 Koşuyolu Heart J 2021;24(Suppl 1):S18-S25 • DOI: 10.51645/khj.2021.m102

The Importance of Gestational Age as a Prognostic Factor on Norwood Stage 1 Outcome

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ABSTRACT

Introduction: The Norwood operation performed for hypoplastic left heart syndrome in the neonatal period remains to be a high-risk and difficult surgical procedure. It is known that preterm birth often accompanied by low birth weight is associated with high mortality and morbidity in these patients.

Patients and Methods: The study included 54 patients who underwent the Norwood procedure in our clinic in the period between December 2012 and December 2019. Patient data were evaluated retrospectively; including gestational week, age, body weight, total bypass time, aortic cross-clamp time, extubation time, the length of stay in the intensive care unit, the length of hospital stay, and the preoperative and postoperative levels of urea, creatinine, alanine aminotransferase, aspartate aminotransferase, and platelet counts.

Results: The body weight of the patients ranged from 2350 to 4500 grams with an average of 3296.3 ± 486.7 grams. The age of the patients at the time of operation ranged from 1 to 374 days with an average of 30.31 ± 70.51 days. The comparison of patients by term pregnancies resulted in no statistically significant differences but the comparison by gestational weeks revealed a statistically significant result.

Conclusion: Preoperative risk factors affect prognosis more than the surgical technique and the treatment approach in patients with a functional single ventricle. When the gestational week was evaluated as a preoperative risk factor for its effects on the postoperative prognosis of stage 1 Norwood operation in our study, it was found that mortality decreased significantly after the 38.8th gestational week (272 gestational days).

Key Words: Gestational age; norwood; pediatric heart surgery.

Gestasyonel Haftanın Norwood Stage 1 Sonuçlarına Prognostik Etkisi

ÖZ

Giriş: Hipoplastik sol kalp sendromu olan hastalarda yenidoğan döneminde yapılan norwood prosedürü halen riskli ve zor bir cerrahi işlemdir. Bu hastalarda preterm doğum ve preterm doğuma sıklıkla eşlik eden düşük doğum ağırlığının mortalite ve morbiditeyi artırdığı bilinmektedir.

Hastalar ve Yöntem: Çalışmaya Aralık 2012-Aralık 2019 tarihleri arasında kliniğimizde Norwood prosedürü uygulanan 54 hasta dahil edilmiştir. Hastaların gestasyonel hafta, yaş, kilo, total baypas süresi, aortik kross klemp süresi, ekstübasyon zamanı, yoğun bakım kalış ve servis yatış süreleri, preoperatif, postoperatif üre, kreatinin, alanin aminotransferaz, aspartat aminotransferaz, trombosit değerleri retrospektif olarak değerlendirilmiştir.

Bulgular: Hastaların kilo değeri 2350 ile 4500 gram arasında değişmekte olup ortalama 3296.3 ± 486.7 gram bulunmuştur. Hastaların operasyon sırasındaki yaşı 1 ile 374 gün arasında değişmekte olup ortalama 30.31 ± 70.51 gün bulunmuştur. Hastalar termlere göre kıyaslandıklarında istatistiksel olarak anlamlı sonuç bulunmamış, fakat gestasyonel haftaya göre kıyaslandıklarında istatistiksel olarak anlamlı sonuç elde edilmiştir.

Sonuç: Fonksiyonel tek ventriküle sahip hastalarda preoperatif risk faktörleri prognoza cerrahi teknik ve tedavi yaklaşımından daha fazla etkilir. Çalışmamızda preoperatif risk faktörlerinden biri olan gestasyonel hafta ile norwood stage 1 operasyonun postoperatif prognozu açısından karşılaştırıldığında 38,8. gestasyonel haftadan (272 gestasyonel gün) sonra mortalite anlamlı olarak düşmüştür.

Anahtar Kelimeler: Gestasyonel hafta; norwood; pediatrik kalp cerrahisi.

