



Original Article.

Effect of Phototherapy on Cardiac Functions in Neonates with Hyperbilirubinemia. A Prospective Cross-Sectional Study

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Abstract

Background: Phototherapy has been reported to alter cardiovascular function by causing increased peripheral blood flow, diminished cardiac output and increased sympathetic activity that may be of concern, particularly in neonates with hyperbilirubinemia. **Aim of work:** To assess the myocardial function in neonates with hyperbilirubinemia by using echocardiography, especially tissue Doppler imaging (TDI). **Patients and Methods:** It was a prospective, cross-sectional study. All participants in this study were full-terms and appropriate for gestational age newborns with hyperbilirubinemia who received phototherapy for jaundice (bilirubin level greater than 15 mg/dl). Myocardial functions were assessed using conventional echocardiography and tissue Doppler imaging techniques. **Results:** The study population consisted of 110 neonates with hyperbilirubinemia; their mean gestational age was 38.8 ± 1.7 weeks and mean birth weight 2785 ± 652 g. After phototherapy, respiratory rate and heart rate were faster whereas oxygen saturation and systolic blood pressure were lower ($p < 0.000$). There was no significant difference in the left ventricular interventricular septum in diastole (LVIVSd), left ventricular interventricular septum in systole (LVIVSs), left ventricular internal dimension in diastole (LVIDd), left ventricular internal dimension in systole (LVIDs), left ventricular posterior wall in diastole (LVPWd), left ventricular posterior wall in systole (LVPWs), ejection fraction (EF) and fraction shortening (FS) before and after phototherapy ($p > 0.05$). Pulsed wave Doppler parameters showed no significant difference in the mitral E velocity, mitral A velocity, and E/A ratio ($p > 0.05$).

Conclusion: Phototherapy had no adverse effects on either systolic or diastolic function of the left ventricle in term neonates with indirect hyperbilirubinemia.

Key words: Cardiac function; hyperbilirubinemia; neonate; tissue Doppler imaging.

Introduction

In the newborn nursery, neonatal jaundice is widespread, and phototherapy is regarded the standard of care when treatment is necessary. Although various adverse effects have been reported, phototherapy is both safe and effective [1]. These include deoxyribonucleic acid (DNA) damage in lymphocytes, as well as physiologic and behavioral impacts on the newborn infant's organ systems [2]. Hyperbilirubinemia has no effect on DNA damage, whereas both conventional and intensive phototherapies are associated with DNA damage in hyperbilirubinemia-affected term infants [3]. Short-term adverse effects of phototherapy include disruption of the mother-infant relationship, alteration of the thermal environment with water loss, electrolyte imbalance, bronze baby syndrome, and circadian rhythm abnormalities. Furthermore, phototherapy may cause long-term negative effects such as melanocytic nevi and skin cancer,

allergic disorders, patent ductus arteriosus, and retinal injury[4-5]. However, phototherapy has been shown to modify cardiovascular function by increasing peripheral blood flow, decreasing cardiac output, and increasing sympathetic activity, which may be concerning in unwell or preterm neonates[5]. It seems that although phototherapy does affect cardiac function; several issues still require verification. The purpose of this study was to determine the effects of phototherapy on systolic and diastolic cardiac function in neonates with hyperbilirubinemia.

Methods

Study setting: Between January 2018 and December 2019, this study was carried out at a newborn care unit linked to the department of paediatrics at Jawaharlal Nehru Medical College & AVBR Hospital in Sawangi, Wardha, Central India.

Study design: A prospective, observational, cross-sectional study.

Study participants: All patients in this trial were full-term and appropriate for gestational age (AGA) neonates with hyperbilirubinemia (bilirubin level more than 15 mg/dl) who were treated with phototherapy in accordance with AAP guidelines [6-7]. The following were the inclusion criteria for study participation: (1) full-term newborns who are healthy (gestational age: 37–42 weeks), (2) have a birth weight of 2500–3500 g, (3) have an Apgar score of 8–10 at delivery, and (4) are undergoing phototherapy for hyperbilirubinemia. Exclusion criteria included dehydration, electrolyte imbalance, acid-base disorders, neonatal sepsis, small for gestational age babies, intrauterine growth restriction, perinatal asphyxia, congenital anomalies, congenital heart defects and neonates who were suspected to have chromosomal abnormalities. The study was authorized by our Institute's institutional review board, and informed permissions were acquired from the parents of the neonates.

