SUMMARY & CONCLUSION
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The present study entitled "myocardial dysfunction in birth asphyxia" was conducted in the Department of Pediatrics with active collaboration of Department of Pathology and Radiology MLB Medical College, Jhansi. The cases were studied from May 05 to May 06.

In our study, a total of 70 cases were selected, of which 50 asphyxiated newborns, served as study group and 20 normal newborns served as control group. Both control group and study group neonates were further subdivided on the basis of gestational age, sex, birth weight, Apgar score at 1 min, HIE classification, mode of delivery and presence or absence of clinical cardiac manifestations.

- According to gestational age (table-1), in control group 12- (60%) were fullterm and 8 (40%) were preterm and in study group 38 (76%) were full term and 12 (24%) were preterm.
- On the basis of sex (table-2), in control group, full term male were 7 (35%) and female were 5 (25%), while preterm male were 5(25%) and female were 2 (15%). In study group, full term male were 30 (60%) and female were 8 (16%), while preterm male were 11 (22%) and female was 1 (2%).
• On the basis of birth weight, (table-3), in control group 8(40%) were low birth weight babies and 12 (60%) were normal birth weight babies, while in study group 21 (42%) were low birth weight babies and 29(58%) were normal birth weight babies.

• On the basis of Apgar score at one minute after birth (table-4) in study group, out of 38 full term neonates, 13(34.2%) had mild asphyxia, 15 (39.4%) had moderate asphyxia and 10 (26.3%) had severe asphyxia, while out of 12 preterm neonates, 4 (33.3%) had mild asphyxia, 5(41.6%) had moderate asphyxia and 3(25%) had severe asphyxia.

• On the basis of HIE classification (table-5), in study group, out of 38 full term neonates, 23 (60.5%) had grade I HIE, 10 (26.3%) had grade II HIE and 5 (13%) had grade III HIE, while out of 12 preterm neonates, 7(58.3%) had grade I HIE, 2 (16.6%) had grade II HIE and 3 (25%) had grade III HIE.

• According to mode of delivery (table-6), in control group 8(40%) fullterm and 6(30%) preterm were delivered per vaginally and 4(20%) fullterm and 2(10%) preterm were delivered by caesarean section. In study group 20(40%) fullterm and 10(20%) preterm were delivered per vaginally and 18(36%)
fullterm and 2(4%) preterm were delivered by caesarean section.

- Out of 50 cases in study group 32(64%) cases had clinical cardiac manifestations and remaining 18(36%) cases had no clinical cardiac manifestation (table-7).

- In accordance to table-8, 30(60%) cases had respiratory distress 22(44%) had CHF, 11(22%) cases had murmur and 9(18%) had shock. Out of 30 cases with respiratory distress, 13 were of grade I HIE 9 were of grade II HIE and 8 were of grade III HIE. Out of 22 cases with CHF, 6 were of grade I HIE, 8 were of grade II HIE, and 8 were of grade III HIE. Out of 11 cases with murmur, 3 were of grade I HIE, 2 were of grade II HIE, and 6 were of grade III HIE. Out of 9 cases with shock, 1 was of grade I HIE, 4 were of grade II HIE and 4 were of grade III HIE.

- The value of serum CPK-MB and LDH in control group were 27.6±13.2 IU/L range 6.2-52.6 IU/L and 133±32 IU/L; range 86.5-199.9 IU/L, while in study group were 230±152.7 IU/L; range 62-510 IU/L and 512±159.5 IU/L; range 287-761 IU/L respectively. The levels of serum CPK-MB and LDH were significantly higher in the study group as compared to the control group (table-9).
• The values of serum CPK-MB in full term control group and study group were 31.4±12.5 IU/L; range 15.2-52.6 IU/L and 225.7±150 IU/L; range 62-510 IU/L respectively, while in preterm control and study group were 21.8±12.3 IU/L; range 6.2-38.4 IU/L and 243.8±158 IU/L; range 66-501.3 IU/L respectively. No statistical significant difference was seen in the levels of CPK-MB of fullterm and preterm of either control or study group (P_FcPs = 0.1, P_FsPs > 0.1) (table-10).

