Cardiology in the Young

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The effect of albumin and total protein values as nutritional markers after Fontan surgery on prognosis

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Abstract

Introduction: Children with CHD develop heart failure due to increased pulmonary blood flow, cyanosis, and pulmonary hypertension. The metabolic needs of these children differ from those of healthy children, and malnutrition is common. Protein-losing enteropathy has been reported in 5 to 13% of patients after the Fontan procedure. Serum albumin and total protein levels, which are indicators of the quality of post-operative care, can be useful tools for monitoring and examining the intensive care treatment strategies of these patients. In our retrospective study, the effects of albumin and total protein values, which are two of the markers that give us an idea about diet, nutritional status, and inflammation, on the prognosis of children who underwent the Fontan procedure were investigated. *Method:* In our study, 127 patients who underwent Fontan procedure in our clinic between 2012 and 2021 were analysed retrospectively. Of the patients, 52.7% (n = 67) were male and 47.3% (n = 60) were female. The mean age is 5.83 ± 4.63 years. Patients who underwent albumin replacement were not included in the study. *Results:* Although the relationship between pre-operative albumin and total protein values and post-operative mortality was not statistically significant, the inverse correlation of post-operative albumin 1st, 2nd, and 3rd-day values and post-operative total protein 1st, 2nd, and 3rd-day values with mortality was found to be statistically significant. In addition, we found that mortality was statistically high in patients whose total protein amount was below 6.65 mg/dl in the early post-operative period. *Conclusion:* Albumin and total protein, whose blood levels can vary with diet, can be used as predictors in the early post-operative prognosis of Fontan patients. In addition, when we examined the exitus patients, it was observed that the total protein amount was below 6.65 mg/dl on the post-operative 1st day. Based on this, we think that a diet with high protein content before surgery will help reduce post-operative early mortality.

Introduction

Children with CHD develop heart failure due to increased pulmonary blood flow, cyanosis, and pulmonary hypertension. As a result, the metabolic needs of these patients differ from those of healthy children. Gastrointestinal malabsorption disorders due to increased oxygen demand and low cardiac output, low-calorie intake, and increased calorie requirement cause malnutrition. The degree of CHD and the degree of malnutrition are directly proportional.[1,2]

Inadequate gastrointestinal absorption causes insufficient serum visceral protein synthesis and inflammation. Thus, low serum albumin, pre-albumin level, and total protein levels occur. Hypoalbuminemia causes liver dysfunction, end-stage liver disease, increased catabolism, nephrotic syndrome, and protein-losing enteropathy in both acute and chronic stages.[3]

Protein-losing enteropathy has been reported in 4–13% of patients undergoing the Fontan procedure. Protein-losing enteropathy is thought to occur secondary to increased systemic venous pressure. Decreased cardiac output, venous congestion, increased mesenteric vascular resistance, and intestinal inflammation may adversely affect the clinical course.[4] In addition, persistent peripheral oedema due to hypoalbuminemia and ascites develops in the abdomen and pleural effusions may occur in the post-operative period. In addition, recurrent infections are seen due to the decrease in immunoglobulin levels and lymphocytes. Dietary regulation, albumin replacement, and steroid therapy in the post-operative period constitute the basic elements of medical treatment.[5] Serum albumin level, which is an indicator of the quality of post-operative care, can be a useful tool for the follow up and examination of intensive care treatment strategies of these patients.[6]

The aim of this study is to investigate the effects of albumin and total protein values, which give us an idea about nutrition and inflammation, on the prognosis of the Fontan procedure.

