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Does contrast agent injection during trans-catheter aortic valve implantation negatively affect kidney function?

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Abstract

Background: Trans-catheter aortic valve implantation (TAVI) has recently emerged as an alternative to conventional surgery in high-risk surgical patients with haemodynamically significant aortic valve stenosis. However, patients referred for TAVI are usually elderly individuals (> 80 years) who frequently also suffer from renal impairment. Trans-catheter valve therapies require extensive use of contrast injections with a risk of nephrotoxicity.

Aim: To evaluate post-TAVI renal function and to determine whether the exposure to contrast injections might cause reduced kidney function and contrast-induced nephropathy.

Methods: From January 2009 to September 2010, TAVI was performed in 39 patients (26 women and 13 men). The mean age of the patients was 81.43 ± 7.39 years, and the mean volume of contrast material administered was 187.95 ± 91.34 mL. Serum creatinine and glomerular filtration rate (GFR, acc. to the MDRD formula) were estimated in all patients prior to and 1, 2, and 5–8 days after TAVI.

Results: Two female patients died on postoperative day 1. Other patients did not show clinically significant reduction in renal function following the procedure (mean creatinine concentration 104.46 *vs* 99.77 *vs* 94.56 *vs* 93.64 μmol/L, NS and mean GFR 52.37 *vs* 56.63 *vs* 60.18 *vs* 61.34 mL/min/1.73 m^2, NS).

Conclusions: 1. The TAVI procedure, which includes contrast injection does not seem to cause a clinically significant decrease of renal function. 2. None of our elderly patients with severe aortic valve stenosis, multiple co-morbidities, and pre-TAVI renal compromise developed contrast-induced nephropathy.

Key words: aortic stenosis, contrast, nephropathy, trans-catheter aortic valve implantation

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INTRODUCTION

Aortic stenosis (AS) is nowadays the most common acquired valvular lesion. The degenerative process of the aortic valve progresses with age, hence the disease is seen most frequently in elderly patients [1, 2]. Until recently, the only treatment option for severe AS was surgical aortic valve replacement. As the disease is most common in the elderly, multiple co-morbidities occur, substantially increasing operative risk. Therefore, over 30% of patients > 75 years with severe AS are disqualified from surgical treatment [2].

Trans-catheter aortic valve implantation (TAVI) has become an alternative for patients with severe AS and high operative risk (as assessed by Logistic EuroScore [> 20%] and/or STS [> 10%]) or with other contraindications to surgical tre-

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atment, not included in these risk scores, such as porcelain aorta [3–6]. Successful TAVI procedure improves aortic valve area (AVA) and AVA index as well as reduces mean and maximal trans-valvular gradient, what results in symptom reduction and improved exercise capacity in these patients. About 70–80% of patients live up to 2 years, co-morbidities being the main cause of death, and quality of life is markedly improved [6–8].

The novel method of TAVI was introduced in 2002 in France by A. Cribier, who initiated a new era in the management of severe AS [9–13]. Unequivocal usefulness of TAVI procedures was confirmed in the recently published PARTNER study [14].

The TAVI is performed via either femoral, subclavian or trans-apical access [15, 16]. The procedures are carried out in the catheterisation laboratory, under x-ray guidance. A potentially nephrotoxic contrast agent is injected during the procedure [17, 18]. Patients selected for TAVI are usually over 80 years, frequently with pre-procedural compromise of renal function. Despite the fact that TAVI becomes a more and more available and common treatment option for patients with severe AS not eligible for surgery, data concerning the effects of these procedures on renal function are scarce. The aim of our study was to retrospectively assess renal function in patients after TAVI.

METHODS

Between January 2009 and September 2010, 39 TAVI procedures were performed in our institution. The patients (26 women and 13 men) aged 81.43 ± 7.39 years with severe AS, were disqualified from surgical treatment due to high peri-operative risk of death (Logistic EuroScore 22.19 ± 10.05%; Table 1). All the decisions regarding patient eligibility for TAVI were made by the Heart Team.

