ORIGINAL RESEARCH

E/e' Ratio and Diastolic Function Between Deep Vein Catheterization and Internal Fistula Treatment in Patients with Chronic Kidney Disease

Qiaoqiao Guo, BM; Liyan Hu, BM; Xiaoyang Qi, BM; Lifang Ge, BM; Anli Zhao, BM; Chaoxiang Ren, BM

ABSTRACT

Objective • To examine the relationship between diastolic function and the ratio of early diastolic mitral inflow to early diastolic mitral annular velocity (E/e') in patients with chronic renal disease who had deep vein catheterization and internal fistula.

Methods • The clinical data of 50 uremia patients treated at The Affiliated Dongyang Hospital of Wenzhou Medical University from January 2020 to January 2022 were retrospectively analyzed. To assess the differences in E/e' ratio and patients' diastolic function between the two groups, they were split into two teams according to the various therapy modalities: the internal fistula team (n = 42) and the deep vein catheterization team (n = 8).

Results • After treatment, the left ventricular end-diastolic diameter (LVd), E peak, a peak and E/A value, the volume and area of four chambers of the left ventricle (LV), the volume and area of two chambers of LV in both groups were significantly lower than those before treatment ($P < .001$). After treatment, the LVd left ventricular end-systolic diameter (LVs), the four-chamber volume of LV, and the two-chamber volume and area of LV in patients with internal fistula were significantly lower than those in patients with deep vein catheterization ($P < .001$). After treatment, E peak, A peak and E/A value, e' interventricular septum, E/e' value of interventricular septum, e' lateral wall, and E of lateral wall in patients with internal fistula group.

Conclusion • Both deep vein catheterization and internal fistula treatment can improve the diastolic function and reduce the pulmonary pressure of uremic patients to a certain extent, but internal fistula treatment is better than deep vein catheterization in reducing LVd, LVs, LV four-chamber volume, LV two-chamber volume and area, and the effects of both in improving the E/e ratio of patients are not obvious. (*Altern Ther Health Med.* [E-pub ahead of print.])

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Chronic kidney disease (CKD) is a disorder of kidney structure and function caused by a variety of factors, which can lead to decreased glomerular filtration rate, in recent years, it has been reported that the incidence and mortality of chronic kidney disease are increasing year by year, and cardiovascular disease is the common complication and cause of death.[4-5] The last stage of chronic renal disease is uremia. These patients' heart structures have changed, showing signs like myocardial fibrosis and hypertrophy. The most frequent cardiac alteration in patients with end-stage renal illness is left ventricular hypertrophy. This is due to the patients' overloaded volume, increased ventricular wall pressure, decreased hemoglobin, and release of various abnormal factors that can cause left ventricular hypertrophy.[6-8] Research has shown that left ventricular pathological hypertrophy is usually associated with increased left ventricular stiffness and diastolic dysfunction.[9] Cardiac catheter manometry is the gold standard for detecting left ventricular diastolic function. However, this method is invasive, which makes it difficult to popularize in clinic.[10] While non-invasive detection of diastolic function requires a comprehensive analysis of multiple indicators, especially in patients with normal ejection fraction and impaired diastolic function, this is easy to be ignored.[11] The left ventricular diastolic function of uremic patients tends to decline before the systolic function is damaged, so early and accurate evaluation of diastolic function is of vital guiding significance for clinical diagnosis and treatment and prognosis improvement of such patients.[12-14] To assess left ventricular filling pressure, one can use the ratio of early diastolic mitral inflow velocity to early diastolic mitral annulus velocity (E/e'), which has become an important marker for the diagnosis of diastolic heart failure.[15] At present, the clinical treatment of uremic patients is mainly through hemodialysis. The dialysis access is an arteriovenous fistula or deep venous catheterization, which significantly removes toxins in uremic patients maintains the balance of electrolyte, water, and acid-base, and plays a vital role in improving the clinical symptoms of patients.[16-17] There is a lack of information regarding the difference in E/e' ratio and diastolic function among uremic patients who have undergone deep venous catheterization and internal fistula treatment. This study aims to analyze these differences to suggest ways to enhance the prognosis and quality of life of uremic patients.