Assessments: All term neonates with hyperbilirubinemia (study cases) had their demographic information gathered, including their age, gender, gestational age, and birth weight. All patients had a relevant perinatal history (including maternal sickness, manner of birth, Apgar score, history of cyanosis or convulsions) and clinical examination (with specific attention on vital signs, anthropometric measurements, the presence of cephalhematoma and neurological examination) was done for all cases. Laboratory investigations included complete blood count, peripheral smear, blood group and Rh typing of the neonate and mother. Total and direct serum bilirubin concentration was measured by using the spectrophotometric method with the Selectra-2 auto-analyzer at the initiation of phototherapy and every 6 hourly by transcutaneous bilirubin-meter. The phototherapy was stopped when the level of total serum bilirubin dropped to less than 12 mg/dl by lab. Serum Calcium

and cardiac troponin levels were measured before starting phototherapy and 24 hours after termination of phototherapy treatment.

Phototherapy: In general, healthy full-term infants were discharged at 3 days of age. If newborn jaundice was discovered and phototherapy was available in the NICU, they were treated there. Fluorescent tubes are often used to give phototherapy at a distance of 45–60 cm from the neonate. An efficient phototherapy device emits specified blue-light wavelengths (peak emission: 450 ± 20 nm), preferably in a narrow bandwidth encompassing approximately 80% of the baby's body surface area [8]. The baby was covered with minimal clothing should be naked except the eyes and genitalia to increase the exposed skin surface area to the therapy light. However, the neonate's eyes and genitalia were covered to prevent damage. Phototherapy was stopped when the level of bilirubin decreased to less than 12 mg/dL.

Echocardiography: Echocardiography was performed using a GE Vivid-e echocardiography machine, United States in accordance with the guidelines of the American Society of Echocardiography (ASE) [9]. A single paediatric cardiologist performed the echocardiographic measurements. Using M-mode echocardiography by parasternal long axis The interventricular septum thickness in diastole (IVSd), the interventricular septum thickness in systole (IVSs), the left ventricular internal dimension in diastole (LVIDd), the left ventricular internal dimension in systole (LVIDs), the LV posterior wall thickness in diastole (LVPWd) and the LV posterior wall thickness in systole (LVPWs) were measured. The fractional shortening (FS) of the left ventricle was calculated using the left ventricular dimensions.

FS is calculated as follows: $(LVIDd - LVIDs) / LVIDd \times 100\%$. The biplane modified Simpson's method was used to calculate left ventricular end-diastolic

and end-systolic volumes, as well as left ventricular ejection fraction (EF). The apical four-chamber view was also used to record LV inflow velocities, with the peak flow velocities of the LV inflow measured in early diastole (E) and late diastole with atrial contraction (A), and the E/A ratio calculated.

Tissue Doppler Imaging (TDI): We employed TDI to assess the LV's systolic and diastolic function. At the apical four-chamber abutment, a 2-mm pulse-wave (PW) sample volume was inserted on the left ventricular septal mitral annulus. Systolic velocity (S'), early diastolic velocity (E'), late diastolic velocity (A'), and time intervals; isovolumetric contraction time (IVCT), isovolumetric relaxation time (IVRT), and ejection time (ET) were measured at each site. The IVRT was measured from the end of the S'wave to the beginning of the E'wave, while the IVCT was measured from the beginning of the A'wave to the beginning of the S'wave. The Tei index was

calculated [10] using the following formula: $(IVCT + IVRT / ET)$.

Sample size calculation: Prior to the research, the sample size was estimated. The predicted minimum detectable difference in heart rate before and after phototherapy in means = 4, standard deviation difference = 4, effect size = 0.307, both sidedness; power = 90%, and alpha error = 5%. The study required a minimum sample size of 110 people.

Ethical consideration

The study was approved by the Committee of Ethics of Department of Pediatrics, Jawaharlal Nehru Medical College, Sawangi Meghe, Wardha, Maharashtra. Written consents were taken by the fathers of all neonates enrolled in the study.

Statistical analysis

Stata software version 10 was used to conduct statistical analysis. Continuous variables are provided as means \pm standard deviations, whereas categorical data are provided as frequencies with percentages. To

compare continuous variables, the paired student's t-test was utilized. Statistical significance was defined as a p-value less than 0.05.

Results

The study population consisted of 110 neonates with hyperbilirubinemia; their mean gestational age was 38.8 ± 1.7 weeks and mean birth weight 2785 ± 652 g. In the study, 56 (50.90%) babies had hyperbilirubinemia at < 48 hours of life, 30 (27.27%) babies had hyperbilirubinemia at 48-72 hours, 13 (11.81%) babies had hyperbilirubinemia at 72-96 hours and 11 (10%) babies had hyperbilirubinemia after 96 hours of life. Out of 110 neonates admitted in NICU with hyperbilirubinemia, 61(55.45%) were males and 49 (44.55%) were females. Male to female ratio was 1.15:1. After phototherapy, respiratory rate ($P < 0.000$) and heart rate ($P < 0.000$) were faster whereas oxygen saturation ($P < 0.000$) and systolic blood pressure ($P < 0.000$) were lower which was statistically significant [Table 1].