• The values of serum LDH in fullterm control group and study group were 135.4±34.8 IU/L; range 96.5-199.9 IU/L and 511.4±158.4 IU/L; range 287-760 IU/L respectively, while in preterm control group and study group were 129.3±27.4 IU/L; range 86.5-179.8 IU/L and 514±162.7 IU/L; range 289-761 IU/L respectively. No statistical significant difference was observed in the levels of LDH of full term and preterm of either control or study group (P_FcPs > 0.1; P_FsPs > 0.1) (table-11).

• Serum CPK-MB and LDH levels were significantly higher in different subgroups of study group neonates as compared to the same subgroups of control group in relation to gestational age (table 10 & 11) (P_FsFc < 0.001; P PsPc < 0.001 for both CPK-MB and LDH).
• The values of serum CPK-MB in low birth weight control group and study group were 27.1±14 IU/L; range 6.2-50 IU/L and 241.7±149.6 IU/L; range 62-510 IU/L respectively, while in normal birth weight control group and study group were 27.9±12.7 IU/L; range 7.2-52.6 IU/L and 221.6±154.2 IU/L; range 62-501 IU/L respectively. No statistical significant difference was observed in the levels of CPK-MB of low birth weight babies and normal birth weight babies of either control or study group ($P_{LCNC} > 0.1; P_{LSNS} > 0.1$) (table-12).

• The values of serum LDH in low birth weight control group and study group were 136.2±30.3 IU/L; range 86.5-179.8 IU/L and 528.5±156.9 IU/L; range 287-761 IU/L respectively, while in normal birth weight control group and study group were 130.8±33.2 IU/L; range 96.5-199.9 IU/L and 500±160.5 IU/L; range 289-758 IU/L respectively. No statistical significant difference was observed in the levels of LDH of low birth weight babies and normal birth weight babies of either control or study group ($P_{LCNC} > 0.1; P_{LSNS} > 0.1$) (table-13).

• Serum CPK-MB and LDH levels were significantly higher in different subgroups of study group neonates as compared to the same subgroups of control group in relation to birth weight
(table 12 &13) \( P_{LsLc} < 0.001; \ P_{NsNc} < 0.001 \) for both CPK-MB and LDH).

- The values of serum CPK-MB in full term male of control and study group were 30.5±13.4 IU/L; range 15.2-50.6 IU/L and 236.7±153.5 IU/L; range 62-501 IU/L, while in full term female of control and study group were 32.8±10.6 IU/L; range 20.6-52.6 IU/L and 184.2±131.6 IU/L; range 72.3-510 IU/L respectively. The values of serum CPK-MB in preterm male of control and study were 21.9±13.4 IU/L; range 6.2-38.4 IU/L and 247.4±164 IU/L; range 66-501.3 IU/L, while in preterm female of control group were 21.6±10.3 IU/L; range 12.5-36.1 IU/L. There was no statistical significant difference found in the serum CPK-MB levels when full term and preterm, male and female were compared \( (P_{FcmFcF} >0.1; \ P_{FcmPcP} >0.1) \), similarly no statistical significant difference in serum CPK-MB levels were found in the full term cases of study group in relation to sex \( (P_{FcmFst} >0.1) \) (table-14).

- The values of serum LDH in full term male of control group and study group were 132±33.2 IU/L; range 96.5-191.2 IU/L and 520.5±163.9 IU/L; range 287-752 IU/L and in full term female were 140.3±35.9 IU/L; range 101-199.9 IU/L and 477.5±129.3
IU/L; range 294-760 IU/L respectively, while in preterm male of control and study group were 123.2±13.7 IU/L; range 113.2-150.1 IU/L and 513±169.9 IU/L; range 289-761 IU/L and in preterm female of control group 139.4±39.2 IU/L; range 86.5-179.8 IU/L. There was no statistical significant difference found in the serum LDH levels when full term and preterm male and female were compared ($P_{FcmFcf}>0.1$, $P_{PcmPcf}>0.1$), similarly no statistical significant difference in serum LDH levels were found in full term cases of study group in relation to sex ($P_{FsmFsf}\leq0.1$) (table -15).