Cite this article as: *Arslanoğlu E, Kara KA, Hatemi AC, Tan BZ, Şavluk ÖF, Ukil Işıldak F, et al. The importance of gestational age as a prognostic factor on norwood stage 1 outcome. Koşuyolu Heart J 2021;24(Suppl 1):S18-S25.*

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Submitted: 18.05.2021
Accepted: 02.07.2021
Available Online Date: 11.07.2021

INTRODUCTION

Hypoplastic left heart syndrome (HLHS), defined as mitral atresia or stenosis and left ventricular hypoplasia with aortic atresia or stenosis, is a disease that requires surgical correction in the neonatal period because such patients cannot survive without surgical interventions. The Norwood procedure has been used in single-ventricle patients since 1983. Despite advances in pediatric cardiac surgery, the Norwood procedure is still a high-risk and difficult surgical procedure(1-4).

Although the information about the relationship between the gestational week at term and congenital heart diseases is limited, it is known that low birth weight (less than 2500 g) and preterm birth (before 37 weeks of gestation) are risk factors for the occurrence of neurodevelopmental problems and cardiovascular complications after the Norwood operation. Low birth weight; which often accompanies preterm birth in single ventricle patients, increases mortality and morbidity associated with complex cardiac surgery that should be performed shortly after the birth of the infant(5-9).

Although the effect of prenatal development of vital organs such as lungs, kidneys, and the brain on the development of preoperative and postoperative complications has not been clarified yet, low gestational week and low birth weight are shown as risk factors in previous studies(10-14).

In our study; we will present the effect of the gestational week on the early postoperative prognosis of patients, who underwent the Norwood stage 1 procedure due to the diagnosis of a single ventricle.

PATIENTS and METHODS

The study included 54 patients; who underwent the Norwood procedure in our hospital in the period between December 2012 and December 2019. Age, weight, operation time, total bypass time, aortic cross-clamping (CC) time, preoperative patent ductus arteriosus (PDA) diameter, extubation time, the length of intensive care unit (ICU) stay, the length of stay in the inpatient unit, and the preoperative and postoperative values of urea, creatinine, alanine aminotransferase (ALT), aspartate aminotransferase (AST), and platelet counts of patients were evaluated retrospectively.

Conventional median sternotomy and selective bicaval cannulation were performed in all cases. Aortic arch repair procedures were performed under total circulatory arrest (18°C) after deep hypothermia in four patients and through the cannulation of the descending aorta with antegrade cerebral perfusion in the rest of the patients. Myocardial protection was performed by administering a single dose of custodiol cardioplegia solution in all patients.

Although pulmonary shunts were placed between the right ventricle and the pulmonary artery (RV-PA) in the majority of the patients, subclavian-PA shunts were preferred in 14 patients.

In this retrospective cohort study, the NCSS software (Number Cruncher Statistical System, 2007, Kaysville, Utah, USA) was used for statistical analysis. Descriptive statistics (mean, standard deviation, median, frequency, percentage, minimum, and maximum) was used to summarize the data. The distribution of the data was evaluated by the Shapiro-Wilk test. The Kruskal-Wallis test was used for comparisons across three or more groups that did not show a normal distribution of quantitative data and the Mann-Whitney U test was used for comparisons of two groups with quantitative data not conforming to a normal distribution. The Friedman test was used for comparing three or more conditions of non-normally distributed periodic quantitative data and the Wilcoxon test was used to determine the differences. Spearman's correlation test was used to determine relationships across quantitative data. The ROC analysis was used to determine the predictive value of the quantitative data. Statistical significance was evaluated at $p< 0.01$ and $p= 0.05$.

The study protocol was approved by the ethics committee. This study was conducted in accordance with the principles of the Declaration of Helsinki (2021/4/457).