DATA AND METHODS

General information

A retrospective analysis was done on the clinical information of 50 uremic patients who were treated at our hospital between January 2020 and January 2022. Criteria of inclusion: (1) The Kidney Diseases Professional Committee of the Chinese Society of Integrated Traditional and Western Medicine published Guidelines for the Diagnosis and Treatment of Chronic Renal Failure by Integrated Traditional Chinese and Western Medicine, which all patients met the diagnostic criteria for uremia[17] ; (2) The patients with stable condition and at least 6 months of the hemodialysis time; (3) patients with complete clinical data; (4) patients or family members agreed to participate in the study and signed the informed consent form. Exclusion criteria: (1) Those with malignant tumors and infectious diseases; (2) Those who did not meet the indications for maintenance hemodialysis; (3) Those who were lost to follow-up; (4) Those who have a language barrier, vision barrier and hearing barrier and others that affect communication. The ethics approval number 2022-YX-304 was granted by the hospital ethics committee. 50 patients with uremia were divided into two teams: those receiving deep vein catheterization (n = 8), and those receiving internal fistula (n = 42). There were 19 men and 23 women in the internal fistula team, with an average age of (60.20 ±13.50) years and an average height of (162.00 ±8.34) cm. According to whether there was a history of drinking alcohol, there were 8 cases with a positive drinking alcohol history and 34 cases with a negative drinking alcohol history. According to whether there was a history of smoking, there were 12 cases with a smoking history and 30 cases with no smoking history, and the average blood flow velocity was (263.00 ±20.60) cm/s. The average single compartment urea clearance index (KT/V) was 1.45±0.28, and the average urea decline rate (URR) was 69.39±7.10%. According to the presence or absence of coronary heart disease, there were 17 cases with and 25 cases without. According to the presence or absence of diabetes, there were 16 cases with and 26 cases without. There were 4 men and 4 women in the deep vein catheterization team, with an average age of (64.80±10.08) years and an average height of (162.00±8.01) cm. According to whether there was a history of drinking alcohol, there were 2 cases with and 6 cases without. According to whether there was a history of smoking, there were 2 cases with and 6 cases without. The average blood flow velocity was (264.00±17.40) cm/s, the average single-chamber urea clearance index (KT/V) was 1.40±0.25, and the average urea reduction rate (URR) was (68.35±6.50)%. According to the presence or absence of coronary heart disease, there were 4 cases with coronary heart disease and 4 cases with no coronary heart disease According to the presence or absence of diabetes, there were 4 cases with diabetes and 4 cases without diabetes. There was no statistically significant variation in the general data of uremic patients between the two teams ($P > .05$). See Table 1.

Table 1. Comparison of client general information between the two teams n (%) ($\bar{x} \pm s$)

grouping	Internal fistula group (n = 42)	Deep vein catheterization group (n = 8)	χ^2/t	*P* value
Gender			0.061	.804
Male	19	4		
Female	23	4		
Age	60.20±13.50	64.80±10.08	2.047	.075
Height (cm)	162.00±8.34	162.00±8.01	0.727	.471
History of drinking			0.149	.670
with	8	2		
without	34	6		
History of smoking			0.043	.837
with	12	2		
without	30	6		
Blood flow velocity (cm/s)	263.00±20.60	264.00±17.40	1.287	.205
KT/V	1.45±0.28	1.40±0.25	1.719	.092
URR (%)	69.39±7.10	68.35±6.50	1.995	.052
Coronary heart disease			0.250	.617
with	17	4		
without	25	4		
Diabetes			0.334	.563
with	16	4		
without	26	4		

Abbreviations: KT/V: average single-chamber urea clearance index; URR, average urea decline rate.

Methods

Both groups were treated with hemodialysis, in which the internal fistula group was treated with arteriovenous fistula plasty of the left upper limb, and the deep vein catheterization group was treated with deep subclavian vein catheterization. Patients in the two groups were examined by thoracic echocardiography before and after hemodialysis treatment.