In terms of left ventricular systolic function, there were no significant differences in the LVIVSd, LVIVSs, LVIDd, LVIDs, LVPWd, LVPWs, EF and FS before or after phototherapy ($P > 0.05$). There were no significant differences in the measurement of left atrium and aortic sizes before and after phototherapy (Table 2 & Figure 4). Among pulsed wave Doppler parameters, study cases showed no significant difference in the mitral E velocity, mitral A velocity and E/A ratio ($p > 0.05$) (Table 3 & Figure 5). Similarly, among tissue Doppler parameters, cases showed no significant difference in the E' wave, A' wave, S'wave, IVRT, IVCT and ET, before and after the phototherapy [Table 4 and Figure 6]. Among tissue doppler-based Tei index parameters, there were no significant differences noted before and after phototherapy (Table 4).

Discussion

Phototherapy is the use of visible light to cure severe jaundice in the early stages of life. Conventional phototherapy uses

fluorescent bulbs, halogen lamps, or light-emitting diodes (LED), all of which are equally efficient in lowering serum bilirubin levels [7-8]. When super (high-intensity) LED equipment are employed, hyperthermia and skin rashes are more common. The effects of light penetrating the heart in newborn newborns due to the thin chest wall are unclear. Non-ocular light exposure and melatonin suppression may have an effect on autonomic and behavioral abnormalities[4-5].However, phototherapy has been shown to modify cardiovascular function by increasing heart rate, decreasing mean arterial blood pressure, increasing peripheral blood flow, decreasing cardiac output, and increasing sympathetic activity, which may be of concern in ill or preterm neonates [11-13].

In our study, newborns with hyperbilirubinemia had substantially higher heart rates, respiration rates, and systolic blood pressure following phototherapy. This outcome is consistent with certain earlier study findings

[11].However, Weissman A et al. 2009 [12] discovered a considerable decrease in heart rate variability (HRV) during phototherapy, a condition thought to be centrally mediated. According to the findings of Bader D et al 2006 [13] study, there was a substantial drop in respiratory rate, an increase in heart rate, and a decrease in respiratory effort in response to apnea during active sleep. These effects were not observed during peaceful sleep. Previous research has shown that [14] myocardial contractility was decreased in an in vitro investigation on hyperbilirubinemia, however in an in vivo investigation with rats, the left ventricular contractile parameters and ejection (fractional shortening and ejection fraction) were the same as in the control group. In addition, Gao XY et al. 2012 [15] found insufficient evidence to support the idea that neonatal jaundice causes cardiac injury in term infants of normal birth weight. Borenstein-Levin L et al 2016 [16] discovered that there is no clinically meaningful change in coronary

artery flow following phototherapy in healthy term newborns. The authors of this study hypothesized that measurements of cardiac output did not differ considerably. In another research, Walther FJ et al 1985 [17] discovered that decreased stroke volume during phototherapy lowered cardiac output by 6%. The decrease in stroke volume during phototherapy may be due to the newborn's reduced activity during phototherapy. Furthermore, Benders MJ et al 1999 [18] found that left ventricular output (LVO) dropped soon after phototherapy began. However, LVO rebounded to pre-phototherapy levels within 12 hours. After 12 hours of exposure, there was a considerable increase in mean left pulmonary artery blood flow (LPA).

Karabulut B et al 2019 [19] found no significant differences between the cases and controls in EF, FS, LVEDd, and LVEDs. They also discovered no statistically significant variations in mitral, tricuspid, septal E', A', and S'

across groups. Firouzi M et al 2020 [20] found that the mean stroke volume before and after phototherapy was 6.99 ± 2.17 and 6.55 ± 1.85 L/m² ($p = 0.011$), respectively, and concluded that phototherapy can lower left ejection fraction in newborn babies with hyperbilirubinemia. In addition, Kapoor S et al 2020 [21] reported that chest shielding of preterm neonates during phototherapy had no influence on the incidence of hemodynamically significant patent ductus arteriosus. Furthermore, Negrine RJ et al 2012 [22] shown that the TDI is viable in newborns, with increased gestation resulting in larger cardiac velocities and lower E/E' ratios. Premature newborns' jaundice is best treated with phototherapy. However, phototherapy has been associated to ductus arteriosus closure failure in these newborns. This might be due to light entering the thin chest wall of extremely preterm neonates and relaxing the smooth muscle of the aorta via the nitric oxide-cyclic GMP

pathway and Ca^{2+} dependent K^{+} ion channels. As a result, neonatal phototherapy may have a relaxing effect on the smooth muscles of the ductus arteriosus in neonates, inhibiting the closure of the patent ductus arteriosus and perhaps causing the ductus arteriosus to reopen [23].