Material and method

In our study, 127 patients who underwent Fontan procedure in our clinic between 2012 and 2021 were retrospectively analysed and included in the study. We routinely use fresh frozen plasma as a cardiopulmonary bypass prime solution, and we use erythrocyte suspension in patients with a haematocrit below 27. We do not routinely use albumin in cardiopulmonary bypass. We add albumin to the prime solution in patients with albumin levels below 2.5 mg/dl. Patients who underwent albumin replacement were not included in the study. Catheter angiography is routinely performed on patients in the pre-operative period. Pre-operative pulmonary pressures and pulmonary circulation values were evaluated and noted. Alanine amino transferase aspartate amino transferase, creatinine, urea, albumin, and total protein values of the patients included in the study were recorded in the pre-operative and post-operative first three days, and their effect on prognosis was evaluated.

Median sternotomy incision was used in all patients. "Fontan" circulation is completed by anastomosis between the inferior vena cava and the right pulmonary artery using a polytetrafluoroethylene graft suitable for the weight, height, and age of the patients. Cardiopulmonary bypass was entered using the superior vena cava, inferior vena cava, and aortic cannula. We do not put a cross-clamp during these anastomoses. When intracardiac procedures such as atrioventricular valve repair were required, the heart was stopped with blood, custadiol, or del nido cardioplegia solutions and the procedure was performed under cross-clamping. At the end of the procedure, patients were appropriately weaned from cardiopulmonary bypass. We routinely cut off the pulmonary antegrade flow of patients during the operation. We monitor the pulmonary pressures in the perioperative period and evaluate the appropriateness of the Fontan circulation intra-operatively.

Intracardiac Fontan procedure was performed in 11 patients and extracardiac Fontan procedure was performed in 116 patients. In the follow up of the patients, a balance between adequate diuresis and <3 mmol/L lactate level was tried to be achieved. Especially colloids have been used to provide cardiac output. Extracorporeal membrane oxygenator support was applied if the low cardiac output syndrome persisted despite volume replacement and inotropic support. Extracorporeal membrane oxygenator need, pre-operative echocardiographic data, systemic ventricular evaluation, post-operative intensive care follow up, and blood gas analysis were noted. Vasoactive-inotrope score score (Vasoactive-inotrope score) was calculated as follows; dopamine dose (mg/kg/min) + dobutamine dose (mg/kg/min) + 100 × dose of epinephrine (mg/kg/min) + 100 × dose of norepinephrine (mg/kg/min) + 10,000 × dose of vasopressin (U/kg/min) + 10 × milrinone dose (mg/kg/min).

Fenestration was opened in patients who were expected to have high pulmonary pressure and who were found to have high pulmonary pressure in intra-operative measurements. Fenestration was created between the right atrium and the polytetrafluoroethylene graft. A four-millimetre punch was used to open a fenestration between the graft and the right atrium.

Number Cruncher Statistical System 2007 (Kaysville, Utah, USA) programme was used for statistical analysis. While evaluating the study data, descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum, maximum) as well as the distribution of the data were evaluated with the Shapiro–Wilk Test. The Mann–Whitney U Test was used to compare the quantitative data between two groups that did not show normal distribution. Friedman test was used for comparisons of three or more periods, and Wilcoxon test was used for comparisons of two periods. Spearman's correlation analysis was used to determine the relationship between quantitative data. Roc analysis was performed to determine the predictive value of the quantitative data. Logistic regression analysis was used to determine the independent variables affecting the dependent variable. Significance was evaluated at $p < 0.01$ and $p < 0.05$ levels.

The study was carried out retrospectively, in accordance with the Declaration of Helsinki, with the permission of the hospital management, taking into account the ethical rules.

Results

In total, 52.7% (n = 67) of the patients included in the study were male. In terms of systemic ventricle, 74% (n = 94) of the patients were left-sided and 26% (n = 33) were right-sided. Extracorporeal membrane oxygenator was used in 14.1% (n = 18) of the patients, while extracorporeal membrane oxygenator was not required in 85.9% (n = 109) of the patients. While 34.7% (n = 26) of the patients died, 65.3% (n = 49) of the patients survived. While fenestration was performed in 29.1% (n = 37) of the patients, fenestration was not performed in 70.9% (n = 90) of the patients.