Observation indicators

(1) The end-diastolic ventricular septal thickness (IVSd), left ventricular end-diastolic diameter (LVd), left ventricular end-systolic diameter (LVs), and left ventricular posterior wall thickness (LVPWd) of patients were compared between the two groups. (2) Patients in the two teams' E peak, A peak, and E/A values were contrasted. (3) Patients in the two teams' e' ventricular septum and E/ e' values, as well as e' lateral wall and E/e values, were contrasted. (4) The left ventricular (LV) four-chamber volume, LA four-chamber area, LA two-chamber volume, and LA two-chamber area of patients were compared between the two groups. (5) The tricuspid insufficiency (TR) and pulmonary pressure of patients were compared between the two groups.

Statistical methods

The study data were analyzed and processed by SPSS version 21.0 software package. The measurement data such as IVSd, LVd, LVs, and LVPWd of patients in the two groups that were consistent with the normal distribution and square difference were expressed by ($\bar{x} \pm s$). The comparison between the two groups used the independent sample *t* test, $P < .05$ was regarded as the difference was statistically significant.

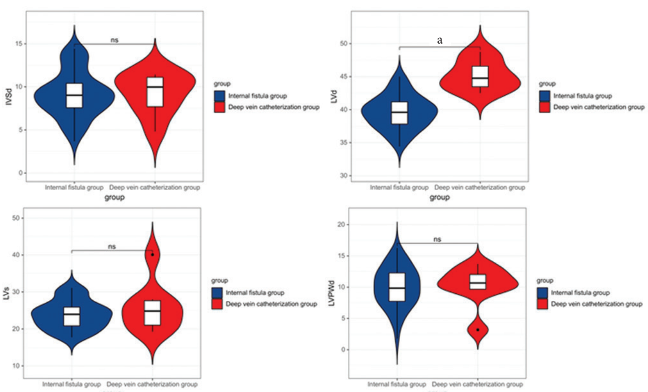
Table 2. Contrast of the two teams' IVSd, LVd, LVs, and LVPWd ($\bar{x} \pm s$)

grouping	time	IVSd (mm)	LVd	LVs	LVPWd
Internal fistula group (n = 42)	Before treatment	9.45±2.77	49.71±7.15	25.00±11.62	9.86±2.56
	After treatment	9.13±2.65	39.60±2.51[a,b]	23.80±3.77[b]	10.01±3.22
Deep vein catheterization group (n = 8)	Before treatment	9.33±2.69	50.57±7.98	24.75±12.79	9.88±2.68
	After treatment	9.25±2.35	45.20±2.26[*]	25.75±6.66	10.25±3.19

[a]shows that in comparison to before therapy, $P < .05$
[b]shows that following therapy, when contrasted to the deep vein catheterization team, $P < .05$.

Abbreviations: IVSd, end-diastolic ventricular septal thickness; LVd, left ventricular end-diastolic diameter; LVs, left ventricular end-systolic diameter; LVPWd: thickness of left ventricular posterior wall.

Figure 1. Contrast of the two teams' IVSd, LVd, LVs, and LVPWd A. Contrast of the two teams' IVSd; B. Comparison of LVd between the two groups; C. Comparison of LVs between the two groups; D. Comparison of LVPWd between the two teams.



[a]indicates that compared with the deep vein catheterization group, $P < .05$

Abbreviations: IVSd, end-diastolic ventricular septal thickness; LVd, left ventricular end-diastolic diameter; LVs, left ventricular end-systolic diameter; LVPWd, the thickness of the left ventricular posterior wall.

RESULTS

Comparison of IVSd, LVd, LVs, and LVPWd between the two groups

After treatment, patients' LVd in both groups was significantly lower than that prior to therapy ($P < .001$); and following therapy, the internal fistula team's LVd was substantially lower than those of the deep vein catheterization team ($P < .001$). See Table 2, Figure 1.

E peak, A peak, and E/A value contrast between the two teams

Patients in the two teams had considerably lower post-treatment E peak, A peak, and E/A values than they had pre-treatment ($P < .001$); after therapy, there was no statistically significant change in the patients' E peak, A peak, and E/A values between the internal fistula team and the deep vein catheterization team ($P = .878, .605, .223$). See Table 3, Figure 2.