Phototherapy is not associated with the risk of hypocalcemia in healthy, full-term neonates. One previous study has suggested that [24] there is no need of prophylactic calcium for healthy, full-term neonates who have undergone phototherapy. However, the study done by Shengyu Y et al 2011 [25] mentioned that hyperbilirubinemia causes a temporary myocardial injury. They also advised that cardiac troponin I and CK - MB can help monitor myocardial injury in jaundiced babies. Li Wei Zhong et al 2004 [26] in his study mentioned that the myocardial enzymes and isoenzymes activities especially CK and CK-MB were elevated in neonates with unconjugated hyperbilirubinemia. He

also found that pathological hyperbilirubinemia in a neonate may induce myocardial function impairment which can be correlated with the degree and duration of jaundice. Because other approaches, particularly invasive measurements are risky in newborns. Hence, echocardiography was the sole technique employed to assess cardiac function in our research. Echocardiography measurements of cardiac size and velocity before and after phototherapy were nearly identical.

Conclusions

Phototherapy had no adverse effects on either systolic or diastolic functions of the left ventricle in term neonates with indirect hyperbilirubinemia.

List of abbreviations

- TDI= Tissue doppler imaging
- LVIVSd= Left ventricular interventricular septum in diastole
- LVIVSs= left ventricular interventricular septum in systole
- LVIDd= left ventricular internal dimension in diastole
- LVIDs= left ventricular internal dimension in systole
- LVPWd= left ventricular posterior wall in diastole

- LVPWs=left ventricular posterior wall in systole
- EF= Ejection fraction
- FS= Fraction shortening
- DNA= Deoxyribonucleic acid
- E=Early diastolic velocity
- A=Late diastole with atrial contraction
- AGA= Appropriate for gestational age
- AAP =Americal Academy of Paediatrics
- S'=Systolic velocity
- E'=Early diastolic velocity
- A'=Late diastolic velocity
- IVCT= Isovolumetric contraction time
- IVRT=Isovolumetric relaxation time
- ET=Ejection time
- LED=Light-emitting diodes

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Author's contributions

All of authors shared equally in this work and have seen and agreed to the submitted version of the manuscript.

Conflict of interest

The authors have no conflict of interests to declare.

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References

1. Faulhaber FRS, Procianoy RS, Silveira RC. Side Effects of Phototherapy on Neonates. *Am J Perinatol.* 2019; 36(3):252-257.
2. Tatli MM, Minnet C, Kocyigit A, Karadag A. Phototherapy increases DNA damage in lymphocytes of hyperbilirubinemic neonates. *Mutat Res.* 2008 30;654(1):93-5.
3. Ramy N, Ghany EA, Alsharany W, Nada A, Darwish RK, Rabie WA, Aly H. Jaundice, phototherapy and DNA damage in full-term neonates. *J Perinatol.* 2016; 36(2):132-6.
4. Xiong T, Tang J, Mu DZ. Side effects of phototherapy for neonatal hyperbilirubinemia. *Zhongguo Dang Dai Er Ke Za Zhi.* 2012; 14(5):396-400.
5. Taksande A, Selvam S. Side Effects of Phototherapy in Neonatal Hyperbilirubinemia. *Acta Scientific Paediatrics* 2018; 5(1): 24-30.

