Comparative Randomized Study of Balanced Salt Solution and Ringer Lactate Fluid Administration on Plasma Electrolytes, Acid Base Status and Renal Function in Cardiac Surgeries

Dr Syed Saqib Naqvi[1]

[1] S.M.S. MEDICAL COLLEGE JAIPUR RAJASTHAN INDIA

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Abstract

Intra operative fluid therapy is an integral part of anaesthesia management (1). Proper fluid therapy during surgery will avoid hypovolumia and hypotension and maintains proper tissue perfusion and oxygenation. Hypotension avoided by proper diagnosis and treatment of the underlying cause. Important causes of hypotension are blood loss, fluid depletion (intra operative fluid loss plus maintenance), third space losses, evaporative losses from wound, hypoxia and vasodilatory effect of anaesthetic agent. Fluid therapy should not only lead to stablization of macrocirculation, but also of microcirculation. Microcirculation especially seems to be affected by different volume substitution fluid. Physiology and pathophysiology of fluid compartment should be accounted for when decision has to be made among different solution (2). Patient who have to undergo cardiac surgery present a major challenge to the anaesthetist beyond the problem of fluid therapy. In cardiac patient oedema is due to water and salt retention so total body water and sodium is more in these patient but retention of water is more than that of salt so hyponatremia is frequently seen which is dilutional. Remember that hyponatremia is usually dilutional and need fluid restriction. In cardiac patient when diuretics instituted urine output will increase don?t follow routine guidelines of fluid replacement.

Index terms—

Introduction-Intra operative fluid therapy is an integral part of anaesthesia management (1). Proper fluid therapy during surgery will avoid hypovolumia and hypotension and maintains proper tissue perfusion and oxygenation. Hypotension avoided by proper diagnosis and treatment of the underlying cause. Important causes of hypotension are blood loss, fluid depletion (intra operative fluid loss plus maintenance), third space losses, evaporative losses from wound, hypoxia and vasodilatory effect of anaesthetic agent. Fluid therapy should not only lead to stablization of macrocirculation, but also of microcirculation. Microcirculation especially seems to be affected by different volume substitution fluid. Physiology and pathophysiology of fluid compartment should be accounted for when decision has to be made among different solution (2). Patient who have to undergo cardiac surgery present a major challenge to the anaesthetist beyond the problem of fluid therapy. In cardiac patient oedema is due to water and salt retention so total body water and sodium is more in these patient but retention of water is more than that of salt so hyponatremia is frequently seen which is dilutional. Remember that hyponatremia is usually dilutional and need fluid restriction. In cardiac patient when diuretics instituted urine output will increase don't follow routine guidelines of fluid replacement.

1 Introduction

ntra operative fluid therapy is an integral part of anaesthesia management (1). Proper fluid therapy during surgery will avoid hypovolumia and hypotension and maintains proper tissue perfusion and oxygenation. Hypotension avoided by proper diagnosis and treatment of the underlying cause. Important causes of hypotension are blood loss, fluid depletion (intra operative fluid loss plus maintenance), third space losses, evaporative losses from wound, hypoxia and vasodilatory effect of anaesthetic agent. Fluid therapy should not only lead to stablization of macrocirculation, but also of microcirculation. Microcirculation especially seems to be affected by different volume substitution fluid. Physiology and pathophysiology of fluid compartment should be accounted for when decision has to be made among different solution (2). Patient who have to undergo cardiac surgery present a major challenge to the anaesthetist beyond the problem of fluid therapy. In cardiac patient oedema is due to water and salt retention so total body water and sodium is more in these patient but retention of water is more than that of salt so hyponatremia is frequently seen which is dilutional. Remember that hyponatremia is usually dilutional and need fluid restriction. In cardiac patient when diuretics instituted urine output will increase don't follow routine guidelines of fluid replacement. Our aim is to remove extra fluid from the body so restrict fluid intake despite good urine output. During cardiac surgery the patient partly experience extreme condition like cardiac arrest or deep hypothermia unlike in any other sub speciality. In the immediate postoperative period, relative insufficiency of blood volume may often occur, especially intra operative use of cardiopulmonary bypass often induces capillary leakage which may lead to interstitial oedema during concomitant intravasal volume depletion (3). Maximising the cardiac output by fluid infusion benefits patient undergoing cardiac surgery but they may not tolerate large volume of fluid due to impaired cardiac performance hence fluid resuscitation without or with minimal risk of fluid excess might be beneficial. A perfect balanced fluid could be considered to be one in which any change induces in total concentration of non volatile weak acid is offsets by a change it induces in strong ion difference so that pH remain stable (4). No fluid is perfect fluid for perioperative volume replacement in the extracellular space during cardiac surgery Currently available balanced crystalloid solution have lower overall osmolarity than 0.9 % NaCl with a lower Sodium (Na) concentration and much lower lower chloride ion concentration. Reduction in anionic content is compensated for by the addition of stable organic anion buffer such as lactate, gluconate or acetate. Colloid intravascular fluid therapy affect acid base balance are iatrogenic acidosis caused by the administration chloride rich fluid and administration of sodium bicarbonate to correct acidosis.

