Journal of
Cardio - Thoracic Medicine

http://jctm.mums.ac.ir

The Association between B-type Natriuretic Peptide Family and Successful Percutaneous Transvenous Mitral Commissurotomy: A Systematic Review

Fereshteh Ghaderi[1], Hadi Tohidi[1]*, Amir Hossein Rafighdoost[1]

[1]*Cardiologist, Preventive Cardiovascular Care Research center, Department of Cardiology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*

ARTICLE INFO

Article type:
Systematic review

Article history:
Received: 25 Apr 2015
Revised: 8 May 2015
Accepted: 7 Jul 2015

Keywords:
B-type Natriuretic Peptide
Mitral Stenosis
Percutaneous Balloon Mitral Valvotomy
Percutaneous Transvenous Mitral Commissurotomy

ABSTRACT

B-type natriuretic peptide (BNP) level is known to increase in patients with rheumatic mitral stenosis. In this systematic review, we aimed to discuss the possible association between plasma BNP level and the success rate of percutaneous transvenous mitral commissurotomy. PubMed and Scopus databases were searched systematically, using the following key terms: "B-type natriuretic peptide" OR "BNP" AND "percutaneous transvenous mitral commissurotomy" OR "percutaneous transluminal mitral commissurotomy" OR "PTMC" OR "percutaneous balloon mitral valvotomy" OR "PBMV". The title, keywords and abstract of relevant articles were searched thoroughly. Among 27 articles found in these databases, 18 studies were excluded during different stages of article selection, based on the inclusion and exclusion criteria. A total of 333 patients were evaluated in the selected studies. Overall, 75 and 191 cases were male and female, respectively. Sex ratio was not specified in two studies, evaluating a total of 67 patients. The obtained results showed that BNP level may decrease after a successful PTMC. Furthermore, post-operative plasma levels of BNP and N-terminal proBNP could be considered as predictors of the success rate of PTMC. Based on the results reported in the evaluated articles, there may be an association between post-operative plasma levels of BNP family and the success rate of PTMC.

►*Please cite this paper as:*
Ghaderi F, Tohidi H, Rafighdoost AH. The Diagnostic Value of End-tidal Carbon Dioxide (EtCO2) and Alveolar Dead Space (AVDS) in Patients with Suspected Pulmonary Thrombo-embolism (PTE). J Cardiothorac Med. 2015; 3(3):319-323.

Introduction

Rheumatic mitral stenosis (MS) is a consequence of acute rheumatic fever occurring during childhood and adolescence, in which the inflammatory process gradually leads to valve damage, fibrosis and finally stenosis (1, 2). MS is associated with elevated left atrial (LA) pressure, as well as increased pulmonary artery pressure (PAP) (3). Echocardiography is regarded as a useful and valuable method for the diagnosis and determination of MS severity and progression and eventually, selection of an appropriate treatment modality.

Natriuretic peptides are a family of structurally related hormones/paracrine factors. (4). Atrial natriuretic peptide and B-type natriuretic peptide (BNP) are secreted from the atria and ventricles of the heart in response to increased wall stress. The level of these hormones is expected to increase in patients with MS due to high LA pressure and PAP. BNP plays a promising role in the diagnosis of cardiac pathologies (4, 5). Moreover, a close association has been recently suggested between the precursor of plasma BNP (proBNP) and the severity of MS (6-8).

Percutaneous transvenous mitral commissurotomy (PTMC) was first introduced by Inoue in 1984 (9,10). Since then, this procedure has been

**Corresponding author:* Hadi Tohidi, Preventive Cardiovascular Care Research center, Department of Cardiology, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. Tel: +9851 38544504, Fax: +9851 38425878; E-mail: hadi_t81@yahoo.com

extensively applied as the treatment of choice for severe MS with a favorable valve anatomy. This procedure is also called "percutaneous transluminal mitral commissurotomy" or "percutaneous balloon mitral valvotomy", abbreviated as "PBMV".

PTMC is regarded as an alternative to open-heart surgery in selected MS patients (9, 10). Reduced length of hospital stay, lower costs, safety and increased patient comfort are the most significant advantages of PTMC, compared to other surgical procedures (11). This procedure can be also effectively applied in patients with severe subvalvular fibrosis (12). Evidence suggests that PTMC is a safe, effective procedure in both children younger than 10 years of age and the elderly (9, 13, 14).