During TAVI, non-ionic contrast agents were used, low-osmolar iomeprol or iso-osmolar iodixanol, in an average dose of 187.95 ± 91.34 mL (Table 1). Iomeprol is excreted with urine within the first 24 hours and only scarce amounts are excreted within 24–38 hours from dose administration. About 80% of iodixanol is eliminated with urine within 4 hours from intravenous administration, and 97% is excreted within 24 hours. Only 1.2% of the dose is eliminated with feces within 72 hours. The prevention of contrast induced nephropathy (CIN) including acetylcysteine and intravenous hydration was used in 17 patients in whom creatinine clearance was < 50 mL/min/1.73 m^2. In these patients, intravenous normal saline was administered one day before and on the day of the procedure (100 mL/h, at least 4 h before the procedure), and continued for 24 hours. Intravenous N-acetylcysteine (NAC) at the dose of 1200 mg/d, was also administered [19–21]. In the remaining patients only hydration with normal saline or Ringer solution were used peri-operatively. In diabetic patients, metformin was withdrawn one day prior to TAVI. In each patient creatinine clearance and glomerular filtration rate (GFR) according to MDRD formula were measured one day before and 1, 2 and 5–8 days after the procedure. The CIN was defined as serum creatinine increase of 0.5 mg/dL (44 μmol/L) or by ≥ 25% of baseline value within 48 hours from contrast media administration with the absence of alternative aetiology [17, 18].

Statistical analysis

Numerical data are expressed as means and SD. Quantitative variables were compared with the use of Kruskall-Wallis test. Statistical significance was set at $p < 0.05$.

RESULTS

Two patients died one day after TAVI: one patient died due to native aortic ring rupture and the other due to massive haemorrhage one day after the procedure. One patient was operated on due to serious gastric bleeding one day after TAVI. No other major complications were observed. Nine patients required pacemaker implantation in the peri-procedural period due to multi-level conduction disturbances. In 37 patients who survived (including the patient operated on due to gastric bleeding), no significant deterioration of the renal function was noted on day 1, 2 and 5–8 days post-procedurally (Figs. 1, 2). None of the patients required renal replacement therapy.

DISCUSSION

The TAVI procedure is a relatively new method of treatment for severe AS in patients who are not candidates for surgical valve replacement [5, 6, 13]. During the procedure, a nephrotoxic contrast agent is administered, which may cause renal function impairment and CIN development [17, 18].

To date, only a few studies referring to the impact of TAVI on renal function were published. Bagur et al. [22] demonstrated that the risk of CIN in TAVI patients was lower than in patients undergoing conventional valve replacement surgery. In the study of Bagur et al. [22] patients were older, had higher creatinine levels, lower GFR values and higher operative risk as calculated by Logistic EuroScore. Even though these patients received contrast media during TAVI, their risk of CIN was lower than in patients undergoing conventional valve replacement surgery.

In our work, we did not find significant increase of creatinine level or GFR reduction in any of the studied patients either on day 1, 2 or 5–8 days post-operatively. As many as 26 patients in the study group had stage 3, and 3 subjects had stage 4 chronic kidney disease according to the NKF DOQI classification [23], but none of these patients had end-stage renal disease or were dialysed. The amount of contrast used and peri-operative risk according to EuroScore were lower than in other studies. This, in conjunction with adequate hydration and NAC administration, could contribute to preservation of renal function in the post-operative period.