This study was carried out with the aim to compare and assess Balance salt solution (BBS) and Ringer Lactate (RL) fluid administrations on plasma electrolytes, acid base status and renal function in patient undergoing cardiac surgeries on cardiopulmonary bypass.

2 II.

3 Materials and Methodology

It is a Hospital based, prospective randomized double blind, Interventional study .Total 80 Cases was 40 in each group Randomization was done by sealed envelope method & blinding was done by covering the solution bottle with bag.

Group A (n=40) received balanced salt solution (BSS) intravenous (5ml/ kg /hour) and in the priming solution1500 ml + 6% hydroxyethyl starch 500ml (130/0.42). Group B (n=40) received RL intravenous (5ml/ kg /hour) and in the priming solution1500 ml + 6% hydroxy ethyl starch 500ml (130/0.42).

Patients included for study were Male and female patients undergoing cardiac surgery on cardiopulmonary bypass, ASA Grade II,III, Age 30-60 Years, weighting 40-60 Kilogram with normal coagulation profile liver and kidney functions. After thorough preanaesthetic check up written informed consent was obtained.

Emergency and redo surgery, patient with Congestive heart failure, renal, liver and respiratory disorder were excluded from the study.

After confirming written informed consent and fasting status, patients were taken on the operation table. Baseline vital parameters like HR, BP, respiratory rate were recorded. 18G i.v. cannula secured. All patient started fluid @ 5ml/kg/hr in peripheral line according to the assigned group .12 lead ECG and pulse oximeter were attached. Patient was premedicated with i.m. morphine 0.1 mg/kg and i.m. promethazine 0.5 mg/kg. After that femoral artery cannulation was performed and central venous catheter was inserted into right internal juglar vein under local anaesthesia. Base line parameter were recorded in the form of HR, MAP, CVP and ABG. Patient was preoxygenated with 100% O2 for 3 minute. Induction of anaesthesia was done with inj midazolam 0.05 mg/kg, inj. fentanyl 5µg/kg & Inj. Etomidate 0.3mg/kg IV slowly over a period of 60-90 second until there was loss of eyelash reflex and lack of response to verbal command. Inj. Rocuronium bromide 0.9 mg/kg I.V. was given to facilitate the intubation. Oral tracheal intubation was done by appropriate sized cuffed endotracheal tube at 2 minute after induction. Position of tube was checked and fix with adhesive. HR, MAP, CVP recorded. Maintainance of anaesthesia with 100% O2, inj. midazolam .01mg/kg hourly, inj. Vecuronium .05 mg/kg every half hourly. Nasopharyngeal temperature probe and nasogastric tube were secured. Patient was catheterised with foleys urinary catheter and urine output was recorded. Patient taken on cardio pulmonary bypass circuit which was primed with 1500ml Balanced salt solution+ 500ml 6% Hydroxy ethyl in Group-A, 1500ml RL + 500ml 6% Hydroxy ethyl starch (130/0.42) in group B.

After completion of surgery patient was shifted to ICU. Extubation criteria were include adequate level of consciousness and muscle strength, stable cardiovascular status, normothermia, adequate pulmonary function and minimal thoracotomy tube output. Pulse, NIBP, ECG, SpO2 were assessed.