6. American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. *Pediatrics* 2004; 114:297–316.
7. Tridente A, De Luca D. Efficacy of light-emitting diode versus other light sources for treatment of neonatal hyperbilirubinemia: a systematic review and meta-analysis. *Acta Paediatr.* 2012; 101:458–65.
8. Bhutani VK, Cline BK, Donaldson KM, Vreman HJ. The need to implement effective phototherapy in resource-constrained settings. *Semin Perinatol.* 2011; 35(3):192-7.
9. Lopez L, Colan SD, Frommelt PC, Ensing GJ, Kendall K, Younoszai AK et al., Recommendations for quantification methods during the performance of a pediatric echocardiogram: a report from the Pediatric Measurements Writing Group of the American Society of Echocardiography Pediatric and Congenital Heart Disease Council. *Journal of the American Society of Echocardiography: official publication of the American Society of Echocardiography.* 2010; 23:465–495.
10. Cui W, Roberson DA. Left ventricular Tei index in children: comparison of tissue Doppler imaging, pulsed wave Doppler, and M-mode echocardiography normal values. *Journal of the American Society of Echocardiography: official publication of the American Society of Echocardiography.* 2006; 19:1438–1445.
11. Uhrikova Z, Zibolen M, Javorka K, Chladekova L, Javorka M. Hyperbilirubinemia and phototherapy in newborns: Effects on cardiac autonomic control. *Early Human Development* 2015; 351-6
12. Weissman A, Berkowitz E, Smolkin T, Blazer S. Effect of phototherapy on neonatal heart rate variability and complexity. *Neonatology.* 2009; 95(1):41-6.
13. Bader D, Kugelman A, Blum DE, Riskin A, Tirosh E. Effect of phototherapy on cardiorespiratory activity during sleep in neonates with physiologic jaundice. *Isr Med Assoc J.* 2006; 8(1):12-6.
14. Bakrania B, Du Toit EF, Ashton KJ, Kiessling CJ, Wagner KH, Headrick JP et al., Hyperbilirubinemia modulates myocardial function, aortic ejection, and ischemic stress resistance in the Gunn rat. *Am J Physiol Heart Circ Physiol* 2014; 307:H1142-9.
15. Gao XY, Yang B, Hei MY, Wang XL, Chen Y, Sun YJ, Tong NN. Clinical study of myocardial damage induced by neonatal jaundice in normal birthweight term infants. *ZhonghuaErKeZaZhi.* 2012; 50(5):343-9
16. Borenstein-Levin L, Sharif D, Amshalom A, Riskin A, Hemo M, Khalil A, Bader D, Kugelman A. Effects of Phototherapy on Coronary Blood Flow in Healthy Neonates: A Pilot Study. *Neonatology.* 2016; 110 (1):75-82.
17. Walther FJ, Wu PY, Siassi B. Cardiac output changes in newborns with hyperbilirubinemia

- treated with phototherapy. *Pediatrics*. 1985; 76(6):918-21.
18. Benders MJ, van Bel F, van de Bor M. Haemodynamic consequences of phototherapy in term infants. *Eur J Pediatr*. 1999; 158(4):323-8.
19. Karabulut B, Şimşek A. Effect of Neonatal Hyperbilirubinemia on Ventricular Functions. *EJCM* 2019; 7(3):142-146
20. Firouzi M, Sherkatolabbasieh H, Nezami A, Shafizadeh S. Effect of Phototherapy on Stroke Volume in Newborn Infants with Jaundice. *J Pediatr Intensive Care*. 2020; 9(3):207-209.
21. Kapoor S, Mishra D, Chawla D, Jain S. Chest shielding in preterm neonates under phototherapy-a randomised control trial. *Eur J Pediatr*. 2020. doi: 10.1007/s00431-020-03763-9.
22. Negrine RJ, Chikermane A, Wright JG, Ewer AK. Assessment of myocardial function in neonates using tissue Doppler imaging. *Arch Dis Child Fetal Neonatal Ed*. 2012; 97(4):F304-6.
23. Yurdakök M. Phototherapy in the newborn: what's new? *J Pediatr Neonat Individual Med*. 2015; 4(2): e040255. doi: 10.7363/040255
24. Gheshmi AN , Naderi S, Homayrani E, Safari B. Prevalence of hypocalcemia after phototherapy among neonates who underwent phototherapy in Koodakan Hospital in Bandar Abbas in 2013. *Electronic Physician*.2015; 7(6): 1387-1390.
25. Shengyu Y, Yichuan C, Cheng W, Linlin Z, Jianhong W. Relationship of neonatal hyperbilirubinemia and myocardial injury. *Modern Practical Medicine*. 2011 https://en.cnki.com.cn/Article_en/CJFD Total-NB YX 201110005.htm
26. LI Wei-zhong, LIN Wei-qing, MA Liang. Clinical value of myocardial enzymes evaluation in neonates unconjugated hyperbilirubinemia. *Hebei Medicine*; 2004. https://en.cnki.com.cn/Article_en/CJFD Total-HCYX 200405004.htm

Table (1): Distribution of vital parameters of the studied neonates before and after phototherapy

Vital parameters (n=110)	Before Phototherapy Mean±SD	After Phototherapy Mean±SD	P value
Heart rate (Beats/min)	133.435±5.44	137.55±6.83	0.000**
Respiratory rate (cycles/min)	44.13±4.73	46.11±4.87	0.000**
SpO2 (%)	98.67±0.84	97.29±0.94	0.000**
Systolic Blood pressure (mmHg)	66.71±3.82	64.92±4.82	0.000**
Diastolic Blood pressure (mmHg)	38.30±3.32	38.42±4.49	0.548

** highly significant

Table (2): Assessment of the left ventricular systolic function by M-mode echocardiography before and after phototherapy

