainage rate reported in 19,584 people after CT study.[18]

The success rates of TCE typically exceed 95%.[21] Our success rate was 95% postprocedurally in 22 CAFs and 86% on follow-up in 21 CAFs. The only 2 procedural complications were minor.

Patients in whom TCE failed remained symptomatic or reported symptoms later. The reasons for failure were not consistent. However, some factors may have affected the outcome, such as wide fistula diameter, anatomic complexity of the ostium, difficulty in microcatheter manipulation, inappropriate coil diameter, and insufficient technical knowledge.

In most CAFs, a single artery of origination is identified. In 10% to 16% of cases, multiple complex feeding

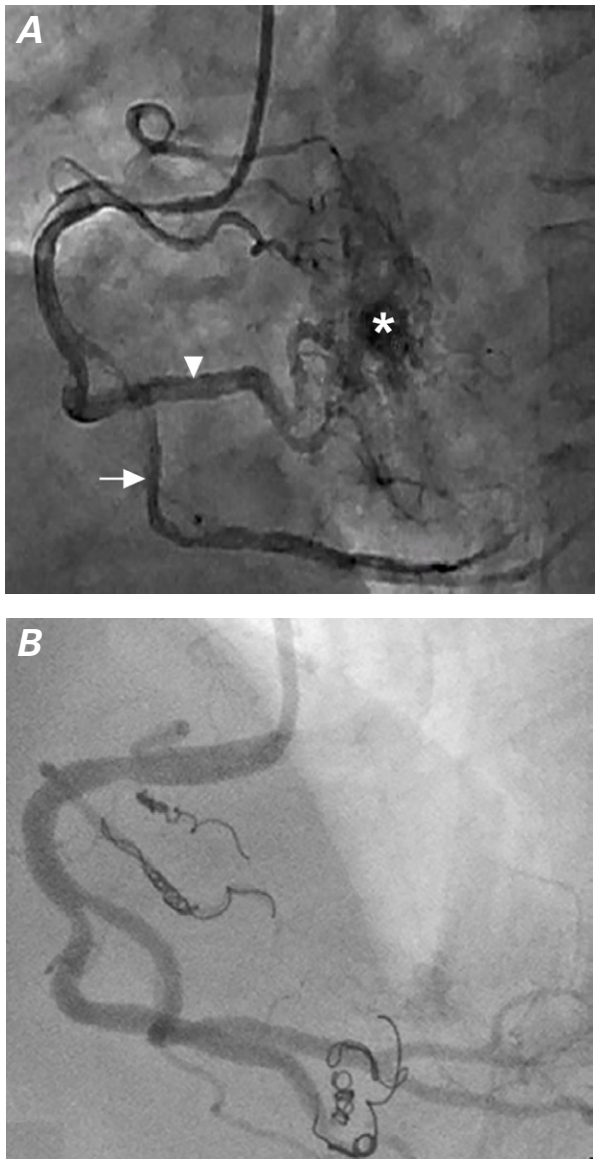

Fig. 2 *Patient 13. Angiograms reveal* ***A****) 3 coronary artery fistulas that drain into the pulmonary artery (asterisk). A fistula originates in the distal right coronary artery (arrowhead) and dilates substantially as it feeds the right coronary artery acute marginal branch (arrow) before draining.* ***B****) Successful results after transcatheter coil embolization.*

arteries are involved,[22] so patients are often symptomatic because of significant shunting; this was the case in our patients who had multiple fistulas. In addition, several coils are often needed to close multiple or large-diameter fistulas, likewise the case in most of our patients.

Study Limitations. Our study was limited by its retrospective nature. The prevalence of CAF in the general population is so low that large randomized controlled studies are not feasible. Our study had no surgical ligation group with which to compare results of TCE. Because so few procedures failed, we could not determine factors predicting the procedural success of TCE.

Conclusion

We found that TCE had high technical success rates and a low risk of complications in CAF closure, and it consistently relieved patients' symptoms. We will continue to use this treatment method when clinical indications and CAF anatomy are appropriate. Our experience supports the findings in existing reports, and it confirms for other physicians that CAFs may be treated successfully.

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