Patients with severe rheumatic MS, whose mitral valve area is less than 1.5 cm^2, are potential candidates for PTMC. The success rate of PTMC is mostly determined, based on echocardiographic criteria. Findings show that age, LA size and mitral valve thickness may be also predictors of PTMC success rate (15).

Some studies have demonstrated the difference in BNP level before and after PTMC due to a significant decrease in LA pressure and PAP (16, 17). Considering the importance of MS, we aimed to systematically review studies, focusing on the diagnostic value of BNP and NT-pro-BNP as a non-invasive indicator of PTMC success.

The results of the present study could determine whether BNP level can be regarded as a valuable indicator of PTMC success in patients without high-quality echocardiographic images or those presenting with different symptoms (despite a successful PTMC), especially when there is no agreement between the symptoms and echocardiographic images. Therefore, we aimed to conduct a brief literature review to assess the correlation between BNP level and the success rate of PTMC.

Materials and Methods

Search methods

PubMed and Scopus databases were searched systematically in order to detect relevant articles. The title, keywords and abstract of the articles were searched to find articles, evaluating the relationship between BNP level and PTMC.

For this purpose, we used the following search strategy in PubMed database: "percutaneous transvenous mitral commissurotomy" OR "percutaneous transluminal mitral commissurotomy" OR "PTMC" OR "percutaneous balloon mitral valvotomy" OR "PBMV" AND "B-type natriuretic peptide" OR "BNP".

Similarly, in order to find relevant articles in Scopus database, first, we searched for the following terms: "percutaneous transvenous" OR "transluminal mitral commissurotomy" OR "PTMC" OR "percutaneous balloon mitral valvotomy" OR "PBMV". Then, we searched the articles looking for the following terms: "B-type natriuretic peptide" OR "BNP". Subsequently, we limited our search to English articles.

Afterwards, the results were restricted to only original articles. Database search was completed on May 10, 2015. To minimize the possibility of missing data, after a thorough search in the databases, we manually searched Google Scholar, as well as the reference lists of the articles to include other potentially relevant publications.

Study selection and inclusion/exclusion criteria

For selecting the articles, no time limitation was defined. However, in order to avoid possible errors or misinterpretations in further processes of data extraction, we only included English articles. The selected articles included case-control studies, cross-sectional studies, case reports and prospective, cohort articles.

Conference papers, abstracts, review articles and meta-analyses were excluded from our assessment. Moreover, duplicated publications and articles with irrelevant subjects (or language) were excluded in the first step of article selection by reviewing their titles, keywords and abstracts. In case of the unavailability of full-text articles, we contacted the corresponding authors and requested for the manuscripts. The studies were excluded in case we were unable to obtain the manuscripts.

Similarly, we excluded articles conducted on animals. Also, articles evaluating the association between PTMC and atrial natriuretic peptide, as another peptide biomarker of cardiac function, were excluded. Therefore, in this literature review, all articles, which evaluated plasma BNP level in MS patients undergoing PTMC or PBMV, were included.

Data extraction

All available information in the articles including the name of the first author, publication date, country of origin, type of study, sample size and assessment methods were extracted and categorized. Other accessible data including follow-up duration, demographic data of the study population and main findings of the study were collected thoroughly, considering the main purpose of the present study.

Regardless of the final conclusions, data were extracted and documented, based on the positive or negative association between PTMC and BNP

level. For this purpose, BNP levels before and after PTMC and their clinical significance were extracted and compared with the normal values reported in the same articles. Since BNP was not the main measured variable in some studies, all BNP types including BNP and NT-proBNP were evaluated in this literature review; the results were reported independently for each marker.

Data extraction, article selection and all processes of data collection were performed by two independent reviewers, following the standard protocol according to the guidelines in PRISMA 2009 checklist (18). Furthermore, any possible disagreement between the reviewers was resolved prior to any further evaluations.

Results

Study search results

Overall, 9 and 12 relevant articles were found in PubMed and Scopus databases, respectively. In the first step, eight irrelevant articles were excluded by reviewing the abstracts; also, three other articles were excluded due to language inconsistency. After excluding duplicated articles in several steps of article selection, only seven studies, which met the defined inclusion criteria, were evaluated for data extraction, considering the main purpose of this study.

By a manual search through the references of included articles and web search in Google Scholar, six relevant articles fully met the inclusion criteria. Four of these papers were excluded due to the unavailability of full-text manuscripts. Finally, after the complete review of the selected articles, only nine relevant studies were selected for further analysis. Figure 1 shows the step-by-step process of literature search and study selection.

