



The Efficacy and Safety of Dobutamine Stress Echocardiography in a Tertiary Hospital, Dhaka, Bangladesh

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Received: 05 July 2021

Revised: 23 August 2021

Accepted: 05 September 2021

Published: 22 October 2021

Abstract

Background: Stress echocardiography with a pharmacologic agent such as dobutamine allows patients who are unable to exercise due to musculoskeletal or pulmonary comorbidities to simulate greater heart rate and increased myocardial physiologic demands. Dobutamine Stress Echocardiography, like exercise echocardiography, has primarily been used in the diagnosis of obstructive epicardial coronary artery disease, the detection of viable myocardium, and the evaluation of the efficacy of anti-ischemic medical therapy in patients with known coronary artery disease. **Objective:** The aim of the study was to assess the efficacy and safety of Dobutamine Stress Echocardiography. **Methods:** The prospective observational study was performed with Dobutamine Stress Echocardiography in 188 cases of the study population in between 30-80 years, from January 2018 to December 2018. A graded dobutamine infusion is given typically at a starting dose of 10 µg/kg per minute for 3 minutes. The goal of the dobutamine infusion is to achieve a heart rate 85% of the maximal predicted heart rate for the patient's age. Accordingly, the dobutamine dose is increased every 3 minutes to doses of 10, 20, and 30, and finally to 40 µg/kg per minute. Dobutamine is metabolized hepatically and in peripheral tissues, but there is no set dose reduction for those with hepatic or renal dysfunction. **Result:** The total study population was 188 aged ≤30 years to >70 years. 5(2.7%) were ≤30, 16(8.5) were 31 years to 40 years 45(23.9) were 41 years to 50 years, 76(40.4%) were 51 years to 60 years, 34(18.1%) were 61 years to 70 years and 12(6.4%) were >70 years. [Table I] Dobutamine Stress Echocardiography performed 122 (64.9%) males and 66 (35.1%) females. [Figure I]. Baseline characteristics Mean±SD value were (55.45±11.041) age, (1.35±0.479) sex, (63.57±11.281) weight and (139.70±8.71). Incidence of the complication of Dobutamine Stress Echocardiography were <0.01% mortality, <0.01% Cardiac Rapture, 0.14 Coronary spasm and 1.3% Hypertension. **Conclusion:** Dobutamine allows performance of an echocardiographic stress test in patients who would not otherwise be able to exercise. This technique has evolved over the years with technological advancements, including development of contrast echocardiography for endocardial definition. Contrast can also be used for myocardial perfusion analyses.

Keywords:- Stress echocardiography, Dobutamine, Coronary artery disease; Myocardial ischemia.

INTRODUCTION

Dobutamine Stress Echocardiography performs an important role in the evaluation and management of valvular heart disease by evaluating the effects of mitral and aortic stenoses, as well as distinguishing true severe valvular aortic stenosis from pseudostenosis that may occur in the setting of left ventricular systolic dysfunction.^[1,2,3,4,5] Dobutamine Stress Echocardiography is generally well tolerated, and its side effects and contraindications are generally related to the effects of excessive inotropic and/or chronotropic heart stimulation. The purpose of this paper is to go over the indications, contraindications, economic advantages, detriments, and risks of Dobutamine Stress Echocardiography.^[6,7] In general, Dobutamine Stress Echocardiography is used to evaluate for the presence and/or extent of coronary artery disease, but there are other specific indications detailed in the 2007 ASE guidelines.^[8] These include ischemic heart disease risk stratification, valvular disease, pulmonary hypertension, hypertrophic cardiomyopathy, dyspnea evaluation, pretransplant evaluation, and assessment of “hibernating” myocardium. In addition, in the 2011 Appropriate Use Criteria for echocardiography was jointly published by multiple professional societies. The Appropriate Use Criteria highlights common clinical scenarios describing the appropriate and inappropriate use of stress echocardiography and mirrors practice guidelines when able.^[9]

MATERIAL AND METHODS

The prospective observational study was performed with Dobutamine Stress Echocardiography in 188 cases of the study population in between 30-80 years, from January 2018 to December 2018. A graded dobutamine infusion is given typically at a starting dose of 10 µg/kg per minute for 3 minutes. The goal of the dobutamine infusion is to achieve a heart rate 85% of the maximal predicted heart rate for the patient’s age. Accordingly, the dobutamine dose is increased every 3 minutes to doses of 10, 20, and 30, and finally to 40 µg/kg per minute. Dobutamine is metabolized hepatically and in peripheral tissues, but there is no set dose reduction for those with hepatic or renal dysfunction