Table 1. Baseline study group characteristics

Parameters	Whole study group	Patients with stage 2 CKD (GFR 60–90 ml/min/1.73 m²)	Patients with stage 3 and 4 CKD (GFR 15–59 ml/min/1.73 m²)
Patients (n)	39	10	29
Sex (F/M)	26/13	4/6	22/7
Mean age [years]	81.43 ± 7.39 (62–90)	77.6 ± 9.01 (62–86)	82.76 ± 6.40 (62–90)
Coronary artery disease (n)	23	5	18
Hypertension (n)	30	8	22
Atrial fibrillation (n):	19	3	16
Chronic (n)/paroxysmal (n)	13/6	2/1	11/5
Mean LVEF [%]	53.11 ± 14.3 (30–79)	52 ± 14.95	53.52 ± 14.3
Type 2 diabetes (n)	10	4	6
COPD (n)	16	3	13
Platelets [K/μL]	167.64 ± 48.08 (66–302)	170.7 ± 49.59 (79–264)	166.59 ± 48.40 (66–302)
Hematocrite [%]	37.88 ± 4.85 (29–53.7)	39.22 ± 3.01 (33.6–44.6)	37.43 ± 5.40 (29–53.7)
Mean creatinine concentration [μmol/L]	104.46 ± 27.92 (49.23–173.22)	79.81 ± 16.13 (49.23–97.12)	112.96 ± 26.12 (82.32–173.22)
Mean GFR [mL/min/1.73 m²]	52.37 ± 15.04 (24–90)	73.01 ± 7.36 (63.7–90)	45.24 ± 9.18 (24–58.37)
GFR < 60 mL/min/1.73 m²	29	0	29
Acetylcysteine administration (n)	17	0	17
Mean Logistic EuroScore [%]	22.19 ± 10.05 (6.59–42.77)	19.54 ± 10.75 (6.71–38.51)	23.01 ± 9.90 (6.59–42.77)
Contrast amount [mL]	187.95 ± 91.34 (70–500)	180 ± 63.25 (100–300)	190.69 ± 100.03 (70–500)
TAVI — access:			
Femoral (n)	26	7	19
Trans-apical (n)	10	2	8
Subclavian (n)	3	1	2
Valve type:			
Edwards-Sapien (n)	19	6	13
CoreValve (n)	19	4	15
Balloon valvuloplasty (n)	1	0	1

CKD — chronic kidney disease; COPD — chronic obstructive pulmonary disease; GFR — glomerular filtration rate; LVEF — left ventricular ejection fraction

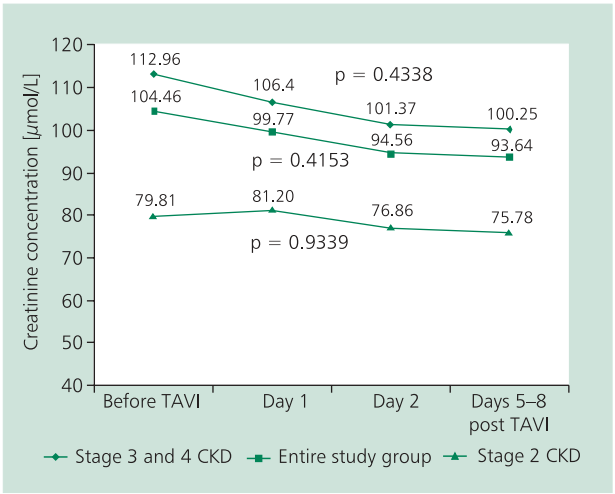

Figure 1. Mean creatinine level in the studied group; CKD — chronic kidney disease

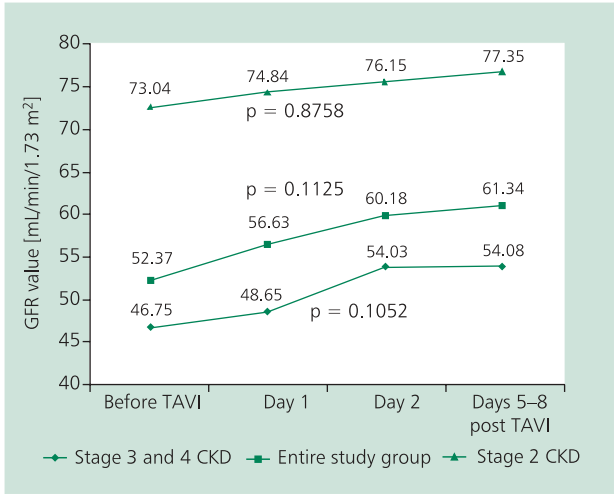

Figure 2. Mean glomerular filtration rate (GFR) in the studied group; CKD — chronic kidney disease

In a retrospective analysis by Aregger et al. [24], acute CIN was observed in 28% of TAVI patients. These patients, however, were older (by 2 years on average), had higher EuroScore peri-operative risk, their baseline creatinine and contrast amount administered were higher than in our study group.