General characteristics of the included articles

A total number of 333 participants were included in the selected studies, evaluating the association between BNP and the success rate of PTMC. Furthermore, 103 healthy volunteers participated in multiple studies as the control group. The number of patients in each study varied between 10 and 70 cases.

Both genders were included in our evaluation. Although the sex ratio was not reported in two studies, 75 and 191 cases were male and female, respectively. Also, the patients' age in the evaluated studies ranged between 12 and 80 years.

In the evaluated studies, post-operative plasma BNP levels were measured 20 minutes to 12 weeks after PTMC. All studies included in this literature review were prospective, observational articles. The oldest and latest studies were published in 1992 and 2014, respectively. The general characteristics of these studies are shown in Table 1 in a chronological order in accordance with the date of publication (Table 1).

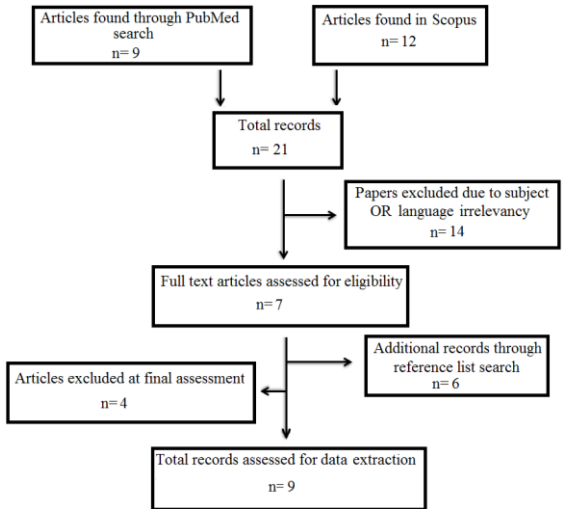

Figure 1. The flowchart of literature search for the selection of relevant articles

Table 1. General characteristics of the included articles

No.	First author	Year	Country	Study population *	Sex ratio	Number of patients
1	El Zayat, A (19)	2014	Egypt	ARMS	Male: 22 Female: 48	70
2	Wilson, V (20)	2014	India	MS	Male: 4 Female: 6	10
3	Pourafkari, L (21)	2014	Iran	RMS	Male: 12 Female: 33	45
4	Ramakrishnan, S (22)	2010	India	SMS	-	37
5	Chadha, DS (23)	2010	India	RMS	Male: 17 Female: 27	44
6	Selcuk, MT (24)	2007	Turkey	SRMS	Male: 9 Female: 51	60
7	Shang, YP (17)	2005	China	RMS	-	30
8	Nishikimi, T (3)	1997	Japan	SMS	Male: 7 Female: 16	23
9	Nakamura, M (25)	1992	Japan	MS	Male: 4 Female: 10	14

*MS: mitral stenosis, SMS: symptomatic mitral stenosis, RMS: rheumatic mitral stenosis, SRMS: symptomatic rheumatic mitral stenosis, ARMS: asymptomatic rheumatic mitral stenosis

Table 2. Specific characteristics of the selected studies

No.	First author	BNP/ NT-pro-BNP values before and after PTMC (pg/ml)		Time of assessment	Significance (P-value)
		Before	After		
1	El Zayat, A	92± 12	31± 9	1 week	P<0.001
2	Wilson, V	44	42	12 weeks	®
3	Pourafkari, L	124.43 ± 85.27	174.14 ± 306.30	20 min	P=0.26
4	Ramakrishnan, S	771 ± 456	700 ± 595	24 hours	P<0.05
5	Chadha, DS	71.3±30.8	60.2±25.9	24 hours	P<0.01
6	Selcuk, MT	293	214	24 hours	P<0.001
7	Shang, YP	128.7 ± 75.9	43.4 ± 26.7	24 hours	P<0.05
8	Nishikimi, T	88*	49*	1 week	P<0.001
9	Nakamura, M	5.3 ± 1.5 **	5.0 ± 1.9 **	24 hours	Not significant

* ng/l; ** fmol/ml; ® Plasma BNP expressed as median

Study results

Although the reported findings in these studies were conflicting, they all suggested an association between cardiac function and BNP (or NT-proBNP) after PTMC. According to the values reported in the selected articles, in 309 out of 333 patients, who underwent PTMC, plasma BNP or NT-proBNP levels significantly dropped, following PTMC.