- In full term neonates the values of serum CPK-MB and LDH in mild asphyxia were 78.5±13.5 IU/L; range 62-95.3 IU/L and 337.2±47.8 IU/L; range 287-411.2 IU/L, in moderate asphyxia 206.4±54 IU/L; range 130-311 IU/L and 513±40.7 IU/L; range 453-571 IU/L and in severe asphyxia 445.8±67 IU/L; range 310-510 IU/L and 735.4±18.9 IU/L; range 703.2-760 IU/L respectively. There was a statistical significant difference between mild and moderate asphyxia, moderate and severe asphyxia and mild and severe asphyxia ($P_{ab}\leq0.001$, $P_{bc}\leq0.001$, $P_{ac}\leq0.001$ for both CPK-MB and LDH) (table-16).
• In preterm neonates, the values of serum CPK-MB and LDH in mild asphyxia were 79.1±11.6 IU/L; range 66-90.3 IU/L and 334.7±44.9 IU/L; range 289-382.4 IU/L, in moderate asphyxia 240.3±81.6 IU/L; range 135-365 IU/L and 517.8±59.3 IU/L; range 451.3-600 IU/L and in severe asphyxia 469.2±42.6 IU/L; range 410-501.3 IU/L and 746.7±20.6 IU/L; range 721.3±761 IU/L respectively. There was a statistical significant difference between mild and moderate asphyxia, moderate and severe asphyxia and mild and severe asphyxia (P_{ab}<0.01 for both CPK-MB and LDH, P_{bc}<0.01 for CPK-MB, P_{bc}<0.001 for LDH, P_{ac}=0.001 for CPK-MB, P_{ac}<0.001 for LDH) (table-17).

• Full term neonates were subgrouped according to HIE classification. In grade I, serum CPK-MB and LDH levels were 151.6±85.9 IU/L; range 62-350 IU/L and 438±125.8 IU/L; range 287-709.3 IU/L, in grade II 264±130 IU/L; range 94-450.1 IU/L and 568.8±120.9 IU/L; range 401.3±746 IU/L and in grade III 500±11.8 IU/L; range 490-510 IU/L and 748±30.8 IU/L; range 740-760 IU/L respectively. There was a statistical significant difference between grade I & grade II, grade II & grade III and grade III & grade I of HIE (P_{ab}<0.01 for both CPK-MB and LDH,
$P_{bc} < 0.001$ for CPK-MB, $P_{bc} < 0.01$ for LDH, $P_{ac} < 0.001$ for both CPK-MB and LDH) (table-18).

- In preterm neonates the values of serum CPK-MB and LDH in grade I HIE were 121.8±54 IU/L; range 66-203.5 IU/L and 395±82 IU/L; range 289-525 IU/L, in grade II 355±55 IU/L; range 300-410 IU/L and 641.1±80.2 IU/L; range 560.9±721.3 IU/L and in grade III, 454.2±63.6 IU/L; range 365-501.3 IU/L and 706±78.2 IU/L; range 600-761 IU/L respectively. There was statistical significant difference between grade I & grade II and grade I & grade III but there was no statistical significant difference between grade II and grade III ($P_{ab} < 0.01$ for both CPK-MB and LDH, $P_{bc} > 0.1$ for both CPK-MB and LDH, $P_{ac} < 0.001$ for both CPK-MB and LDH) (table-19).

