The efficacy of hemodialysis in interventional therapy in coronary artery disease patients with chronic renal insufficiency

Hongxia Zhai, Liang Li, Yaxin Yin, Jinjin Zhang, Haiwei Chen, Runmei Liu and Yun-feng Xia

Department of Cadres, First Hospital Affiliated to General Hospital of People’s Liberation Army, Beijing, China

ABSTRACT
The aim of this study was to explore the efficacy and safety of hemodialysis in interventional therapy for patients with coronary artery disease combined with chronic renal insufficiency. With the aging and social development, the number of coronary artery disease patients with chronic renal insufficiency gradually increased. Total 58 coronary heart disease patients with chronic renal dysfunction were selected. These patients were characterized with typical angina symptoms and typical electrocardiogram (ECG) changes of onset angina. Continuous oral administration of sodium bicarbonate tablets 1 g 3/day for 3 days and slow intravenous input sodium chloride 1000–1500 mL 3–12 h before operation were given. By this way, all patients were treated by hydration and alkalinization. After percutaneous coronary intervention (PCI) treatment, patients were immediately transferred to undergo 4 h of dialysis treatment without removing indwelling of femoral artery puncture sheath tube to protect renal function. Changes in renal function including serum creatinine, glomerular filtration rate, and urine were observed and recorded. All patients were successfully underwent PCI treatment. Within one month after PCI, there were no obvious complication and no stent thrombosis occurred. Among of 58 patients, 56 cases showed no significant increase in serum creatinine levels compared with those before operation. However, serum creatinine level of one patient increased to 251 umol/L and one patient still required permanent dialysis. Using hemodialysis in interventional therapy in coronary artery disease patients with chronic renal insufficiency could significantly improve the prognosis of the patients.

ARTICLE HISTORY
Received 28 July 2015
Revised 30 November 2015
Accepted 25 December 2015
Published online 2 February 2016

KEYWORDS
Coronary artery disease; hemodialysis; interventional therapy; PCI; renal insufficiency

Introduction
With the aging and social development, the number of coronary artery disease patients with chronic renal insufficiency gradually increased. Various reasons lead to coronary artery disease and chronic renal insufficiency, including activation of renin-angiotensin-aldosterone system (RAAS), the change of cerebral blood flow, anemia, and metabolic disorder. Percutaneous coronary intervention (PCI) is an important treatment method for coronary artery disease, which is with many advantages including small operation wound, precise clinical effect and safety.

However, a rapid deterioration of renal function is a common complication of PCI treatment, especially for patients with chronic renal insufficiency. On one hand, the incidence of contrast medium associated nephropathy (CAN) is much higher than those coronary heart disease (CHD) patients without chronic renal disease (CKD). On the other hand, the lesion of CHD patients with CKD is much more complex, the operation is more difficult, and the incidence of post-operative complications is much higher. Thereby, it is difficult for patients with CHD complicated by CKD to undergo interventional treatment for a long time. Besides, contrast medium can cause renal hemodynamic changes, which may cause renal artery vasoconstriction and renal tubular ischemic damage. In addition, CAN may be a direct toxic effect of contrast agents. The contrast medium will take longer time to be excreted in patients with renal insufficiency, and it will further damage the kidney function. Epidemiological studies have shown that, after coronary angiography, the incidence of renal insufficiency in CHD patients with the normal renal function is less than 10% while the rate of correlation contrast nephropathy in CHD patients with renal insufficiency (contrast medium associated nephropathy, CAN) can be as high as 40%. Thereby, interventional therapy seems to be a relative contraindication for those patients with coronary heart disease combined with renal dysfunction.
In order to apply the interventional treatment for CHD patients with CKD, more efficient protect method should be explored. In this study, CHD patients associated with chronic renal insufficiency adopted preoperative hydrated and alkalized method routinely and underwent 4 h of dialysis treatment to improve the post-operative renal protection, and further to explore the safety of interventional treatment.

Materials and methods

Ethics statement

All human studies have been performed in accordance with the ethical standards and approved by China Ethics Committee. The written informed consents were obtained from all patients.