Systolic Parameter of LV (n=110)	Before Phototherapy Mean±SD	After Phototherapy Mean±SD	P value
LVIVSd	4.69±0.78	4.74±0.64	0.488
LVIVSs	5.56±0.79	5.60±0.62	0.419
LVIDd	13.22±1.21	13.23±1.04	0.903
LVIDs	8.01±0.89	8.12±0.77	0.128
LVPWd	4.48±0.85	4.59±0.65	0.071
LVPWs	4.95±0.65	4.90±0.73	0.604
EF	65.95±4.43	66.06±6.6	0.629
FS	33.81±2.28	33.61±2.32	0.237
Left Atrium	9.34±1.15	9.40±1.26	0.336
Aorta	7.85±0.96	7.92±0.88	0.459
LA/Ao	1.20±0.19	1.19±0.18	0.640

LVIVSd= Left ventricular interventricular septum in diastole; LVIVSs= left ventricular interventricular septum in systole; LVIDd= left ventricular internal dimension in diastole; LVIDs= left ventricular internal dimension in systole; LVPWd= left ventricular posterior wall in diastole; LVPWs= left ventricular posterior wall in systole; EF=ejection fraction; FS=fraction shortening; LA=Left atrium; Ao=Aorta

Table (3): Assessment of diastolic function of LV (Mitral Valve)

Diastolic Parameter of LV (n=110)	Before	After	P value
	Phototherapy Mean±SD	Phototherapy Mean±SD	
E wave	44.34±8.08	44.57±8.19	0.675
A wave	56.73±9.77	57.01±11.35	0.723
E/A	0.79±0.18	0.81±0.23	0.406

E=Early diastolic velocity; A=Late diastole with atrial contraction

Table (4): Assessment of myocardial velocity and time interval at mitral valve by tissue Doppler imaging

Tissue Doppler Imaging (TDI) parameter of LV (n=110)	Before Phototherapy Mean±SD	After Phototherapy Mean±SD	P value
E' wave	5.70±0.95	5.78±0.95	0.238
A' wave	7.45±1.30	7.49±1.15	0.464
S' wave	5.79±0.76	5.71±0.99	0.215
IVCT	26.31±5.89	26.72±5.35	0.465
IVRT	24.89±3.98	24.45±4.07	0.367
ET	219.91±34.85	218.53±32.01	0.221
Tei Index	0.23±0.04	0.22±0.05	0.961

E'=Early diastolic velocity; A'=Late diastolic velocity S'=Systolic velocity; IVCT= Isovolumetric contraction time; IVRT=Isovolumetric relaxation time ; ET=Ejection time

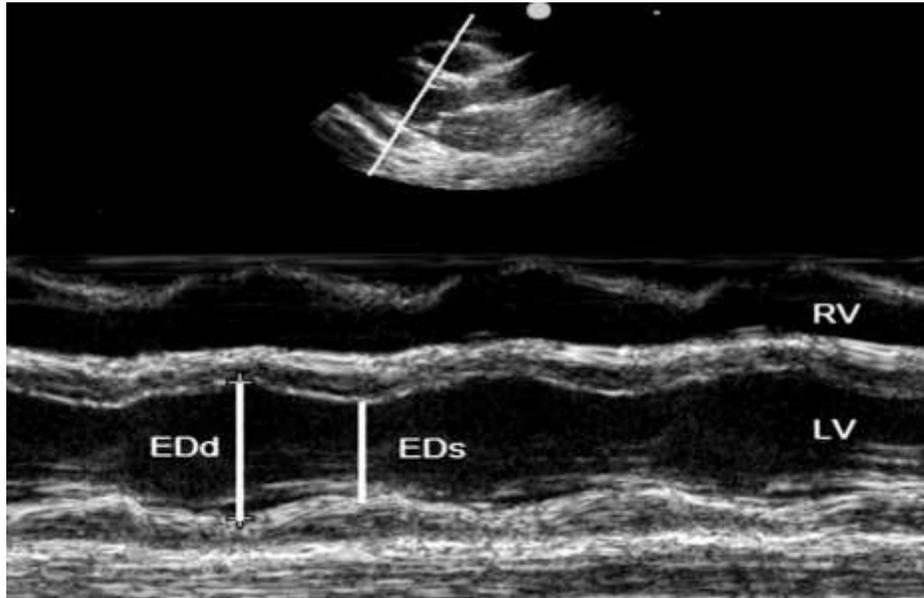


Figure (1): M-Mode echocardiography for the measurement of left ventricular dimensions in systolic and diastolic phase