4 a) Data Recorded

Primary variables plasma electrolytes (sodium, chloride), lactate, bicarbonate, pH levels. Secondary variables blood glucose, serum creatinine levels, hemodynamic parameters (HR, MAP, CVP, Spo2) were noted at the interval mentioned Base line(T0), After anaesthesia induction(T1), Before going on bypass (T2), After coming of bypass(T3), At the end of surgery (T4) , 2 hour after surgery(T5) and 24 Hours after beginning of surgery(T6).

5 III.

6 Statistical Analysis

Continuous data were summarized in from of mean and standard deviation. The difference in means was analyzed using student t-test .Count data we form of proportions. The difference in proportions was analyzed using Chi-Square test. The level of significance was kept 95% for all statistical analysis re summarized in form of proportions. The difference in proportions was analyzed using Chi-Square test. The level of significance was kept 95% for all statistical analysis.

7 IV.

8 Results

There were no statistically significant difference in the demographic data between the two groups .In both the groups all variables were comparable at baseline.(Table **??**,2). The baseline blood glucose levels were comparable in both of the groups. In present study the mean glucose was higher in group B than group A. This can be explained due to conversion of lactate to bicarbonate and gluconeogenesis. Various studies were in accordance with present study.

There was no significant difference between both the groups at baseline and interval T1 and T3. There was significant difference between group A and group B at interval T2,T4,T5,T6. The mean glucose was higher in group B than group A. (Graph 2). Baseline heart rate, MAP, CVP and SPO2 were comparable in both the groups at different time intervals. In our study there was no significant difference between both the groups in MAP at interval T1,T2,T3,T5,T6 (p value >.05) and there was significant difference between both the groups at interval T4.There was increased in MAP after anesthesia induction and decreased at T2 interval.

9 b) Serum Electrolytes

There was no significant difference in Sodium (Na+) between both the groups (p value>.05) at baseline and at all intervals. In our study There was statistical significant difference between both groups in mean Bicarbonate (HCO 3 -) at interval T3,T5,T6. Mean HCO 3 was higher in group A than group B. we found that the Cl-was lower in group A then group B at interval T5, T6 this Is in accordance with previous studies. In our study in the reference of pH there was no significant difference between both the groups (p value >.05) at baseline and interval at T1,T2,T3,T4,T5.

There was significant difference between both the groups at interval T6. The mean pH was higher in group A than group B. No significant difference observed between two groups at baseline (p value >.05)

There was statistically significant difference between both the groups at all intervals in the mean of lactate concentration which was higher in group B than group. In our study there was no significant difference between two groups at baseline (p value >.05) (Ggraph 1).

Graph 2: Showing blood Glucose lavels in both groups. There was significant difference between group A and group B in Serum creatinine and p value was 0.0003 the mean creatinine was higher in group B than group A while base line values were comparable. (Graph 3).

Graph 3: Showing mean Creatinine lavels in both the groups.

V.

10 Discussion

Perioperative intravenous fluid therapy has been a much neglected area of clinical practice (5,6) and suboptimal prescribing has often resulted in morbidity and even mortality. (7),During CPB, mild to severe dysfunction occurs in many organs due to physiological alterations inherent to this technique. As blood is exposed to foreign surfaces, a series of inflammatory reactions that induce changes in capillary permeability are activated. Furthermore, the hemodilution causes by CPB lowers the osmotic pressure, resulting in oedema that may compromise the normal function of many organs (8,9).

A balanced electrolyte solution has the physiological electrolyte pattern of plasma in terms of sodium, potassium, calcium, magnesium, chloride and their relative contributions toward osmolality, and achieves a physiological acid-base balance with bicarbonate or metabolizable anions. Infusion of such a balanced solution

is devoid of the risk of iatrogenic disruptions except for potential volume overload. A balanced solution should reflect the physiological roles of the sodium, potassium, calcium, and magnesium cations, and also contain chloride and phosphate anions, and, above all, bicarbonate. (10) With this back ground, the present study was performed to compare Balanced Salt Solution and Ringer Lactate fluid administration on plasma electrolytes, acid base status and renal function in ca Various studies have been performed to see the effect of Balanced salt solution and RL solution on heart rate during at different time intervals. In our study we found that difference in rate was not significant among both groups during all intervals. This is in accordance with previous studies conducted by Thomas Stand et al in 2010 who found no significant difference among Hydroxyethyl starch 6% in a balanced electrolyte solution during cardiac surgery(11).