RESULTS

The body weight of the patients ranged from 2350 to 4500 grams with an average of 3296.3 ± 486.7 grams. The age of the patients at the time of operation ranged from 1 to 374 days with an average of 30.31 ± 70.51 days. Weeks of gestation varied between 242 and 295 days with an average of 265.61 ± 10.57 days. Changes between preoperative and postoperative ALT levels varied from -686 to 73 U/L with a mean of -22.97 ± 99.96 U/L. Changes between preoperative and postoperative AST levels varied from -3233 to 2322 U/L with a mean of 22.5 ± 615.79 U/L. Changes between preoperative and postoperative urea levels varied from -25 to 161 mg/dL with a mean of 22.06 ± 30.68 mg/dL. Changes between preoperative and postoperative creatinine levels varied from -0.65 to 3.11 mg/dL with a mean of 0.29 ± 0.64 mg/dL. Changes between preoperative and postoperative platelet counts varied from -474 to 203 $10^3/\mu L$ with a mean of -109.56 ± 129.95 103/μL. PDA diameters ranged from 2.3 to 11 mm with an average of 5.75 ± 1.71 mm. Postoperative saturation values ranged from 60% to 96% with an average of 81.8 ± 6.31%. Bypass times ranged from 134 to 405 minutes with an average of 215.98 ± 62.38 minutes. CC times ranged from 40 to 201 minutes with an average of 91 ± 31.75 minutes. Postoperative vasoactive-inotropic scores (VIS) ranged from 11 to 47 with an average of 22.02 ± 7.77. Drainage volumes on the first postoperative day ranged from 20 to 580 cc with a mean of 165.93 ± 109.09 cc. The length of ICU stay ranged from 1 to 129 days with an average of 31.22 ± 28 days (Table 1).

Gestational age was not statistically significantly different between the patients that were discharged from the hospital and the patients that died ($p> 0.05$). However, the mean gestational age of the survivors was higher compared to the patients, who died (Table 2).

Table 1. Demographic data

	Mean ± SD	Min-Max (median)
Weight (gram)	3296.3 ± 486.7	2350-4500 (3200)
Patient age at the operation (days)	30.31 ± 70.51	1-374 (9)
Gestational week (days)	265.61 ± 10.57	242-295 (264)
Preop-Postop change in ALT levels (U/L)	-22.97 ± 99.96	-686-73 (-7)
Preop-Postop change in AST levels (U/L)	22.5 ± 615.79	-3233-2322 (-1.5)
Preop-Postop change in urea levels (mg/dL)	22.06 ± 30.68	-25-161 (14.5)
Preop-Postop change in creatinine levels (mg/dL)	0.29 ± 0.64	-0.65-3.11 (0.14)
Preop-Postop change in PLT count (10^3/mL)	-109.56 ± 129.95	-474-203 (-100)
Preop PDA diameter (mm)	5.75 ± 1.71	2.3-11 (5.5)
Postop saturation (%)	81.8 ± 6.31	60-96 (82.5)
Total bypass time (min)	215.98 ± 62.38	134-405 (214.5)
CC time (min)	91 ± 31.75	40-201 (84)
Postop VIS score	22.02 ± 7.77	11-47 (20)
1st day drainage (cc)	165.93 ± 109.09	20-580 (140)
Length of stay in the intensive care unit (days)	31.22 ± 28	1-129 (21.5)

The cut-off point of 272 days for gestational age was found out to be reliable with 35.3% sensitivity and 86.5% specificity (Table 3, Figure 1).

Of the patients; 18.5% (n= 10) were preterm, 42.6% (n= 23) were early term, 25.9% (n= 14) were term, and 13% (n= 7) were late term (Table 4, Figure 2).

There is a positive and weakly significant correlation between gestational age and postoperative saturation levels (r= 0.276, p< 0.05). No statistically significant correlations of gestational age exist with changes between preoperative and postoperative ALT, AST, urea, and creatinine levels, and platelet counts; PDA diameters, bypass times, CC times, postoperative VIS scores, drained fluid volumes on the first postoperative day, and the length of stay in ICU (p> 0.05) (Table 5).

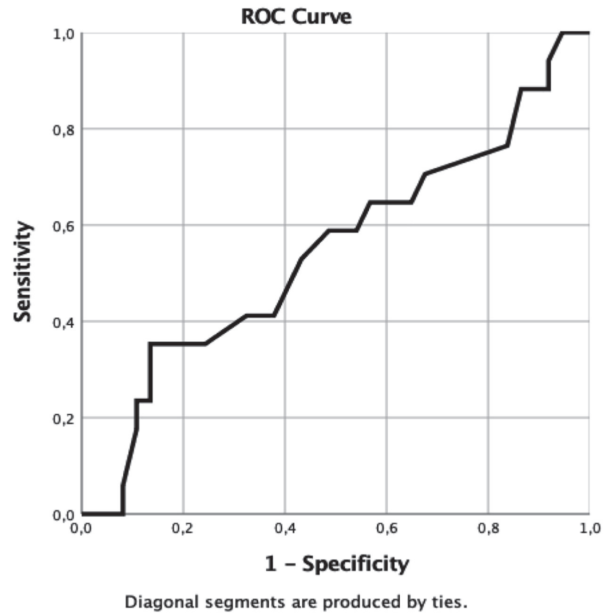

Figure 1. ROC curve of gestational age.