Table 3. E peak, A peak, and E/A value contrast between the two groups ($\bar{x} \pm s$)

grouping	time	E peak (m/s)	A peak (m/s)	E/A value
Internal fistula group (n = 42)	Before treatment	0.79±0.26	1.08±0.09	0.75±0.08
	After treatment	0.62±0.10[a]	0.94±0.10[a]	0.67±0.08[a]
Deep vein catheterization group (n = 8)	Before treatment	0.81±0.27	1.03±0.16	0.72±0.12
	After treatment	0.61±0.10[a]	0.92±0.13[a]	0.68±0.12[a]

[a]shows that in comparison to before therapy, $P < .05$

Figure 2. E peak, A peak, and E/A value contrast between the two teams. A. Comparison of E peaks between the two groups; B. Comparison of A peaks between the two groups; C. Comparison of E/A values between two groups

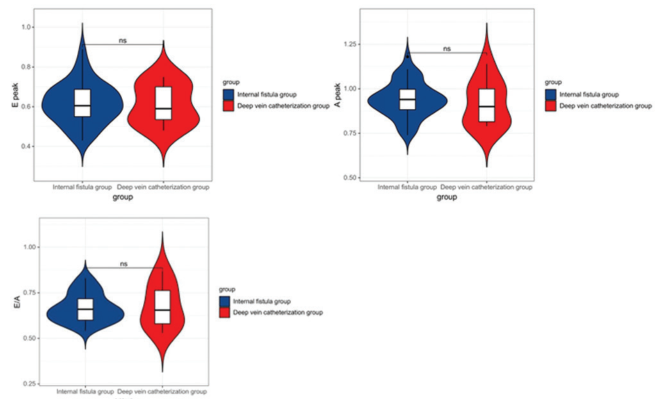
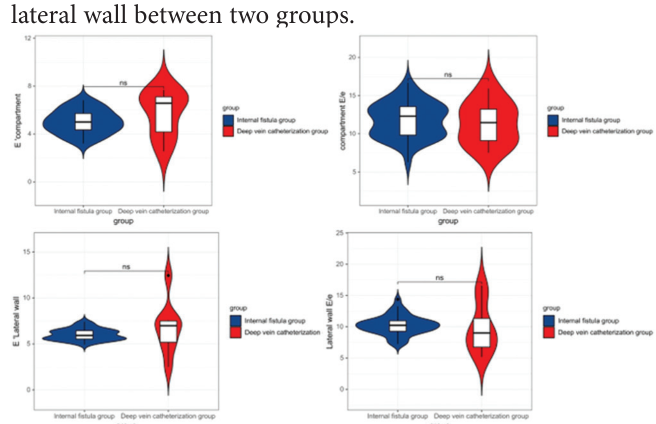


Table 4. Contrast of the two teams' e' ventricular septum and E/e values, as well as e' lateral walls and E/e values ($\bar{x} \pm s$)

grouping	time	E 'compartment	E/e' value	E 'outer wall	E/e' value
Internal fistula group (n = 42)	Before treatment	5.64±0.88	12.18±2.02	7.02±1.88	10.59±1.62
	After treatment	5.02±0.99	11.80±2.30	6.02±0.62	10.25±1.53
Deep vein catheterization group (n = 8)	Before treatment	5.77±0.10	12.10±2.05	6.99±1.95	10.48±1.76
	After treatment	5.73±1.88	11.38±2.84	6.73±2.90	9.78±4.03

Abbreviations: E/e', Early Diastolic Mitral Inflow Velocity and Early Diastolic Mitral Annular Velocity.

Figure 3. Comparison of e 'ventricular septum and E/e value, e' lateral wall and E/e value between the two groups. A. Comparison of e 'ventricular septum between the two groups; B. Comparison of E/e values of ventricular septum between the two groups; C. Comparison of e 'lateral wall between the two groups; D. Comparison of E/e values of lateral wall between two groups.



Abbreviations: E/e', Early Diastolic Mitral Inflow Velocity and Early Diastolic Mitral Annular Velocity.