Patients' age (years), operative time (min), weight (kilograms), pre-operative SpO_2 (%), post-operative SpO_2, vasoactive-inotrope score Score, po 24 hours highest BP (mmHG), po 24 hours max lactate level (mmol/dL), po 24 Hours highest central venous pressure (mmHG), ICU stay (days), service hospitalisation time (days), total hospital stay (days), ventilation time (hours), pre-op pulmonary pressure (mmHg), total bypass time (minutes)), and aortic cross-clamp time (minutes) values are given in the table (Table 1).

Table 2 compares the exitus and living Fontan patients; 24-hours max lactate, ICU hospitalisation time, service hospitalisation time, ventilation time, pre-op pulmonary pressure, total bypass time, aortic cross-clamp time time, Albumin Postop-1. day, Albumin Postop-2. day, and Albumin Postop-3. day values were found to be statistically significant. Pre-op albumin values were statistically insignificant (Table 2).

There are statistically significant changes in albumin, total protein, and creatinine levels on post-operative days ($p = 0.001$; $p < 0.01$) (Table 3).

There is a statistically significant difference in alanine amino transferase and aspartate amino transferase levels on post-operative days. ($p = 0.001$; $p < 0.01$). It was found statistically significant that the pre-operative alanine amino transferase and aspartate amino transferase values were lower than the other periods ($p = 0.001$; $p < 0.01$). It was found statistically significant that the alanine amino transferase and aspartate amino transferase values on the post-operative 1st day were lower than the post-operative 2nd day and post-operative 3rd day ($p = 0.001$; $p < 0.01$).

When the lower limit of total protein was taken as 6.65, the sensitivity was determined as 92.3% and the specificity as 81.6% as the reliable cut-off point (Fig. 1).

In the correlation analysis, there is a positive correlation between length of stay in ICU and ventilation time, pre-operative pulmonary artery pressure values, cardiopulmonary bypass time, and aortic cross-clamp time. Correlation coefficients were 0.887– 0.540– 0.554– 0.443, respectively ($p < 0.01$). There is a positive correlation between ventilation time and pre-operative pulmonary

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Table 1. Averages of demographic data

	Mean ± Sd	Min–Max (Median)
Age (years)	5,83 ± 4,63	2–23 (4)
Operation time (min)	312,56 ± 97,47	100–580 (310)
Weight (kilogram)	20,17 ± 13,51	8,4–70 (15)
Pre-operative SpO_2 (%)	81,6 ± 4,83	70–91 (81)
Post-operative SpO_2 (%)	89,69 ± 3,67	83–97 (89)
VIS score	13,33 ± 4,1	0–22 (14)
Po 24 hour peak systolic bp (mmHG)	140,71 ± 27,06	90–200 (140)
Po 24 hours max lactate (mmol/dL)	11,6 ± 3,82	4–21 (11)
Po 24 hours highest CVP (mmHG)	18,17 ± 3,62	7–28 (18)
ICU duration (days)	15,73 ± 13,53	3–64 (10)
Service time (days)	10,13 ± 9,69	0–49 (10)
Total length of stay in hospital (days)	25,87 ± 14,37	4–89 (22)
Ventilation time (hours)	10,55 ± 13,91	1–64 (3)
Pre-op pulmonary pressure (mmHg)	12,04 ± 3,7	4–20 (11)
Total bypass (minutes)	118,97 ± 41,27	72–280 (104)
ACC (minutes)	19,24 ± 34,59	0–140 (0)

Po=post-operative; Bp=Blood pressure; ACC=Aortic cross-clamp time; CVP=central venous pressure; VIS=vasoactive-inotrope score.

artery pressure values, and cardiopulmonary bypass time and aortic cross-clamp time. Correlation coefficients were 0.624–0.494–0.393, respectively ($p < 0.01$).