Anne kiran kumar et al in 2017 also found that the difference in heart rate was not significant by administration RL and Kabilyte. In our study there was no significant difference between both the groups (p value >.05). increased in heart rate after anesthesia induction (T1) in both the groups might be explained as the effect of laryngoscopy and intubation (12).

The presenting study was similar with Anne Kiran Kumar et al in 2017 and Jigar Patel et al in 2016 where they also observed that the mean arterial pressure was not significantly differ after administration of ringer lactate and Kabilyte (12)and priming CPB by albumin,Hydroxyethyl starch respectively(13).

In our study there was no significant difference between both the groups at interval T1,T2,T3,T5,T6(p value >.05) and there was significant no significant difference in cvp after difference between both the groups at interval T4.There was increased in MAP after anesthesia induction and decreased at T2 interval.

Central venous pressure was comparable in both the groups there was no significant difference between both the groups (p value >.05) at baseline and at all time intervals.

Clindy Elfir Boom et al in 2013 and Carlo Alverto Volta et al in 2013 also observed same results after administration of sodium lactate and balanced fluid during cardiac surgery (14,15).

In reference to S P O 2 % the presenting study was comparable with Carlo Alverto Volta et al in 2013 and Hasan ALper Gurbuz et al in 2013 they also found that the S p O 2 % not significantly differ among both the study groups.

11 Serum Electrolytes

There was no significant difference in Sodium (Na+) between both the groups (p value>.05) at baseline and at all intervals. This was in concordance with study of Carlo Alberto et al in 2013 (15).

Different studies have been performed to see the effect of balanced salt solution and ringer lactate on chloride (Cl-). In our study we found that the cl-was lower in group A then group B at interval T5,T6 this Is in accordance with previous studies.

James MFM et al in 2011 also found that that the Clwas not increased by balanced salt solution administration and cl-was increased by RL infusion during surgery(16).

The present study was in concordance with Carlo Alverto volta et al in 2013 who found that there was no hyperchloremia with balanced salt solution in patients undergoing abdominal surgeries but normal saline administration should dilute the bicarbonate concentration of the extracellular space. Based on the Stewart's approach, the decrease of the strong ion difference is mainly the result of the plasmatic increase of chloride (hyperchloremic acidosis) (15).

The presenting study was similar with Bertrand Guidet et al in 2010 and they found that dilutionalhyperchloraemic acidosis is a side effect, mainly observed after the administration of large volumes of isotonic saline as a crystalloid. In this particular setting, however, the effect remains moderateand relatively transient (24 to 48 hours), and is minimized with the use of balanced solution (17).

Our study results differ with Anne Kiran Kumar et al in 2017. Who observed higher lavels of chloride (RL and sterofundin) compared to plasma, less than that in normal saline but there was no significant no difference between the groups in reference to the chloride (7).

There was no significant difference between both the groups at baseline and at interval T1,T2,T4.

There was statistical significant difference between both groups in mean bicarbonate (HCO 3 -) at interval T3,T5,T6 .Mean HCO 3 was higher in group A than group B.

The present study was in concordance with Roger J Smith et al in 2010, who found that there was reduced incidence of metabolic acidosis with balanced salt solution group (4).

Carlo Alverto Volta et al in 2013 found similar result as our study that bicarbonate level was higher with balanced salt solution than unbalanced salt solution (15).

Thomas Stand et al in 2010 found in their study that The serum chloride level (mmol/L) was lower ($p < 0.05$ at the end of surgery), and arterial pH was higher in the balanced group at all time points except baseline, and base excess was less negative at all time points after baseline ($p < 0.01$) (11)

The presenting study was against the study by Anne Kiran Kumar et al in 2017 who found that balanced salt solution and ringer lactate give similar outcome on acid basis status(no change) (7).

In our study in the reference of pH there was no significant difference between both the groups (p value >.05) at baseline and interval at T1,T2,T3,T4,T5.

There was significant difference between both the groups at interval T6. The mean pH was higher in group A than group B.

The present study was in concordance with Carlo Alverto Volta et al in 2013, and they found that there was metabolic acidosis with unbalanced salt solution(15).