The obtained results showed that BNP level may be used as a parameter for risk assessment in asymptomatic MS patients, especially those whose echocardiographic assessments did not indicate any improvements after PTMC. On the other hand, the findings showed that NT-proBNP level significantly reduced in MS patients, following successful PTMC.

Studies included in this literature review showed that other factors such as aortic regurgitation can influence plasma BNP level. In these cases, BNP level did not decrease despite a successful PTMC. Table 2 shows the main clinical characteristics of the included studies.

Discussion

So far, many studies have assessed the relationship between plasma BNP level and PBMV or PTMC, particularly in patients with MS. The results showed that BNP and NT-proBNP measurements after PTMC may be valuable indicators for assessing the success rate of this procedure (17, 19, 24). Moreover, based on the comparison between patients and healthy controls, plasma BNP concentrations were significantly higher in MS patients (3,20). Therefore, BNP can be considered as a marker for severe rheumatic MS (8).

Although the reported results are contradictory, the majority of studies demonstrated that both types of natriuretic peptides (i.e., BNP and NT-proBNP) decreased after PTMC. Therefore, they can have a predictive value in the assessment of the success rate of PTMC. The obtained results also showed that in both symptomatic and asymptomatic patients with MS, who underwent PTMC, both BNP and NT-proBNP decreased after the procedure; however, the significance level varied among these studies (3, 19, 22).

The obtained results were indicative of a possible association between MS and the neuro-hormonal regulatory system. Therefore, based on this review article, various types of natriuretic peptides including BNP and NT-proBNP may have a predictive value for MS. Furthermore, based on the literature review, BNP and NT-proBNP may be indicative of the success rate of PTMC.

The major limitations of this study included insufficient data on factors possibly influencing the production of BNP after successful PTMC. In addition, sex ratio had not been reported in two studies (including 67 patients); therefore, the results could not be reported based on sex distribution. The limited number of relevant studies was another important shortcoming of this study.

Conclusion

The results of this study were indicative of a possible association between natriuretic peptides (i.e., BNP and NT-proBNP) and the success rate of PTMC. The results also demonstrated that plasma BNP level was not correlated with successful PTMC within the first hour after the procedure.

Acknowledgements

We would like to thank the Clinical Research Development Center of Ghaem Hospital for their assistance. This research project (a medical thesis) was supported by a grant from the Vice-Chancellery for Research at Mashhad University

of Medical Sciences, Mashhad,Iran. (approval number: 911294).