There was an inverse and weakly significant correlation between the length of stay in the ICU and albumin on the 2nd post-operative day ($r = -0.351$, $p < 0.01$). There was an inverse and weakly significant correlation between the maximum lactate level in the first 24 hours post-operatively and the albumin level on the post-operative 1st day ($r = -0.324$, $p < 0.01$). There is an inverse and very weak significant correlation between total length of stay in hospital and post-operative 2nd day albumin ($r = -0.248$, $p < 0.05$). There was no statistically significant difference between albumin values and the amount of drainage in the first three post-operative days ($p > 0.05$).

Discussion

After Fontan surgery, patients are most at risk of ventricular dysfunction, bronchitis, protein-losing enteropathy, and chronic Fontan failure. When we look at protein-losing enteropathy, we see that the levels of albumin and total protein will have an effect on the prognosis. Pre-operative risk stratification is important and guiding in the follow up of these patients.

Hypoalbuminemia is common in children with paediatric heart disease. Surgical stress is manifested by a decrease in serum albumin concentrations. It has been stated that serum albumin concentration may be associated with the risk of post-operative infection. Hypoalbuminemia is an independent risk factor for patients undergoing paediatric heart surgery.[7,8] In our study, a weak inverse correlation was found between the albumin values on the post-operative 1st day and the post-operative 24 hour maximum lactate values. This situation was interpreted in favour of the positive effect of albumin on peripheral tissue perfusion.

The effect of nutritional parameters on prognosis in patients undergoing paediatric heart surgery was investigated, but no significant relationship was found. When evaluated together with anthropometric parameters, a link between malnutrition and post-operative morbidity has not been established yet. However, albumin values used to determine the degree of malnutrition have been found to affect post-operative prognosis and mortality.[9,10] In our study, it was found statistically significant that post-operative low albumin values were associated with mortality. The post-operative 1st, 2nd, and 3rd-day values of albumin were found to be higher in the living group compared to the exitus group ($p(po1) = 0.01$; $p(po2) = 0.005$ $p(po3) = 0.015$ $p < 0.05$). We also believe that post-operative albumin values also have an effect on mortality.

Berbel-Franko et al. stated that the degree of hypoalbuminemia after open heart surgery has negative effects on the development of post-operative complications (especially septic or bleeding complications) and long-term mortality, and they stated that the development of hypoalbuminemia may be due to nutritional and inflammatory factors.[6] In our study, an inverse and weakly significant correlation was found between the length of hospital stay and the albumin value on the second post-operative day. It was concluded that low albumin values affect the length of hospital stay and hospital costs.

Geukers et al. investigated the consequences of normal and excess protein intake after cardiac surgery. They argued that protein intake over 5 g/kg/day in the post-operative period may have side effects such as metabolic acidosis, but although they could not obtain statistically significant results, they argued that normoprotein 2 g/kg/day nutrition in the early period is more appropriate.[11] When the albumin values on the pre-operative and post-operative 1st, 2nd, and 3rd days were compared on a daily basis, it was determined that the albumin values showed a significant decrease in the post-operative period. Considering the effect of albumin values within normal limits on post-operative prognosis, it has been interpreted that the post-operative prognosis of patients whose pre-operative albumin levels are not lower than normal will be better than patients with low pre-operative albumin levels. We did not perform pre-op albumin replacement on the patients in our study group. In addition, we excluded four neonatal hypoplastic patients whose pre-op albümin level was below 2.5 mg/dl and who had pre-operative albumin replacement. Thus, we think that we cannot directly affect the course of post-operative albumin. The prognostic nutritional index is used as an indicator of the nutritional and immune status of cancer patients calculated according to serum albumin concentration and peripheral blood lymphocyte count. Measurements made with this index have yielded significant results in many patient populations, including heart failure patients undergoing left ventricular assist device implantation, as well as those undergoing gastrointestinal cancer surgery.[12,13] When we investigated the effect of albumin and total protein on the prognosis in our own patient group, we could not obtain a fixed cut-off value for albumin, but when the total protein value was above 6.65 (sensitivity 92.3%; specificity 81.6%), there was a significant decrease in mortality.