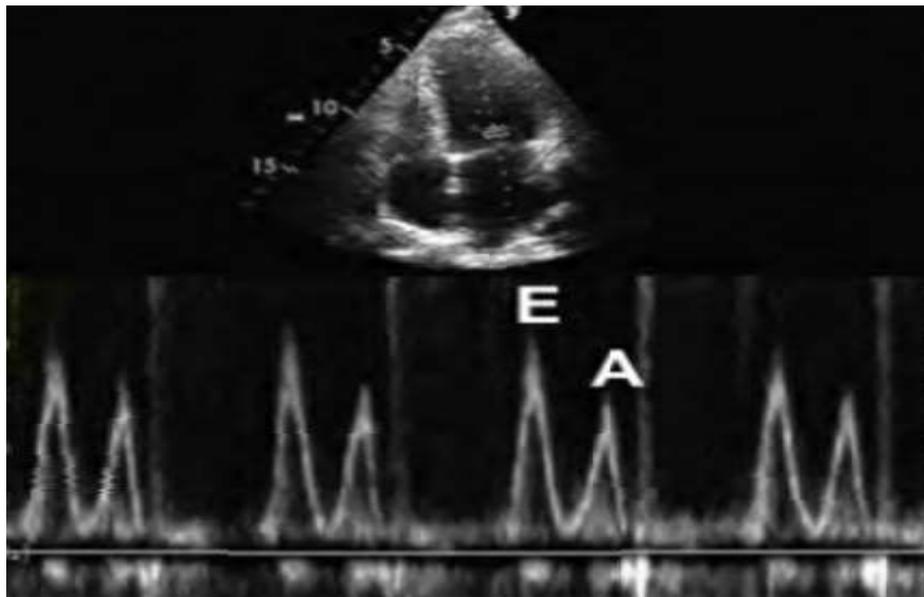


Figure (2): Pulse Doppler echocardiography across the mitral valve for the assessment of diastolic function

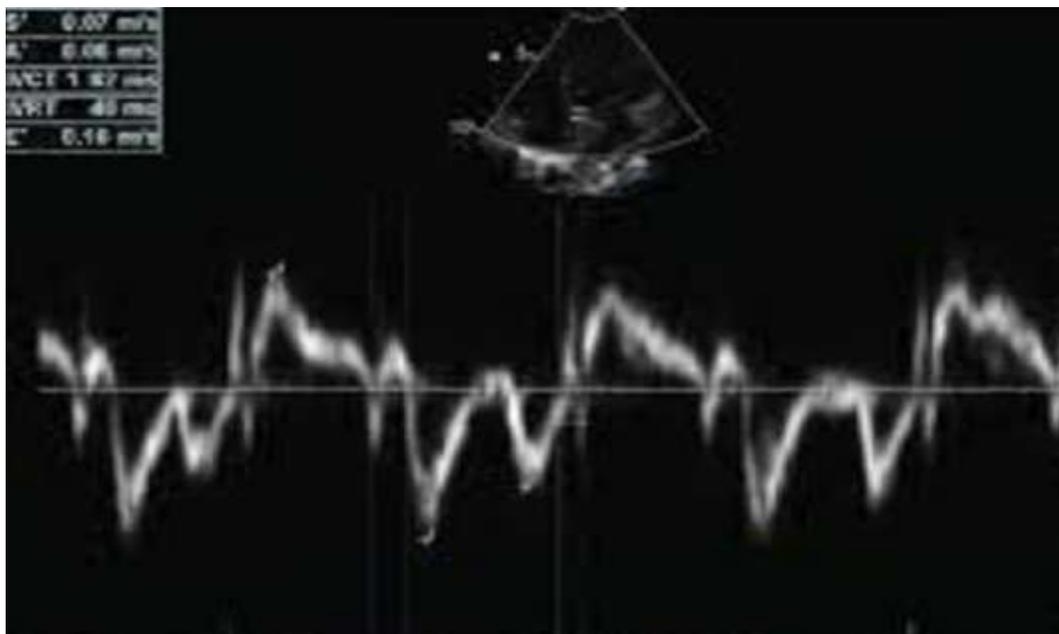


Figure (3): Tissue Doppler imaging for the assessment of systolic and diastolic function of the LV