Study population

From October 2011 to October 2013, a total of 58 CHD patients, including 40 male cases and 18 female cases (ages, 46 to 84 years; average age, 64 ± 11 years), with chronic renal insufficiency who were treated in the first affiliated hospital of the General hospital of People’s Liberation Army were conducted. All the selected patients were characterized with typical angina symptoms and typical electrocardiogram (ECG) changes of onset angina. The patients were excluded by the following criteria: (1) with atypical symptoms; (2) with a history of renal insufficiency (one month to 10 years) and were treated with dialysis. Among of the 58 patients, there were 30 cases of diabetic nephropathy, three cases of renal artery stenosis in unilateral renal atrophy, five cases with a history of specific chronic nephritis, 12 cases of hypertensive nephropathy, and eight patients with unknown cause. The biological indexes of these patients were that serum creatinine (128–425 μmol/L, average 232 ± 42 umol/L), isotope renography determination of glomerular filtration rate (12–51 mL/min, average 28 ± 16 mL/min), 800 ~1800 mL/24 h of urine (an average of 1046 ± 423 mL). Some patients needed to receive intravenous injection of diuretics.

Perioperative treatment

Sufficient preoperative antiplatelet therapy were processed for all patients with aspirin 100 mg/day, clopidogrel 75 mg/day and the accumulative amount not less than 450 mg. The patients received the process of alkaline hydration before operation. Continuous oral sodium bicarbonate 1 g for three times a day for 3 days were adopted, and 1000 to 1500 mL sodium chloride was given slowly through intravenous infusion during 3 to 12 h before the operation. Nonionic media Ultravist 370 (Bayer Schering Pharma AG, Berlin, Germany) were chosen as contrast agent (dose: 80 to 285 mL; average dose, 199 ± 54 mL). After operation, arterial puncture sheath tube was left behind. The patients were immediately sent to dialysis room and undertaken 4 h continuous dialysis by the insertion of temporary dialysis catheters in subclavian vain of patients. The Fresenius 4008s dialysis machine, FX100 dialyzer, and dialysate (K⁺, 2.5 mmol/L; Na⁺, 135 mmol/L; Cl⁻, 95 mmol/L; Ca²⁺, 1.5 mmol/L; HCO₃⁻, 35 mmol/L; Mg²⁺, 0.75 mmol/L) from Ziweishan Pharmaceutical Co., Ltd (Hebei, China) were used. Blood flow (260–300 mL/min) was adjusted according to the blood pressure of patients. After dialysis, artery sheath pipe for femoral artery was closed by stitching instrument, or artery sheath pipe for radial artery was pressed by compressor. Low molecular heparin (2000 IU) was used for hemodialysis process, while 100 U/kg unfractionated heparin was used during the PCI process. Low molecular heparin (in accordance with heparin 1/12 h 40 mg) was used after operation with subcutaneous injection and was applied for 7 days in a row.

Intervention treatment

Duplex digital angiographic camera (GE Company, Munich, Germany) was used in intervention treatment. The right radial artery or right femoral artery was chosen as the puncture site. After puncture success, left and right coronary angiography was processed by Judkins methods. The positive standard was that fixed coronary artery stenosis was more than 50%. When the fixed stenosis was judged more than 70%, the interventional therapy was processed. The fixed coronary artery stenoses of all patients were judged by two experienced clinicians.

CAN diagnostic criteria

24-72 h after using contrast medium, Scr levels rise 44.2 μmol/L, or the basic value rose by 25%. At the same time, heart failure, severe arrhythmia, myocardial infarction, and other affecting factors were excluded.¹⁴

Statistics analysis

Paired Student’s t-test was processed to ascertain statistical significance of data. p < 0.05 was considered statistically significant while p < 0.01 was regarded with more significant differences.
Results

Renal function changes before and after interventional therapy

As shown in Table 1, one day after treatment, serum creatinine was significantly decreased while the concentration was increased at 3 days after treatment. Other indexes of renal function including β2 microglobulin, creatinine clearance rate, hemoglobin, total plasma protein, and plasma albumin changed with no significant difference.

Patients with coronary artery intervention treatment

Imaging results showed that the coronary artery lesions in two patients were less than 50%. However, other 56 patients with more than 70% coronary artery lesions need intervention treatment. Besides, among these 56 patients, there were six cases with single lesions, 13 cases with double branch lesions, and 35 cases with three lesions. In the treatment process, 137 vessels were received balloon expansion and PCI therapy. Thereinto, 214 drug eluting stents were implanted into 128 vessels while nine coronary total obstruction vessels did not open.

Among of the 58 patients, 56 patients kept renal function without apparent deterioration and two patients occurred with CAN. The levels of serum creatinine of the 56 patients declined significantly after dialysis. In addition, their levels of serum creatinine at 3 and 7 days had no obvious change. The two patients who had occurred CAN have severe kidney dysfunction before operation. The levels of serum creatinine were more than 350 umol/L. Thereinto, preoperative serum creatinine level and total glomerular filtration rate of an elder male patient was 179 umol/L and 30.15 mL/min, respectively. The incidence of recurrent angina was frequently and the exertion tolerance of this patient was level 4. After PCI treatment, this patient obviously improved. The serum creatinine level is higher than that of preoperation, but the amount of urine is still enough. However, the other patient with urine volume decreased significantly after operation required permanent dialysis. Because of poor preoperative renal function, level of serum creatinine has reached 365 umol/L. In addition, serum creatinine clearance of this patient was only 12 mL/min. Moreover, the patients have heart failure as well. Thereby, they need to take more than 60 mg furosemide to remain at around 800 mL of urine.