RESULTS

The total study population was 188 aged ≤30 years to >70 years. 5(2.7%) were ≤30, 16(8.5%) were 31 years to 40 years, 45(23.9%) were 41 years to 50 years, 76(40.4%) were 51 years to 60 years, 34(18.1%) were 61 years to 70 years and 12(6.4%) were >70 years. [Table I] Dobutamine Stress Echocardiography performed 122 (64.9%) males and 66 (35.1%) females. [Figure I]. Baseline characteristics Mean±SD value were (55.45±11.041) age, (1.35±0.479) sex, (63.57±11.281) weight and (139.70±8.71). Incidence of the complication of Dobutamine Stress Echocardiography were <0.01% mortality, <0.00% Cardiac Rapture, 0.14% Coronary spasm and 1.3% Hypertension.

Table 1: Age Distribution of the study (n=188)

Age Distribution (years)	n=188	%
≤30	5	2.7
31-40	16	8.5
41-50	45	23.9
51-60	76	40.4
61-70	34	18.1
>70	12	6.4

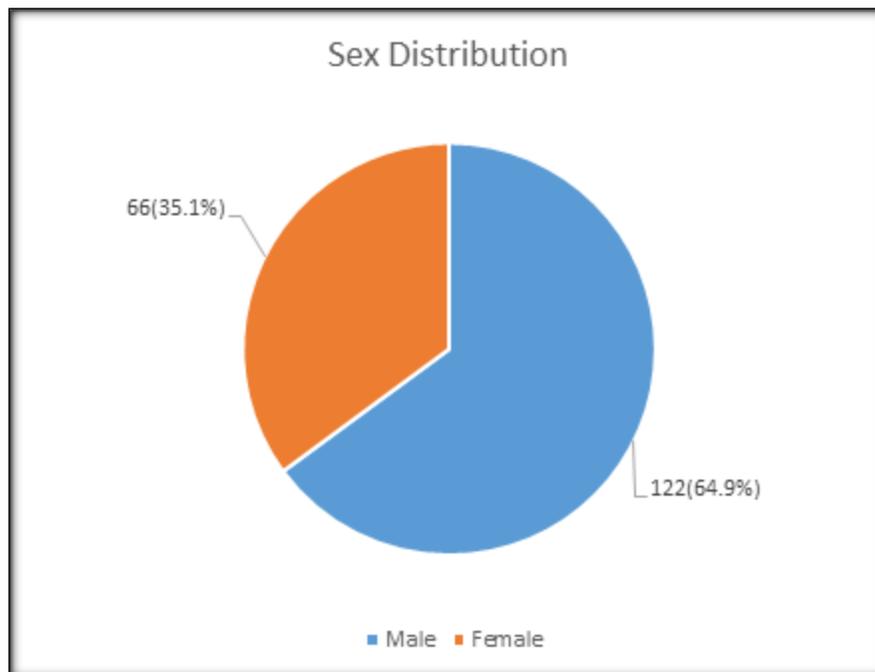


Figure 1: Sex Distribution of the study (n=188)

Table 2: Baseline characteristics

	Mean±SD
Age	55.45±11.041
Sex	1.35±0.479
Weight	63.57±11.281
Target H / R	139.70±8.71

Table 3: Incidence of the complication of Dobutamine Stress Echocardiography.

Complication	Incidence	Incidence (range)
Mortality	<0.01%	0.00%-0.01%
Cardiac Rapture	<0.01%	0.00%-0.01%
Coronary spasm	0.14	True incidence unknown
Hypertension	1.3%	0.2%-5.5%