Bertrand Guidet et al 2010 found that pH was more with balanced solution then unbalanced solution. and they concluded that dilutional hyperchloraemic acidosis is a side effect, mainly observed after the administration of large volumes of isotonic as a crystalloid. In this particular setting, however, the effect remains moderate and relatively transient (24 to 48 hours), and is minimized with the use of colloids(17).

Anne Kiran Kumar et al in 2017. found similar results that pH was more with balanced solution than unbalanced solution (7).

Anne Kiran Kumar et al in 2017, found that the lactate level was more with RL solution (7).

The present study was in accordance with Carlo Alverto Volta et al in 2013, and they found that the lactate level was more with RL Solution then salt solution (15).

In our study there was no significant difference between two groups at baseline (p value >.05)

There was statistically significant difference between both the groups at intervals T1, T2,T3,T4,T5 and T6 The mean of lactate concentration was higher in group B than group A.

The baseline blood glucose was comparable in both of the groups. In present study the mean glucose was higher in group B than group A. This can be explained due to conversion of lactate to bicarbonate and gluconeogenesis various studies was in accordance with present study.

Anne Kiran Kumar et al in 2017, found similar results that the glucose level was more with RL solution (7).

The present study was consistent with Carlo Alverto Volta et al in 2013, as they found that the glucose level was more with RL Solution than balanced salt solution group (15).

There was significant difference between group A and group B in Serum creatinine and p value was 0.0003 the mean creatinine was higher in group B than group A.

The present study was in concordance with SM Alvani, et al 2012 and they also found that kidney function was better in the short term in the HES group than in the other two groups(RL and Gelatin Group) (18). Carlo Alverto Voltaet et al in 2013 also observed that the use of balanced solutions was responsible of less alteration of kidney function and it might be associated with an early anti-inflammatory mechanisms triggering.

The present study was against with Hasan Alper Gurbuz et al in 2013, and they did not document any difference between HES and crystalloid solutions used for CPB priming regarding postoperative outcomes like postoperative bleeding, renal functions and the use of blood and FFP (6).

Limitations of the study This study had some limitations including the absence of the data expressing cardiac contractility after BSS or RL infusion and measurement of extra vascular lung water. we were anable to measure due to lack of suitable monitors.

12 VI.

13 Conclusion

The

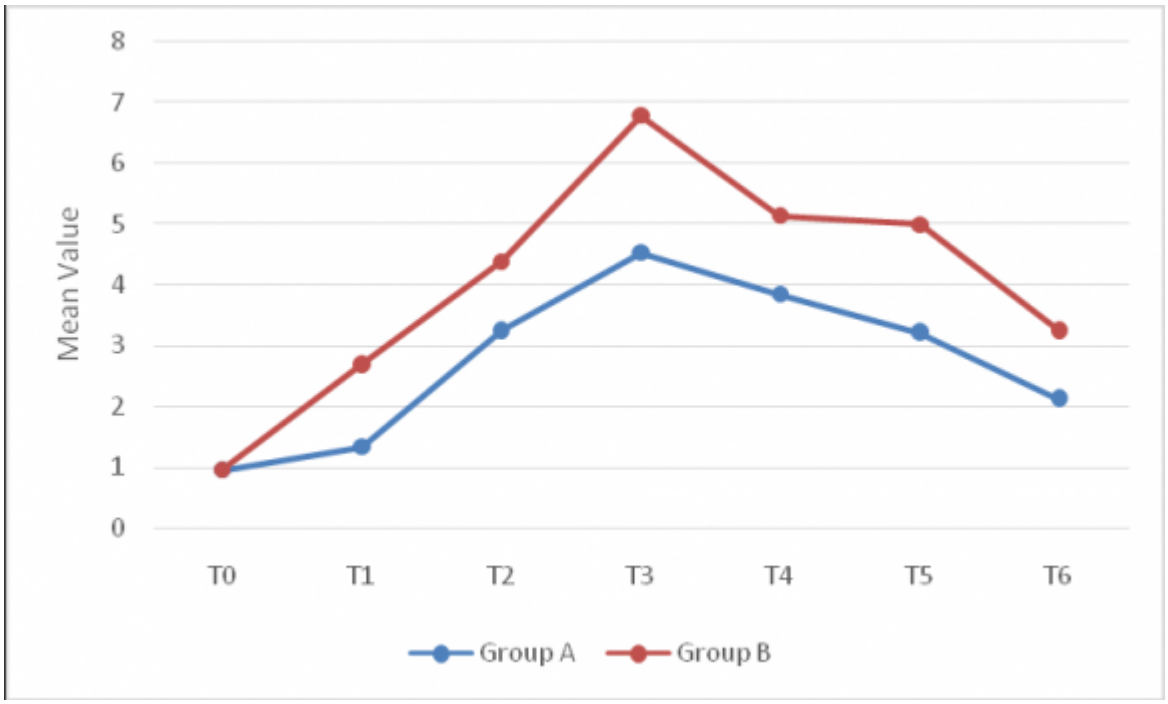

Figure 1:

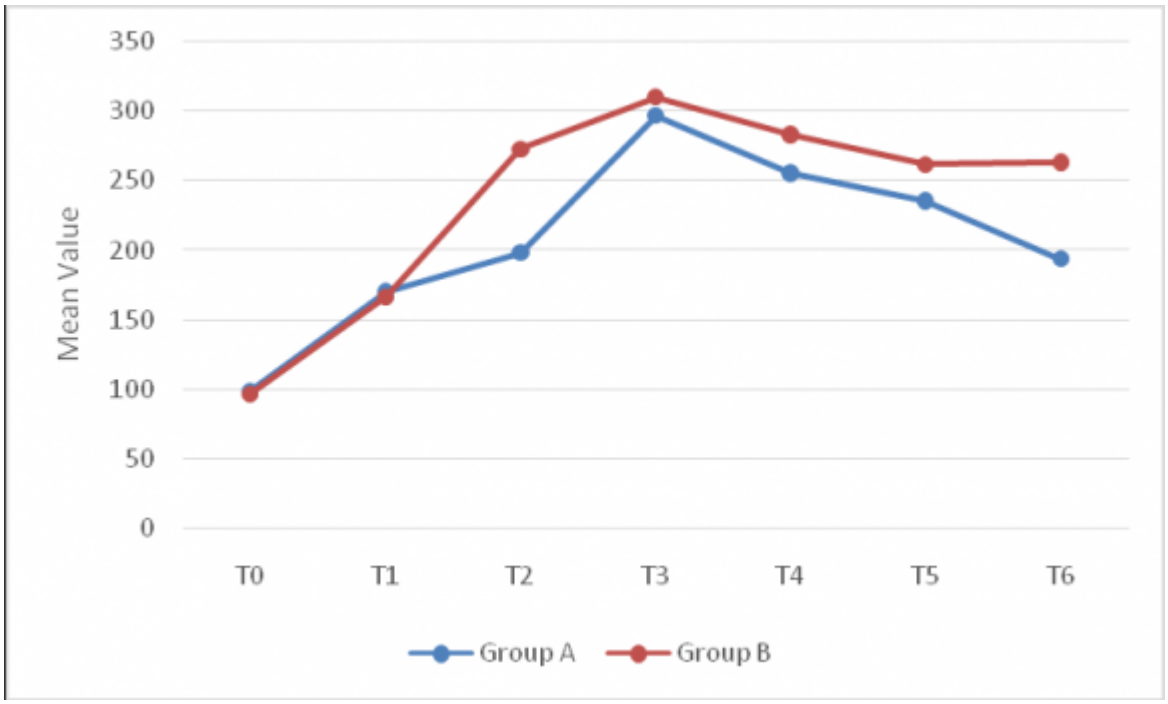

Figure 2:

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	Group A		Group B		p value	Significance
Mean Age	Mean	SD	Mean	SD		
(years)	39.80	8.13	39.65	8.09	0.934	N.S.
Mean Weight(kg)	48.80	7.29	49.25	7.33		
Mean height(cm)	147.70	8.04	148.35	8.27	0.722	NS
Duration of Surgery(Hours)	2.70	0.56	2.48	0.51	0.064	NS

Table 2

	Group A		Group B	
	No.	%	No.	%
ASA Grade 2	25	62.5	23	57.5
ASA Grade 3	15	37.5	17	42.5
Total	40	100.00	40	100.00
	No.	%	No.	%
Male	19	47.5	15	37.5
Female	21	52.5	25	62.52
Total	40	100.00	40	100.00

[Note: Graph 1: Showing distribution of mean Lactate lavels in two groups.]

Figure 3: Table - 1

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Figure 4:

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