There is a positive and moderately significant correlation between the levels of change between the preoperative and postoperative ALT and AST values (r= 0.552, p< 0.01). There is not a statistically significant relationship of ALT levels with urea, and creatinine levels; platelet counts, PDA diameters, postoperative saturation levels, bypass times, CC times, postoperative VIS scores, drained fluid volumes on the first postoperative day, and the length of stay in ICU (p> 0.05).

The change between the preoperative and postoperative AST levels is not statistically significantly related to any of the following parameters; including the change between the preoperative and postoperative urea and creatinine levels and platelet counts, PDA diameters, postoperative saturation levels, bypass times, CC times, postoperative VIS scores, the volume of the drained fluid on the first postoperative day, and the length of stay in ICU (p> 0.05).

There is a positive and weakly significant correlation between the changes in preoperative and postoperative urea and creatinine levels (r= 0.493, p< 0.01). There is a positive

Table 2. Comparison of gestational weeks (days) between patients that were discharged from the hospital and patients that died

		n	Mean ± SD	Min-Max (median)	p
Gestational day	Died	37	264.95 ± 10.83	242-295 (263)	0.595
	Survived	17	267.06 ± 10.15	253-283 (266)	

Table 3. ROC analysis results for cut-off and AUC values

Parameter	Sensitivity (%)	Specificity (%)	Cut-off point	Area under the curve
Gestational week	35.3	86.5	272	55

Table 4. Distribution of patients by term pregnancies

Term pregnancies	Preterm (< 37 weeks)	10	18.5
	Early term (37-38 weeks)	23	42.6
	Term (39-40 weeks)	14	25.9
	Late term (> 40 weeks)	7	13.0

and weakly significant relationship between the PDA diameter and changes in preoperative and postoperative urea levels ($r= 0.306$, $p< 0.05$). There is a negatively and weakly significant correlation between postoperative VIS scores and changes in preoperative and postoperative urea levels ($r= -0.304$, $p< 0.05$). There is not a statistically significant relationship of the change between the preoperative and postoperative urea levels with

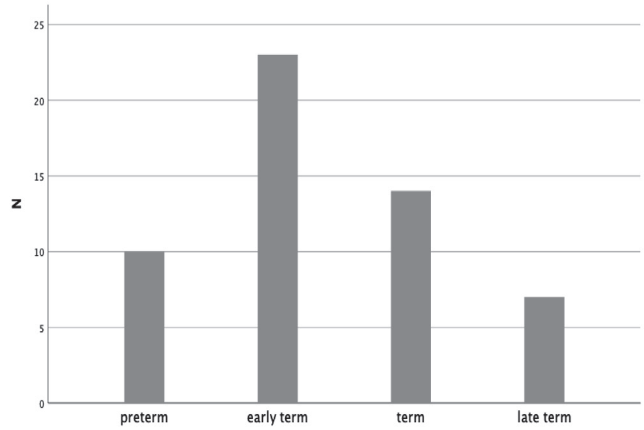

Figure 2. Descriptive chart.