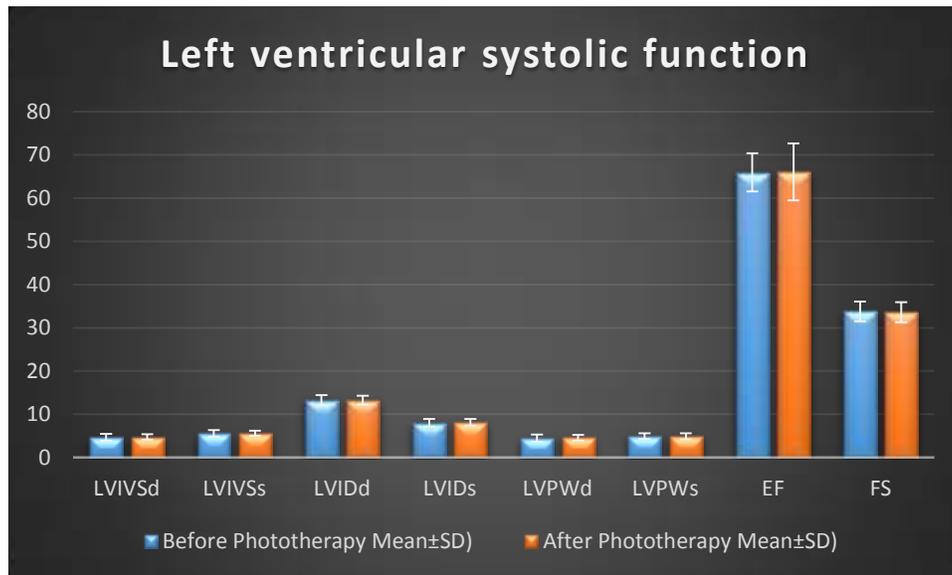


Figure (4): Comparison of the M-mode echocardiography parameter of LV systolic function before and after phototherapy

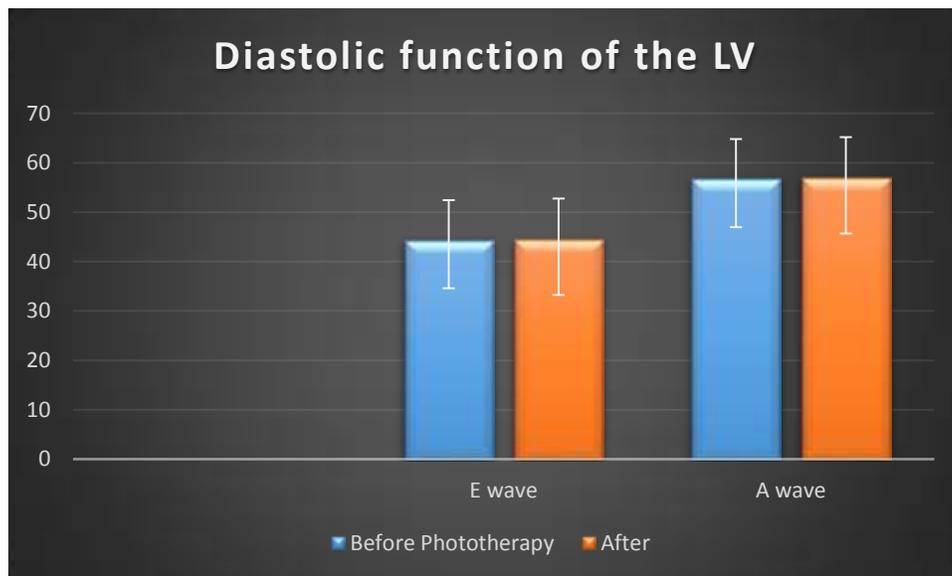


Figure (5): Comparison of the pulse Doppler echocardiography parameter for LV diastolic function before and after phototherapy

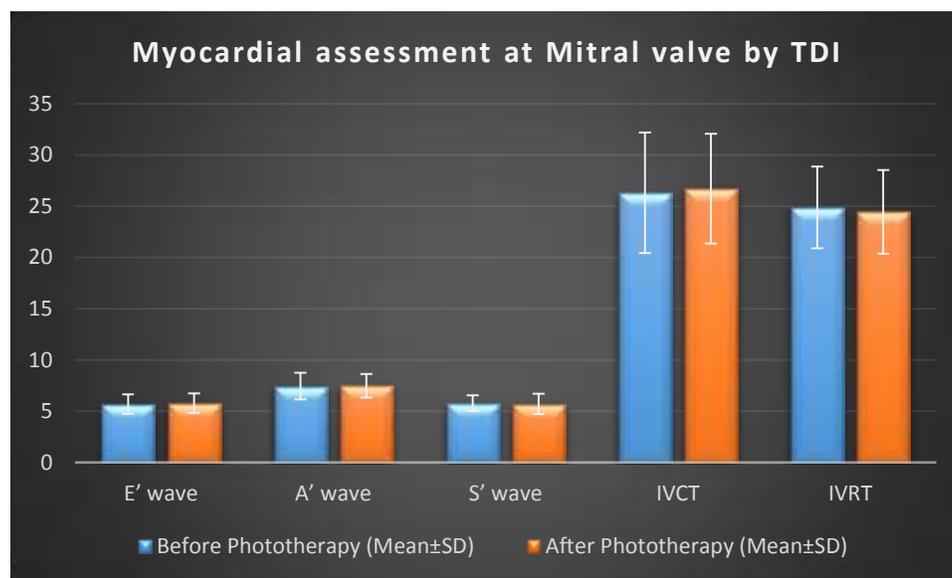


Figure (6): Comparison of the tissue Doppler imaging parameter, before and after phototherapy

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