It should be recognised that in children requiring surgery for CHD, clinicians and surgeons should carefully consider the child's nutritional status when planning non-emergency surgery for CHD and counselling parents about the potential risks of surgery. Longer

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Table 2. Comparison of parameters by living status

		N	Mean ± Sd	Min–Max (Median)	p
Age (Month)	**Exitus**	19	7,27 ± 6,27	2–23 (4,5)	0,424
	Alive	108	5,06 ± 3,29	2–17 (4)	
Operation time (min)	**Exitus**	19	353,54 ± 97,05	142–580 (345)	***0,014****
	Alive	108	290,82 ± 91,38	0–480 (300)	
Weight (kg)	**Exitus**	19	24,52 ± 17,67	8,5–70 (16)	0,114
	Alive	108	17,87 ± 10,15	8,4–65 (14)	
Pre-operative SpO_2 (%)	**Exitus**	19	83,04 ± 4,49	74–91 (84)	0,086
	Alive	108	80,84 ± 4,88	70–91 (81)	
Post-operative SpO_2 (%)	**Exitus**	19	89,85 ± 3,84	83–97 (89)	0,840
	Alive	108	89,61 ± 3,6	84–97 (90)	
Vis score	**Exitus**	19	14,77 ± 3,8	8–22 (14,5)	0,058
	Alive	108	12,57 ± 4,09	0–22 (13)	
24 hour peak BP (mmHG)	**Exitus**	19	141,62 ± 33,53	90–200 (135)	0,880
	Alive	108	140,22 ± 23,3	98–190 (140)	
24 hours max lactate	**Exitus**	19	13,65 ± 3,66	6–21 (14)	***0,001****
	Alive	108	10,51 ± 3,47	4–19 (9)	
24 hours highest CVP (mmHG)	**Exitus**	19	18,73 ± 2,86	13–24 (18,5)	0,308
	Alive	108	17,88 ± 3,96	7–28 (18)	
ICU length of stay (days)	**Exitus**	19	26,73 ± 15,33	4–64 (23,5)	***0,001****
	Alive	108	9,9 ± 7,71	3–40 (7)	
Post-operative service time (days)	**Exitus**	19	0 ± 0	0–0 (0)	***0,001****
	Alive	108	15,51 ± 7,72	6–49 (15)	
Total hospital stay (days)	**Exitus**	19	26,73 ± 15,33	4–64 (23,5)	0,738
	Alive	108	25,41 ± 13,98	10–89 (22)	
Ventilation time (days)	**Exitus**	19	25,19 ± 14,91	4–64 (23)	***0,001****
	Alive	108	2,78 ± 2,14	1–10 (2)	
Pre-op pulmonary pressure (mmHg)	**Exitus**	19	14,31 ± 3,76	5–20 (14,5)	***0,001****
	Alive	108	10,84 ± 3,08	4–18 (11)	
Total bypass (minutes)	**Exitus**	19	139,65 ± 43,33	84–240 (125)	***0,001****
	Alive	108	108 ± 35,96	72–280 (95)	
ACC (minutes)	**Exitus**	19	35,38 ± 44,37	0–140 (7,5)	***0,001****
	Alive	108	10,67 ± 24,56	0–105 (0)	
Albumin Pre-op (mg/dL)	**Exitus**	19	4,46 ± 0,52	3,5–5,63 (4,4)	0,514
	Alive	108	4,49 ± 0,36	3,7–5,2 (4,5)	
Albumin Postop-1 (mg/dL)	**Exitus**	19	3,3 ± 0,54	2,5–4,4 (3,27)	***0,01****
	Alive	108	3,72 ± 0,67	2,4–5,2 (3,8)	
Albumin Postop-2 (mg/dL)	**Exitus**	19	3,39 ± 0,56	2,1–4,5 (3,37)	***0,005****
	Alive	108	3,79 ± 0,57	2,5–4,8 (3,9)	
Albumin Postop-3 (mg/dL)	**Exitus**	19	3,39 ± 0,58	2,1–4,5 (3,35)	***0,015****
	Alive	108	3,75 ± 0,57	2,6–5 (3,88)	

Mann–Whitney U Test *$p < 0,05$; **$p < 0,01$.