Table 5. Correlation analysis

		1	2	3	4	5	6	7	8	9	10	11	12	13
1. Gestational Age (Day)	r	1												
	p	.												
2. Preop-postop change in ALT levels	r	0.051	1											
	p	0.716	.											
3. Preop-postop change in AST levels	r	0.049	0.552**	1										
	p	0.726	0.000	.										
4. Preop-post-op change in urea levels	r	0.076	0.055	0.210	1									
	p	0.586	0.694	0.128	.									
5. Preop-postop change in creatinine levels	r	0.246	-0.04	0.243	0.493**	1								
	p	0.073	0.775	0.076	0.000	.								
6. preop-post-op change in PLT counts	r	0	-0.174	-0.163	-0.166	-0.054	1							
	p	0.223	0.208	0.240	0.230	0.697	.							
7. Pre-op PDA Diameter	r	–0.056	0	0.175	0.306*	-0.022	0.060	1						
	p	0.687	0.602	0.206	0.024	0.877	0.666	.						
8. Postop saturation	r	0.276*	-0.012	0	0.108	0.048	0.008	-0.017	1.000					
	p	0.043	0.929	0.65	0.438	0.733	0.952	0.904	.					
9. Total Bypass Time	r	0.066	-0.263	-0.229	0	-0.046	0.400**	0.095	0.015	1				
	p	0.635	0.055	0.096	0.13	0.741	0.003	0.492	0.915	.				
10. CC Time	r	0.009	-0.204	-0.242	-0.117	0	0.18	0.171	-0.007	0.565**	1			
	p	0.947	0.139	0.078	0.399	0.745	0.193	0.216	0.959	0.000	.			
11. Postop VIS Scores	r	0	0.172	0.044	-0.304*	-0.215	0	-0.075	-0.096	0.317*	0.26	1		
	p	0.999	0.215	0.754	0.026	0.118	0.711	0.588	0.489	0.019	0.058	.		
12. Day 1 - Drainage Fluid Volume	r	0.132	-0.019	-0.054	0.123	0.129	-0.172	0	0.148	-0.122	-0.068	-0.111	1	
	p	0.340	0.892	0.697	0.377	0.352	0.213	0.225	0.285	0.380	0.625	0.426	.	
13. Intensive Care Stay	r	-0.022	-0.016	0.007	0.225	0.146	-0.003	-0.073	0	-0.237	-0.297*	-0.278*	0.312*	1.000
	p	0.877	0.910	0.960	0.102	0.292	0.985	0.602	0.948	0.085	0.029	0.042	0.022	.

Table 6. Comparison of parameters by term pregnancies

		n	Mean ± SD	Min-Max (median)	p
Preop ALT	Preterm	10	35.3 ± 28.22	4-81 (28.5)	0.345
	Early term	23	49.57 ± 105.66	1-505 (20)	
	Term	14	64.07 ± 88.7	11-310 (35)	
	Late term	7	111.43 ± 256.48	9-693 (16)	
Preop AST	Preterm	10	59.9 ± 42.09	23-164 (47)	0.413
	Early term	23	82.3 ± 148.38	15-719 (43)	
	Term	14	376.36 ± 872.54	13-3278 (48)	
	Late term	7	534.29 ± 1260.02	16-3391 (62)	
Preop urea	Preterm	10	21.3 ± 12.51	10-44 (15.5)	0.194
	Early term	23	24.52 ± 12.46	6-57 (23)	
	Term	14	30.79 ± 14.92	13-68 (29)	
	Late term	7	40 ± 30.87	10-89 (21)	
Preop creatinine	Preterm	10	0.63 ± 0.21	0.29-0.93 (0.64)	0.849
	Early term	23	0.65 ± 0.29	0.24-1.2 (0.65)	
	Term	14	0.82 ± 0.6	0.16-2.43 (0.76)	
	Late term	7	0.94 ± 0.65	0.22-1.78 (0.85)	
Preop PLT	Preterm	10	308.5 ± 90.99	211-488 (284.5)	0.543
	Early term	23	293.26 ± 165.46	52-727 (259)	
	Term	14	270.71 ± 130.78	133-625 (258)	
	Late term	7	216 ± 128.47	57-361 (230)	
Postop ALT	Preterm	10	20.06 ± 14.58	0.6-45 (16.5)	0.938
	Early term	23	36.52 ± 77.84	1-383 (16)	
	Term	14	56.14 ± 108.93	1-383 (9)	
	Late term	7	14.71 ± 9.34	3-25 (19)	
Postop AST	Preterm	10	65.6 ± 56.06	18-180 (39)	0.552
	Early term	23	233.48 ± 619.7	12-3041 (104)	
	Term	14	369.21 ± 598.2	3-1863 (84)	
	Late term	7	217.29 ± 393.43	20-1103 (65)	
Postop urea	Preterm	10	39.9 ± 22.14	9-87 (36)	0.432
	Early term	23	49.96 ± 36.4	8-184 (39)	
	Term	14	54.93 ± 22.13	26-99 (55.5)	
	Late term	7	51.71 ± 25.41	26-85 (43)	
Postop creatinine	Preterm	10	0.63 ± 0.37	0.22-1.43 (0.47)	0.200
	Early term	23	1 ± 0.77	0.16-3.5 (0.9)	
	Term	14	1.23 ± 0.71	0.34-2.33 (1.04)	
	Late term	7	1.19 ± 0.85	0.3-2.21 (1.31)	
Postop PLT	Preterm	10	122.3 ± 54.38	54-216 (117)	0.167
	Early term	23	205.52 ± 106.79	20-378 (195)	
	Term	14	155.57 ± 86.61	46-308 (131.5)	
	Late term	7	155.43 ± 91.45	63-270 (98)	