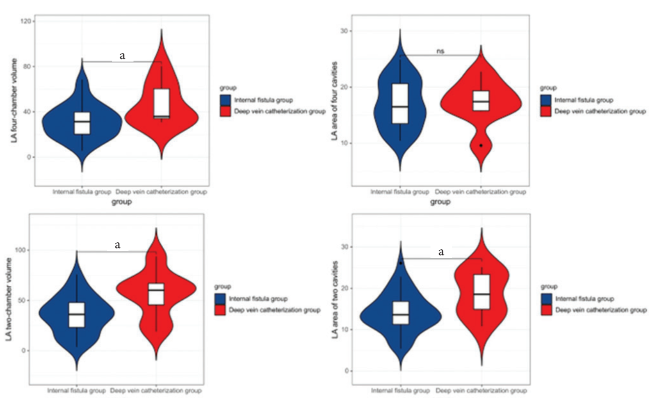
Table 5. Volume and area of LV four chambers and LV two chambers in two groups ($\bar{x} \pm s$)

grouping	time	LA four-chamber volume	LA four-chamber area	LA two-chamber volume	LA area of two chambers
Internal fistula group (n = 42)	Before treatment	60.32±25.53	19.22±4.43	63.98±20.13	19.52±5.00
	After treatment	31.62±14.63[a,b]	16.98±4.23[a]	35.67±18.50[a,b]	14.15±4.68[a,b]
Deep vein catheterization group (n = 8)	Before treatment	60.29±25.64	19.87±4.60	64.83±19.68	19.68±4.83
	After treatment	46.60±18.35[a]	17.27±3.92[a]	56.10±23.37[a]	18.70±5.32

[a]shows that in comparison to before therapy, $P < .05$
[b]shows that following therapy, when contrasted to the deep vein catheterization team, $P < .05$

Abbreviations: LV, left ventricle.

Figure 4. Contrast of the volume and area of LA four chambers and LA two chambers in two groups. A. Comparison of the volumes of LV four chambers in two groups; B. Comparison of the four-chamber areas of LV between the two groups; C. Comparison of the volumes of the two chambers of LV in the two groups; D. Comparison of two chamber areas of LV in two groups.



[a]shows that following therapy, contrasted to the controlling team, $P < .05$

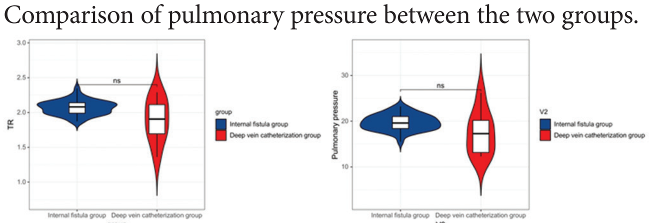
Abbreviations: LV, left ventricle.

Table 6. Comparing the two teams' pulmonary pressures and TR ($\bar{x} \pm s$)

grouping	time	TR	Pulmonary pressure (mmHg)
Internal fistula group (n = 42)	Before treatment	1.90±0.52	26.10±9.36
	After treatment	2.07±0.10	19.75±1.71
Deep vein catheterization group (n = 8)	Before treatment	1.88±0.53	26.87±9.20
	After treatment	1.89±0.31	17.50±4.80

Abbreviations: TR,tricuspid incompetence.

Figure 5. Contrast of TR and pulmonary pressure between the two groups. A. TR comparison between the two groups; B. Comparison of pulmonary pressure between the two groups.



Abbreviations: TR,tricuspid incompetence.

Comparison of e 'ventricular septum and E/e value, e' lateral wall and E/e value between the two groups

After treatment, the difference in e 'interventricular septum, E/e value of interventricular septum, e' lateral wall, and E/e' value of lateral wall of patients between the internal fistula group and the controlling team was not statistically significant (P = .328, .652, .511, .752). See Table 4, Figure 3.