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Boudoulas H. Etiology of valvular heart disease in the 21st century. Hellenic J Cardiol. 2002; 43:183-8.
2. 2. de Lemos JA, McGuire DK, Drazner MH. B-type natriuretic peptide in cardiovascular disease. Lancet. 2003; 362:316-22.
3. Nishikimi T, Nagata S, Sasaki T, Tomimoto S, Matsuoka H, Takishita S, et al. Plasma concentrations of adrenomedullin correlate with the extent of pulmonary hypertension in patients with mitral stenosis. Heart. 1997; 78:390-5.
4. Goetze JP, Friis-Hansen L, Rehfeld JF, Nilsson B, Svendsen JH. Atrial secretion of B-type natriuretic peptide. Eur Heart J. 2006; 27:1648-50.
5. Golbasy Z, Ucar O, Yuksel AG, Gulel O, Aydogdu S, Ulusoy V. Plasma brain natriuretic peptide levels in patients with rheumatic heart disease. Eur J Heart Fail. 2004; 6:757-60.
6. Arat-Ozkan A, Kaya A, Yigit Z, Balci H, Okcun B, Yazicioglu N, et al. Serum N-terminal pro-BNP levels correlate with symptoms and echocardiographic findings in patients with mitral stenosis. Echocardiography. 2005; 22:473-8.
7. Ucar O, Bayar N, Karagoz A, Aydogdu S. Valvular heart disease: plasma B-type natriuretic peptide levels in patients with pure rheumatic mitral stenosis. Acta Cardiol. 2012; 67:59-64.
8. Iltumur K, Karabulut A, Yokus B, Yavuzkir M, Taskesen T, Toprak N. N-terminal proBNP plasma levels correlate with severity of mitral stenosis. J Heart Valve Dis. 2005; 14:735-41.
9. Adhikari CM, Malla R, Rajbhandari R, Bhatta YK, Maskey A, Thapaliya S, et al. Percutaneous transvenous mitral commissurotomy in elderly mitral stenosis patients. A retrospective study at shahid gangalal national heart centre, bansbari, kathmandu, Nepal. Maedica. 2013; 8:333-7.
10. Joseph PK, Bhat A, Francis B, Sivasankaran S, Kumar A, Pillai VR, et al. Percutaneous transvenous mitral commissurotomy using an Inoue balloon in children with rheumatic mitral stenosis. Int J Cardiol. 1997; 62:19-22.
11. Harrison JK, Wilson JS, Hearne SE, Bashore TM. Complications related to percutaneous transvenous mitral commissurotomy. Cathet Cardiovasc Diagn. 1994; (Suppl 2):52-60.
12. Bahl VK, Chandra S, Talwar KK, Kaul U, Manchanda SC, Sharma S, et al. Influence of subvalvular fibrosis on results and complications of percutaneous mitral commissurotomy with use of the Inoue balloon. Am Heart J. 1994; 127:1554-8.
13. Kothari SS, Kamath P, Juneja R, Bahl VK, Airan B. Percutaneous transvenous mitral commissurotomy using Inoue balloon in children less than 12 years. Cathet Cardiovasc Diagn. 1998; 43:408-11.
14. Lopez-Meneses M, Martinez Rios MA, Vargas Barron J, Reyes Corona J, Sanchez F. Ten-year clinical and echocardiographic follow-up of patients undergoing percutaneous mitral commissurotomy with Inoue balloon. Arch Cardiol Mex. 2009; 79:5-10.
15. Sadeghian H, Salarifar M, Rezvanfard M, Nematipour E, Lotfi Tokaldany M, Safir Mardanloo A, et al. Percutaneous transvenous mitral commissurotomy: significance of echocardiographic assessment in prediction of immediate result. Arch Iran Med. 2012; 15:629-34.
16. Razzolini R, Leoni L, Cafiero F, Liva S, Faggian D, Ramondo A, et al. Neurohormones in mitral stenosis before and after percutaneous balloon mitral valvotomy. J Heart Valve Dis. 2002; 11:185-90.
17. Shang Y, Lai L, Chen J, Zhang F, Wang X. Effects of percutaneous balloon mitral valvuloplasty on plasma B-type natriuretic peptide in rheumatic mitral stenosis with and without atrial fibrillation. J Heart Valve Dis. 2005; 14:453-9.
18. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Annals Intern Med. 2009; 151:W-65-W-94.
19. El Zayat A. Potential use of Brain Natriuretic Peptide in patients with asymptomatic significant mitral stenosis. Egypt Heart J. 2014; 66:269-75.
20. Wilson V, Gupta N, Prabhakar P, Ramakrishnan L, Seth S, Maulik SK. Effect of Percutaneous Transvenous Mitral Commissurotomy on Plasma Apelin Level in Mitral Stenosis Patients. J Clin Exp Cardiolog. 2014; 5:2.
21. Pourafkari L, Seyedhosseini S, Kazemi B, Esmaili H, Aslanabadi N. Changes in Serum NT-Pro BNP and Left Atrial BNP Levels after Percutaneous Transvenous Mitral Commissurotomy in Sinus Rhythm Versus Atrial Firilation. J Cardiovasc Thorac Res. 2014; 6:175-9.
22. Ramakrishnan S, Agarwal A, Singh S, Karthikeyan G, Seth S, Narang R, et al. NT-pro-BNP levels as a marker of success of percutaneous transvenous mitral commissurotomy. Indian Heart J. 2010; 62:35-8.
23. Chadha DS, Karthikeyan G, Goel K, Malani SK, Seth S, Singh S, et al. N-terminal pro-BNP plasma levels before and after percutaneous transvenous mitral commissurotomy for mitral stenosis. Int J Cardiol. 2010; 144:238-40.
24. Selcuk MT, Selcuk H, Maden O, Erbay AR, Temizhan A, Aksu T, et al. The effect of percutaneous balloon mitral valvuloplasty on N-terminal- pro B- type natriuretic peptide plasma levels in mitral stenosis. Int Heart J. 2007; 48:579-90.
25. Nakamura M, Kawata Y, Yoshida H, Arakawa N, Koeda T, Ichikawa T, et al. Relationship between plasma atrial and brain natriuretic peptide concentration and hemodynamic parameters during percutaneous transvenous mitral valvulotomy in patients with mitral stenosis. Am Heart J. 1992; 124:1283-8.