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Table 3. Comparison of biochemistry measurements by periods for all patients

		Preop	Postop-1. day	Postop-2. day	Postop-3.day	p
Albumin (mg/dL)	**Mean ± Sd**	4,48 ± 0,42	3,58 ± 0,66	3,65 ± 0,59	3,63 ± 0,59	***0,001*** **
	Min–Max (Median)	3,5–5,63 (4,5)	2,4–5,2 (3,5)	2,1–4,8 (3,7)	2,1–5 (3,7)	
Total protein (mg/dL)	**Mean ± Sd**	7,15 ± 0,71	5,62 ± 0,95	5,71 ± 0,81	5,72 ± 0,77	***0,001*** **
	Min–Max (Median)	4,8–8,6 (7,1)	3,3–7,9 (5,5)	3,7–7,5 (5,7)	3,7–7,8 (5,8)	
Creatinin (mg/dL)	**Mean ± Sd**	0,38 ± 0,11	0,7 ± 0,4	0,85 ± 0,76	0,98 ± 1,02	***0,001*** **
	Min–Max (Median)	0,19–0,82 (0,36)	0,18–2,08 (0,58)	0,22–3,8 (0,5)	0,11–4,2 (0,44)	
ALT (u/L)	**Mean ± Sd**	16,89 ± 7,64	108,56 ± 387,43	378,2 ± 781,71	465,21 ± 767,41 5	***0,001*** **
	Min–Max (Median)	6–60 (16)	5–3159 (22)	7–4586 (31)	3342 (105)	
AST (u/L)	**Mean ± Sd**	35,45 ± 9,99	262,79 ± 905,14	889,35 ± 1739,81	1113,4 ± 1668,68	***0,001*** **
	Min–Max (Median)	10–69 (34)	15–7454 (79)	16–7056 (113)	11–7254 (203)	
Drainage (cc)	**Mean ± Sd**	–	405,47 ± 164,2	290,13 ± 109,17	206,4 ± 127,54	***0,001*** **
	Min–Max (Median)		130–900 (380)	100–700 (270)	0–600 (200)	

Friedman test: **p < 0,01, AST=aspartate amino transferase; ALT=alanine amino transferase.

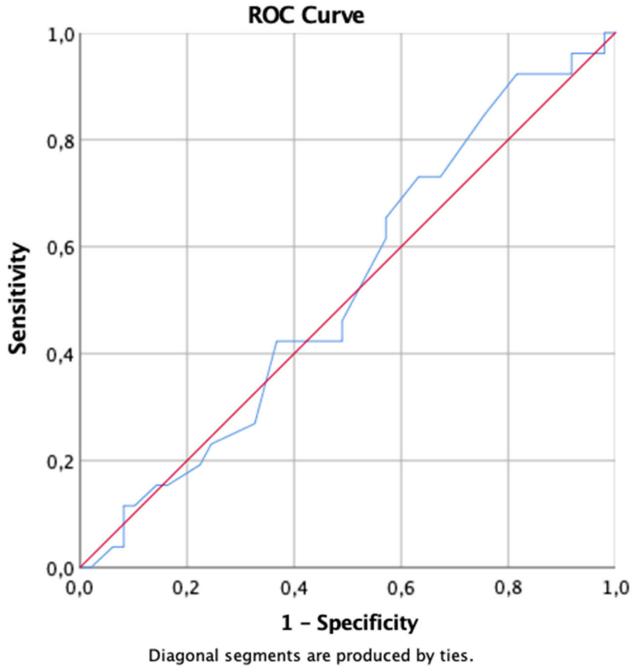

Figure 1. Total protein Roc analysis graph.

hospital stays and higher readmission rates were observed among malnourished children who underwent surgery for CHD. It is argued that nutrition should be improved by making necessary interventions in the pre-operative period in order to improve nutrition and patient outcomes.[14] We evaluate all our patients together with our paediatrician in the pre-operative period, make pre-operative preparations in optimal conditions according to the patient and cardiac pathology, and inform the family.