- Out of 50 cases in study group, 39 (78%) cases showed ECG changes, rest 11 (22%) did not show ECG changes (table 20). Main ECG changes were flat or inverted ‘T’ wave present in 39 (78%) cases, ST depression present in 23 (46%) cases and abnormal ‘Q’ wave present in 20 (40%) cases (table 21). In mild asphyxia ECG change was flat or inverted ‘T’ wave present in 6 (35%) cases. In moderate asphyxia ECG changes were flat or inverted ‘T’ wave present in 20 (100%) cases, abnormal ‘Q’
wave present in 20 (100%) cases and ST depression present in 10 (50%) cases. In severe asphyxia ECG changes were ST depression and flat or inverted T wave, each present in 13 (100%) cases (table no. 22). ECG changes in grade I HIE were flat or inverted T wave in 20 (66%) cases, abnormal Q wave in 13 (43.3%) cases and ST depression in 7 (23%) cases, in grade II HIE were flat or inverted T wave in 11 (91.6%) cases, ST depression in 9 (75%) cases, and abnormal Q wave in 6 (50%) cases and in grade III HIE were ST depression in 8 (100%) cases, flat or inverted T wave in 8(100%) cases and abnormal Q wave in 1(12.5%) cases (table no. 23).

- Serum CPK-MB and LDH levels in ECG positive cases were 272.8±144.8 IU/L; range 62-510 IU/L and 562.2±143.2 IU/L; range 289-761 IU/L, while in ECG negative cases were 78.4±45.4 IU/L; range 62-94 IU/L and 334.3±46.6 IU/L; range 287-411.2 IU/L. There was a statistical significant difference in serum levels of CPK-MB and LDH between ECG positive cases and ECG negative cases ($P_{E_{R_{E}}}<0.001$ for both CPK-MB and LDH) (table-24).

- Out of 50 cases of study group Echopositive cases were 11 (22%), while Echonegative cases were 39(78%) (table 25).
• Among echocardiographic findings, patent ductus arteriosus was present in 7 (14%) cases and tricuspid regurgitation and pulmonary hypertension were present in 4 (8%) cases (table 26).

• In mild asphyxia no echocardiographic findings were present, in moderate asphyxia, echocardiographic findings were patent ductus arteriosus in 3 (15%) cases and tricuspid regurgitation and pulmonary hypertension in 1 (5%) case and in severe asphyxia echocardiographic findings were patent ductus aneriosus in 4 (30.7%) cases and tricuspid regurgitation and pulmonary hypertension in 3 (23%) cases (table 27).

• In grade I HIE, echo findings were patent ductus arteriosus in 2 (6.6%) cases and tricuspid regurgitation and pulmonary hypertension in 1 (3.3%) case, in grade II HIE, patent ductus arteriosus in 1 (8.3%) case and tricuspid regurgitation and pulmonary hypertension in 1 (8.3%) case, while in grade III HIE, patent ductus arteriosus in 4 (50%) cases, and tricuspid regurgitation and pulmonary hypertension in 2 (25%) cases (table 28).

• The values of serum CPK-MB and LDH levels in echopositive cases were 379.5±148 IU/L; range 130-510 IU/L and 658.4±119
IU/L; range 461-761 IU/L, while in echonegative cases were 187.8±124 IU/L; range 62-490 IU/L and 470.8±144 IU/L; range 287-752 IU/L respectively. There was a statistical significant difference in serum levels of CPK-MB and LDH between Echopositive cases and Echonegative cases ($P_{EpEn} <0.001$ for both CPK-MB and LDH) (table-29).

**CONCLUSION**

From the data presented above, the following conclusions may be drawn.

- Serum CPK-MB and LDH were significantly higher in asphyxiated newborns as compared to normal newborns in both fullterm and preterm ($P<0.001$).

- Serum CPK-MB and LDH had no relationship with the gestational age, birth weight and sex of the newborn.

- There was a direct correlation of increasing levels of serum CPK-MB and LDH with increasing severity of asphyxia in both fullterm and preterm neonates.

- The increase in serum CPK-MB and LDH levels with increasing severity of asphyxia, has been ascribed to stress related efflux of CPK-MB and LDH from their respective enriched tissues.
In mild asphyxia, ECG findings were flat or inverted ‘T’ wave, in moderate asphyxia ECG findings were ST depression, flat or inverted ‘T’ wave and abnormal Q wave and in severe asphyxia the ECG findings were ST depression and flat or inverted ‘T’ wave.

In asphyxiated newborns echocardiographic findings were patent ductus arteriosus and tricuspid regurgitation and pulmonary hypertension. Serum levels of CPK-MB and LDH were significantly higher in echopositive cases as compared to echonegative cases.