Comparison of volume and area of LA four chambers and LA two chambers in two groups

Both teams' volume of two chambers of LV, area of four chambers of LV, and volume of four chambers of LV were substantially lower after therapy than they were before; and in the internal fistula team, the area of LV two chambers was dramatically reduced after therapy compared to before therapy ($P < .001$). After therapy, the internal fistula team's volume of LV-4 chambers, as well as their volume and area of LV-2 chambers, were substantially lower than those of the deep vein catheterization team ($P < .001$). See Table 5 and Figure 4.

Contrast of TR and pulmonary pressure between the two groups

After treatment, the difference in TR and pulmonary pressure of patients between the internal fistula group and the deep vein catheterization group was not statistically significant (P = .147, .229). See Table 6, Figure 5.

DISCUSSION

The progression of CKD to uremia can lead to the accumulation of a large amount of metabolic wastes and toxins in the body, causing adverse effects and damage to the kidney and other organs.[18-19] According to research, coronary heart disease and chronic kidney disease can both significantly increase the chance of dying from cardiovascular causes in persons with the condition.[20] Several times as likely as healthy persons to die from cardiovascular disease are those with chronic renal disease, according to data from various surveys, and heart failure has become a common cardiovascular complication of patients with chronic kidney disease, which is due to the irreversibility of changes in cardiac structure and function of patients with chronic kidney disease.[21-22]

Currently, the primary clinical treatment for patients is hemodialysis. This procedure involves redirecting the blood flow in the body to a dialyzer, which is made up of several hollow fibers outside the body. The dialyzer facilitates the exchange of substances through convection or diffusion, leading to an improvement in glomerular filtration function. Additionally, it helps maintain the electrolyte and acid-base balance, prolongs the survival time of patients, and plays a critical role in controlling the patient's condition.[23-25] The occurrence and severity of chronic kidney disease are closely related to the progress of left ventricular diastolic dysfunction, which has been widely found in patients with chronic kidney disease, and the risk of cardiovascular disease has also increased significantly with the decline of renal function.[26-27] In recent years, people often used E/e' ratio to diagnose left ventricular diastolic function, especially left ventricular diastolic function, which can reflect the changes in the long axis orientation of left ventricular myocardial fibers. It has also been used by certain researchers to assess the right ventricular diastolic function.[28-29] Study has shown that the E/e' ratio in uremic patients is significantly increased, and the degree of increase is closely related to the weakening of left ventricular diastolic function.[30] Arteriovenous internal fistula and deep venous catheterization are the pathways for hemodialysis treatment. At present, there are relatively few reports on the relationship between the two dialysis pathways and the diastolic function and E/e' ratio of patients with chronic kidney disease. Therefore, this survey's goal was to examine them to generate fresh suggestions for enhancing uremic patients' prognosis and quality of life. According to the varied hemodialysis access methods used in this research, uremic patients were split into the internal fistula team and deep vein catheterization team. LVd, E peak, A peak, E/A value, LV four-chamber volume and area, and LV two-chamber volume of patients in the two teams were considerably lower after therapy than they were before therapy, according to the data ($P < .05$); and successfully treated, patients in the internal fistula team's LVd, LVs, LV four-chamber volume, LA two-chamber volume, and area were considerably smaller than those in the deep vein catheterization team ($P < .05$). However, there was no statistically significant disparity in the E/e' ratio of patients between the internal fistula team and the deep vein catheterization team ($P > .05$), showing that both methods have certain effects on improving the diastolic function of uremic patients, and treatment of internal fistula is better than that of deep venous catheterization.

To sum up, both deep vein catheterization and internal fistula treatment can improve the diastolic function of uremic patients and reduce the pulmonary pressure of patients to a certain extent, but internal fistula treatment is better than deep vein catheterization in reducing LVd, LVs, LV four-chamber volume, LV two-chamber volume and area, and the effects of the two methods in improving the E/e' ratio of patients are not obvious. However, this study has certain limitations. The sample size included is relatively small, and the statistical results may have some deviation. Therefore, the sample size will be expanded for further verification in future research.

DATA AVAILABILITY

The experimental data used to support the findings of this study are available from the corresponding author upon request.

CONFLICTS OF INTEREST

The authors declared that they have no conflicts of interest regarding this work.

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