Age is one of the risk factors of CIN development. The number of functioning glomeruli and GFR decrease with age. Sidhu et al. [25] demonstrated that elderly women are more prone to CIN development as compared to their male peers. As their body surface is smaller than in men, the number of glomeruli in women is also smaller what results in earlier and more pronounced GFR reduction [25].

Strauch et al. [26] analysed 30 patients (mean age 82 years) and EuroScore operative risk of 19% in whom TAVI was performed and found that CIN developed in as many as 57% of these patients; the highest creatinine levels were noted on day 4 post-procedurally. They did not demonstrate any relationship between contrast amount, age, co-morbid diabetes and acute kidney injury related to contrast administration. The only variable that correlated with CIN development was coronary artery disease [26]. In our group, the proportion of patients with coronary artery disease was as high as 59%, but this seems not to have any impact on CIN incidence.

CONCLUSIONS

1. The TAVI procedure which includes contrast injection, does not seem to cause a clinically significant decrease of renal function.
2. None of our elderly patients with severe aortic valve stenosis, multiple co-morbidities, and pre-TAVI renal compromise developed contrast-induced nephropathy after the procedure.

Conflict of interest: *none declared*

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Czy przezcewnikowe wszczepienie zastawki aortalnej wpływa na pogorszenie funkcji nerek?

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Streszczenie

Wstęp: Zabieg przezcewnikowego wszczepienia zastawki aortalnej (TAVI) jest od niedawna stosowany w leczeniu części chorych z istotnym hemodynamicznie zwężeniem zastawki aortalnej i z wysokim ryzykiem leczenia operacyjnego. Pacjenci kwalifikowani do TAVI to zwykle osoby starsze, przeważnie powyżej 80 rż., często z upośledzoną funkcją nerek. Jednocześnie w trakcie zabiegu TAVI podaje się środek kontrastowy o działaniu nefrotoksycznym.

Cel: Celem pracy była ocena funkcji nerek po TAVI oraz zbadanie, czy podanie kontrastu podczas tego zabiegu nie prowadzi do pogorszenia czynności nerek i rozwoju nefropatii pokontrastowej.

Metody: W okresie od stycznia 2009 do września 2010 roku w Instytucie Kardiologii w Warszawie metodą przezcewnikową wszczepiono zastawkę aortalną u 39 pacjentów (26 kobiet i 13 mężczyzn) w średnim wieku 81,43±7,39 roku. Podczas zabiegu stosowano środek kontrastowy w średniej objętości 187,95±91,34 ml o potencjalnym działaniu nefrotoksycznym. U każdego chorego oznaczano stężenie kreatyniny i wartość przesączania kłębuszkowego wg wzoru MDRD przed TAVI oraz w 1., 2. i 5.–8. dobie po zabiegu.

Wyniki: Dwie pacjentki zmarły w 1. dobie po zabiegu. U pozostałych chorych po TAVI nie obserwowano istotnego pogorszenia funkcji nerek.

Wnioski: 1. Zabieg TAVI nie pogarsza istotnie funkcji nerek. 2. W przedstawionej grupie starszych pacjentów z ciężkim zwężeniem zastawki aortalnej, licznymi chorobami współtowarzyszącymi oraz wyjściowo upośledzoną funkcją nerek podanie kontrastu podczas zabiegu TAVI nie doprowadziło do rozwoju nefropatii pokontrastowej.

Słowa kluczowe: stenoza aortalna, kontrast, niewydolność nerek, przezcewnikowe wszczepienie zastawki aortalnej

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