DISCUSSION

The study's main finding is that a continuous, single-stage, high-dose dobutamine infusion protocol is a safe, feasible, and efficient way to perform stress echocardiography in patients with suspected or known coronary artery disease. Patients undergoing the dobutamine protocol reach their target heart rate sooner, resulting in a shorter test duration and a lower cumulative dobutamine dose. The proportion of patients achieving target heart rate was similar in both protocols, most likely due to the protocol being compared to a high-dose dobutamine-atropine stress protocol. Several large studies have shown that Dobutamine Stress Echocardiography is safe in a wide range of patient populations.^[10,11,12,13] Despite increasingly aggressive protocols, higher dobutamine doses, more frequent use of atropine, and inclusion of higher risk patients, no increase in the incidence of major side effects was observed.^[10,11,12,13] However, because dobutamine was administered at a high dose with a graded increase in our protocol, it is possible that dobutamine causes arrhythmias in the presence of an arrhythmic substrate. Other studies, however, found no clinical predictors of serious ventricular arrhythmias, such as left ventricular dysfunction or recent myocardial infarction.^[7,8,9,10,11,12,13,14] Furthermore, higher dobutamine doses were not associated with the occurrence of significant arrhythmias.^[10,11] Indeed, severe ventricular arrhythmias have been reported with low infusion rates (e.g., 20 mg/kg/min) 28, as well as after dobutamine infusion was stopped. Thus, dobutamine infusion should necessarily result in more arrhythmic events, particularly in view of the lower cumulative dose administered.

Multiple factors affect the accuracy of cardiovascular diagnostic tests. Various studies report sensitivities for overall detection of coronary artery disease by Dobutamine Stress Echocardiography ranging from 61%–96% and specificities ranging from 70%–100%.^[16] Examination of 62 studies from 1991 to 2006 that included over 6,800 patients found that the sensitivity of DSE was related to inclusion of patients with prior myocardial infarction. Specificity was lower in patients who had pre-existing echocardiographic wall motion abnormalities. In addition, referral bias decreased the specificity of Dobutamine Stress Echocardiography. Ultimately, the actual specificity of Dobutamine Stress Echocardiography may be lower than expected due to inclusion of patients with prior myocardial infarction (due to the definitions of a positive test) and the negative effects of referral bias.^[17] In addition to patient-specific characteristics, whether or not the maximal age-predicted heart rate is reached has a significant impact on the sensitivity and specificity of Dobutamine Stress Echocardiography. The risk was nearly three-fold for patients with abnormal stress echocardiography and submaximal heart rate response versus patients with normal stress echocardiography and submaximal heart rate response.^[18]

Limitations of The Study

The current study's small sample size lacks the power to provide the information required to detect differences in the occurrence of rare side effects. Although both protocols produced comparable hemodynamic responses, the sensitivity and specificity of dobutamine administration were not investigated in this

study. To address these issues, a large-scale study is required. The purpose of our study was not to assess "viable" myocardium in dysfunctional segments at rest.

CONCLUSIONS

Dobutamine allows patients who would otherwise be unable to exercise to undergo an echocardiographic stress test. With

technological advancements, such as the development of contrast echocardiography for endocardial definition, this technique has evolved over time. Contrast can also be used to assess myocardial perfusion. Contrast enhancement has increased the number of eligible patients while improving testing accuracy.