Feeding difficulties are common in infants with CHD, often presenting with recurrent lung infection, tachypnoea, and sweating. Malnutrition causes low immunity in children with CHD and predisposes them to infections, leading to heart failure, higher rates of complications, and more frequent hospital admissions. Malnutrition and the vicious cycle of infections pose a significant problem in these children. Nutritional assessment and appropriate counselling help improve the situation.[15,16] We follow up with our patients in the post-operative period by calling them for routine controls.

Growth retardation is common in children with single ventricular physiology. In a study by Luo et al. on the nutritional status of children with single ventricle physiology who had undergone Glenn operation, they stated that nutritional status affected clinical results and increased the length of hospitalisation.[17] In our study, there was an inverse and weakly significant relationship between the length of stay in the ICU and the albumin level on the 2nd post-operative day, and we believe that nutrition is an important factor in terms of post-operative prognosis, in line with the literature.

Albumin contributes to Starling forces in capillaries. It also helps to prevent hemodilution associated with cardiopulmonary bypass and preserve erythrocyte morphology. Both of these factors affect microcirculation, and hypoalbuminemia can exacerbate tissue damage, resulting in prolonged hospital stay. However, a clear limit value has not been determined for the values at which albumin transfusion should be performed.[18] Although there was no clear lower limit value for albumin in our study, mortality decreased significantly above 6.65 mg/dl for total protein values in the blood.

Zaccagni et al found that albumin values lower than 5% in the early post-operative period were associated with prolonged chest tube output and prolonged hospital length of stay.[19,20] We attribute our finding of a statistically significant difference between albumin values and the amount of early post-operative drainage to the fact that the main cause of early drainage is bleeding and coagulation factors. We think that the relationship between albumin values and prolonged chest tube output in the late post-operative period may be significant.

Endothelial dysfunction triggered by extracorporeal circulation makes it difficult to maintain fluid homeostasis during and after cardiac surgery. The albumin solution affects the plasma oncotic pressure, which causes an increase in intravascular volume. The increased plasma volume interacts positively with tissue perfusion and the endothelial glycocalyx layer, reducing the leakage from the

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capillaries to the extravascular space.[21,22] Similarly, in our study, statistically significant results were obtained between the highest lactate value in 24 hours and the albumin value on the post-operative 1st day. Here, the positive effect of albumin on microcirculation is shown.

Rauf et al., in their study in which they compared the patients who received albumin in the cardiopulmonary bypass prime solution and those who did not, found that adding albumin to the prime solution had an effect on hemodynamic stability and preserved platelet count in the post-operative period.[23] Except for special patient groups with severe hypoalbuminemia, we do not prefer to routinely add albumin to the prime solution in our protocol due to high costs.

Conclusion

Fontan is a palliative, not a corrective surgery with high morbidity and mortality, but we think that it is the best solution that can be offered to patients with functional single ventricles who do not have a known risk factor for today. It can be said that with the contribution of the developing technique, pre-operative evaluation methods and preparatory operations, late complications will be less and long-term results will be better in these patients. Albumin and total protein, the levels of which can vary with the amount and quantity of nutrition, can be used as predictors in the prognosis of these patients. Although the total protein values of 6.65 mg/dl and above in our study group decreased the post-operative mortality statistically significantly, we think that it is only one of the predictors that can affect the post-operative mortality.

Limitations

The study is a retrospective single-centre study. Albumin and total protein levels are affected by many factors, and blood levels vary, and studies with larger populations are needed to determine more precise limits.

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