Discussion

In the present study, patients with severe kidney dysfunction (average level of serum creatinine is 232 umol/L) was chosen. The level of creatinine clearance is less than 30 mL/min in some patients. Thereby, the incidence of CAN may be higher. More proactive methods were used to protect the renal function after PCI in this study. Thereinto, keeping arterial puncture sheath tube can provide dialysis access directly, reduce the risk of deep vein puncture again, and shorten the time between PCI to dialysis. This process needs the nurse to take close care of arterial sheath pipe to make sure there is no bleeding. There was no arterial puncture bleeding and the effects were satisfied.

Importantly, we kept arterial puncture sheath pipe and sent the patients to the dialysis room immediately for a 4-hour continuous dialysis. The remaining contrast medium was reduced quickly through dialysis. The more dosage of contrast agent, the elder patients, the higher level of preoperative creatinine, the weaker of the heart function, with or without diabetes are all the reasons for the increasing correlation contrast nephropathy.15 The clinical side effects incidence, such as acute myocardial infarction (AMI), length of hospital stay extension, and 1-year mortality increased significantly in those patients with CAN.16 At present, the main methods of perioperative renal protection for CHD patient with CKD were hydration and alkalization.17 The patients who developed acute renal insufficiency after operation should be given small doses of dopamine and 1000~1500 mL sodium chloride.18 The mechanism was that hydration could dilute contrast agent and promote eliminate from kidney.19 In addition, alkalization treatment could reduce the creatinine rise of patients with chronic renal insufficiency, and further protect renal injury induced by

| Table 1. Renal function changes before and after interventional therapy. |
|----------------|----------------|----------------|----------------|
|                | Before          | 1 day after treatment | 3 days after treatment | 7 days after treatment |
| Serum creatinine (umol/L) | 232 ± 42 | 126 ± 23* | 192 ± 39 | 229 ± 51 |
| β2 microglobulin (mg/L)    | 4.5 ± 0.4 | 4.5 ± 0.5 | 4.5 ± 0.6 | 4.6 ± 0.5 |
| Creatinine clearance rate (mL/min) | 28 ± 16 | Not done | Not done | 31 ± 1.8 |
| Hemoglobin (g/L)           | 97 ± 16 | 96 ± 14 | 96 ± 17 | 96 ± 17 |
| Total plasmaprotein (g/L)  | 63 ± 11 | 64 ± 14 | 65 ± 13 | 63 ± 12 |
| Plasma-albumin (g/L)       | 33 ± 9 | 32 ± 9 | 34 ± 9 | 35 ± 8 |

Note: *p<0.01.
contrast media. In this study, all patients were hydrated and alkalized by given continuous oral administration of sodium bicarbonate tablets 1 g for 3/day × 3 days and slow intravenous input sodium chloride 1000–1500 mL at 3–12 h before operation. In addition, the patients were encouraged to drink more water. Intravenous aminophylline, papaverine, and 60–100 mg furosemide daily were given. These methods could effectively reduce the occurrence of correlation contrast nephropathy but still with a high incidence. In this study, we adopted fully preoperative antiplatelet, immediately dialysis after operation, and sufficient anticoagulation which ensured the success of the operation. There were no obvious postoperative complications. Only 3% patients have occurred with CAN and others kept renal function without apparent deterioration. So it can provide clinical experience for future intervention treatment. Besides, the key steps including strict observation, accurate records of urine, monitoring of blood glucose, dietary guidance, and mental nursing were essential.

Study limitations

The object of this study was patients with typical angina symptoms. In addition, the patients who had been adopted for dialysis were excluded. The exclusion criteria may induce a potential selection bias. Because of the small study patients, for patients with long-time dialysis, the interventional therapy for CHD patient with CKD still exist significant risks. Further research with more study patients still is needed to verify the results of this study.

Conclusion

For the patient whose coronary artery is suitable for interventional treatment, the key to success is that we should guarantee the stability of the patient’s condition during the perioperative period. Using hemodialysis in interventional therapy in coronary artery disease patients with chronic renal insufficiency could significantly improve the prognosis of the patients.

Disclosure statement

All authors declare that they have no conflict of interests to state.