REFERENCES

1. Picano E, Sicari R, Landi P, Cortigiani L, Bigi R, Coletta C, et al. Prognostic value of myocardial viability in medically treated patients with global left ventricular dysfunction early after an acute uncomplicated myocardial infarction: a dobutamine stress echocardiographic study. *Circulation*. 1998;98(11):1078-84. doi: 10.1161/01.cir.98.11.1078.
2. Poldermans D, Arnese M, Fioretti PM, Boersma E, Thomson IR, Rambaldi R, et al. Sustained prognostic value of dobutamine stress echocardiography for late cardiac events after major noncardiac vascular surgery. *Circulation*. 1997;95(1):53-8. doi: 10.1161/01.cir.95.1.53.
3. Geleijnse ML, Fioretti PM, Roelandt JR. Methodology, feasibility, safety and diagnostic accuracy of dobutamine stress echocardiography. *J Am Coll Cardiol*. 1997;30(3):595-606. doi: 10.1016/s0735-1097(97)00206-4.
4. Poldermans D, Fioretti PM, Boersma E, Bax JJ, Thomson IR, Roelandt JR, et al. Long-term prognostic value of dobutamine-atropine stress echocardiography in 1737 patients with known or suspected coronary artery disease: A single-center experience. *Circulation*. 1999;99(6):757-62. doi: 10.1161/01.cir.99.6.757.
5. Orsinelli DA, Daniels CJ. Pharmacologic stress echocardiography. Dobutamine and arbutamine stress testing. *Cardiol Clin*. 1999 Aug;17(3):461-79. doi: 10.1016/s0733-8651(05)70091-6.
6. Segar DS, Brown SE, Sawada SG, Ryan T, Feigenbaum H. Dobutamine stress echocardiography: correlation with coronary lesion severity as determined by quantitative angiography. *J Am Coll Cardiol*. 1992;19(6):1197-202. doi: 10.1016/0735-1097(92)90324-g.
7. Poldermans D, Boersma E, Fioretti PM, van Urk H, Boomsma F, Man in 't Veld AJ. Cardiac chronotropic responsiveness to beta-adrenoceptor stimulation is not reduced in the elderly. *J Am Coll Cardiol*. 1995;25(5):995-9. doi: 10.1016/0735-1097(94)00527-w.
8. Pellikka PA, Nagueh SF, Elhendy AA, Kuehl CA, Sawada SG; American Society of Echocardiography. American Society of Echocardiography recommendations for performance, interpretation, and application of stress echocardiography. *J Am Soc Echocardiogr*. 2007;20(9):1021-41. doi: 10.1016/j.echo.2007.07.003.
9. Douglas PS, Garcia MJ, Haines DE, Lai WW, Manning WJ, Patel AR, Picard MH, Polk DM, Ragosta M, Parker Ward R, Weiner RB. ACCF/AHA/ASA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography. A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance American College of Chest Physicians. *J Am Soc Echocardiogr*. 2011;24(3):229-67. doi: 10.1016/j.echo.2010.12.008.
10. Mertes H, Sawada SG, Ryan T, Segar DS, Kovacs R, Foltz J, et al. Symptoms, adverse effects, and complications associated with dobutamine stress echocardiography. Experience in 1118 patients.



- Circulation. 1993;88(1):15-9. doi: 10.1161/01.cir.88.1.15.
11. Smart SC, Knickelbine T, Stoiber TR, Carlos M, Wynsen JC, Sagar KB. Safety and accuracy of dobutamine-atropine stress echocardiography for the detection of residual stenosis of the infarct-related artery and multivessel disease during the first week after acute myocardial infarction. *Circulation*. 1997;95(6):1394-401. doi: 10.1161/01.cir.95.6.1394.
 12. Pellikka PA, Roger VL, Oh JK, Seward JB, Tajik AJ. Safety of performing dobutamine stress echocardiography in patients with abdominal aortic aneurysm \geq 4 cm in diameter. *Am J Cardiol*. 1996;77(5):413-6. doi: 10.1016/s0002-9149(97)89374-5.
 13. Secknus MA, Marwick TH. Evolution of dobutamine echocardiography protocols and indications: safety and side effects in 3,011 studies over 5 years. *J Am Coll Cardiol*. 1997;29(6):1234-40. doi: 10.1016/s0735-1097(97)00039-9.
 14. McNeill AJ, Fioretti PM, el-Said SM, Salustri A, Forster T, Roelandt JR. Enhanced sensitivity for detection of coronary artery disease by addition of atropine to dobutamine stress echocardiography. *Am J Cardiol*. 1992;70(1):41-6. doi: 10.1016/0002-9149(92)91387-j.
 15. Fleischmann KE, Hunink MG, Kuntz KM, Douglas PS. Exercise echocardiography or exercise SPECT imaging? A meta-analysis of diagnostic test performance. *JAMA*. 1998;280(10):913-20. doi: 10.1001/jama.280.10.913.
 16. Medical Advisory Secretariat. Stress echocardiography for the diagnosis of coronary artery disease: an evidence-based analysis. *Ont Health Technol Assess Ser*. 2010;10(9):1-61.
 17. Geleijnse ML, Krenning BJ, van Dalen BM, Nemes A, Soliman OI, Bosch JG, et al. Factors affecting sensitivity and specificity of diagnostic testing: dobutamine stress echocardiography. *J Am Soc Echocardiogr*. 2009;22(11):1199-208. doi: 10.1016/j.echo.2009.07.006.
 18. Makani H, Bangalore S, Halpern D, Makwana HG, Chaudhry FA. Cardiac outcomes with submaximal normal stress echocardiography: a meta-analysis. *J Am Coll Cardiol*. 2012;60(15):1393-401. doi: 10.1016/j.jacc.2012.05.041.

Source of Support: Nil, Conflict of Interest: None declared