References

1. Lamprea-Montealegre JA, Astor BC, McClelland R, et al. LDL Phenotype-B is strongly associated with CHD risk among individuals with CKD. The Multi-ethnic Study of Atherosclerosis (MESA). Circulation. 2013;128:A9258.

2. Damman K, Lambers-Heerspink HJ, Are renin-angiotensin–aldosterone system inhibitors lifesaving in chronic kidney disease? J Am Coll Cardiol. 2014;63:659–660.

3. Selnes OA, Gottesman RF, Grega MA, Baumgartner WA, Zeger SL, McKhann GM. Cognitive and neurologic outcomes after coronary-artery bypass surgery. N Engl J Med. 2012;366:250–257.

4. Chung CP, Oser A, Solus JF, et al. Prevalence of the metabolic syndrome is increased in rheumatoid arthritis and is associated with coronary atherosclerosis. Atherosclerosis. 2008;196:756–763.

5. Montalescote G, Sechtem U, Achenbach S, et al. Corrigendum to:’2013 ESC guidelines on the management of stable coronary artery disease’. Eur Heart J. 2014;35:2260–2261.

6. De Bruyne B, Fearon WF, Pijls NH, et al. Fractional flow reserve–guided PCI for stable coronary artery disease. N Engl J Med. 2014;371:1208–1217.

7. Malyszko J, Bachorzewska-Gajewska H, Poniatowski B, Malyszko JS, Dobrzynki S. Urinary and serum biomarkers after cardiac catheterization in diabetic patients with stable angina and without severe chronic kidney disease. Ren Fail. 2009;31:910–919.

8. Hoeger TJ, Wittenborn JS, Segel JE, et al. A health policy model of CKD: 1. Model construction, assumptions, and validation of health consequences. Am J Kidney Dis. 2010;55:452–462.

9. Newhouse JH, Kho D, Rao QA, Starren J. Frequency of serum creatinine changes in the absence of iodinated contrast material: Implications for studies of contrast nephropathy. AJR Am J Roentgenol. 2008;191:376–382.

10. Ten Dam M, Wetzels J. Toxicity of contrast media: An update. Neth J Med. 2008;66:416–422.

11. Seeliger E, Sendeski M, Rihal CS, Persson PB. Contrast-induced kidney injury: Mechanisms, risk factors, and prevention. Eur Heart J. 2012;33:2007–2015.

12. Bashore TM, Bates ER, Berger PB, et al. American College of Cardiology/Society for Cardiac Angiography and Interventions Clinical Expert Consensus Document on cardiac catheterization laboratory standards. A report of the American College of Cardiology Task Force on Clinical Expert Consensus Documents. J Am Coll Cardiol. 2001;37:2170–2214.

13. Liistro F, Falsini G, Bolognese L. The clinical burden of contrast media-induced nephropathy. Ital Heart J. 2003;4:668–676.

14. Rihal CS, Textor SC, Grill DE, et al. Incidence and prognostic importance of acute renal failure after percutaneous coronary intervention. Circulation. 2002;105:2259–2264.

15. Nikolsky E, Aymong ED, Dangas G, Mehran R. Radiocontrast nephropathy: Identifying the high-risk patient and the implications of exacerbating renal function. Rev Cardiovasc Med. 2002;4:57–514.

16. Marenzi G, Lauri G, Assanelli E, et al. Contrast-induced nephropathy in patients undergoing primary angioplasty for acute myocardial infarction. J Am Coll Cardiol. 2004;44:1780–1785.

17. Baek SD, Jang S-J, Park S-E, et al. Fatal rhabdomyolysis in a patient with liver cirrhosis after switching from simvastatin to fluvasatin. J Korean Med Sci. 2011;26:1634–1637.
18. Desir GV. Role of renalase in the regulation of blood pressure and the renal dopamine system. *Curr Opin Nephrol Hypertens.* 2011;20:31–36.

19. Maioli M, Toso A, Leoncini M, Micheletti C, Bellandi F. Effects of hydration in contrast-induced acute kidney injury after primary angioplasty: A randomized, controlled trial. *Circ Cardiovasc Interv.* 2011;4:456–462.

20. Haase M, Haase-Fielitz A, Bellomo R, et al. Sodium bicarbonate to prevent increases in serum creatinine after cardiac surgery: A pilot double-blind, randomized controlled trial. *Crit Care Med.* 2009;37:39–47.

21. Sandbaek A, Griffin SJ, Rutten G, et al. Stepwise screening for diabetes identifies people with high but modifiable coronary heart disease risk: The ADDITION study. *Diabetologia.* 2008;51:1127–1134.