Kruskal Wallis Test. * $p< 0.05$, ** $p= 0.01$.

the change between the preoperative and postoperative platelet counts, postoperative saturation levels, bypass times, CC times, the volume of the drained fluid on the first postoperative day, and the length of stay in ICU ($p> 0.05$).

There is a positive and weakly significant correlation between the bypass time and the change between preoperative and postoperative platelet counts ($r= 0.400$, $p< 0.01$). There is not a statistically significant relationship of the change in platelet counts with PDA diameters, postoperative saturation levels, CC times, postoperative VIS scores, drained fluid volumes on the first postoperative day, and the length of ICU stay ($p> 0.05$).

There is not a statistically significant relationship of PDA diameters with postoperative saturation levels, bypass times, CC times, postoperative VIS scores, drained fluid volumes on the first postoperative day, and the length of stay in ICU ($p> 0.05$).

There is a positive and moderately significant correlation between the bypass time and the CC time ($r= 0.565$, $p< 0.01$). There is a positive and weakly significant relationship between the bypass time and postoperative VIS scores ($r= 0.317$, $p< 0.05$). There is not a statistically significant relationship of the bypass time with the volume of the drained fluid on the first postoperative day and the length of ICU stay ($p> 0.05$).

There is a negative and weakly significant relationship between the CC time and the length of ICU stay ($r= -0.297$, $p< 0.05$).

There is a negative and weakly significant relationship between postoperative VIS scores and the length of ICU stay ($r= -0.278$, $p< 0.05$). There is not a statistically significant relationship between postoperative VIS scores and the volume of the drained fluid on the first postoperative day ($p> 0.05$).

There is a positive and weakly significant relationship between the volume of the drained fluid on the first postoperative day and the length of ICU stay ($r= 0.312$, $p< 0.05$).

Preoperative levels of ALT, AST, urea, creatinine, and preoperative platelet counts did not show any statistically significant differences by term pregnancies ($p> 0.05$). Postoperative levels of ALT, AST, urea, creatinine, and preoperative platelet counts did not show any statistically significant differences by term pregnancies ($p> 0.05$) (Table 6).

DISCUSSION

Although mortality rates associated with the Norwood operation continue to decrease upon the introduction of many technical and technological advances in pediatric cardiac surgery in the last 20 years, mortality and morbidity of the procedure are still high in the early postoperative period. The following anomalies accompanying HLHS; including pulmonary venous return anomaly, advanced atrioventricular valve insufficiency, low birthweight, low gestational age, diagnosed or suspected genetic anomalies, and the presence of a restrictive or intact atrial septum are the most important risk factors for Norwood operation in the early postoperative period[14-16].

Higher gestational age, higher birth weight, advanced organ maturation, and completion of fetal development increase the likelihood of successful surgical outcomes after such a difficult operation. As for the maturation of lungs; formation of airways, development of the lung parenchyma, and formation of capillaries occur in the intrauterine period until the 36th gestational week. Pathogens settle more easily in immature bronchial walls of babies born in earlier gestational weeks, leaving the baby more vulnerable to respiratory infections[17-19]. Our results correlate with the results reported by previous studies showing that the development of bronchopulmonary dysplasia in infants born in early gestational weeks cause lower postoperative saturation levels and a higher need for mechanical ventilation compared to infants born in later gestational weeks.

In our study, we have found that patients born in early gestational weeks with low birth weight are associated with high risks. We have found that mortality and morbidity decreased significantly in patients born at gestational ages of 272 days (38.8 weeks) and later. Furthermore, we have found that the increase in bypass and CC times during the operation extended the stay in ICU.

In the study conducted by Baba et al., mortality and morbidity of the Norwood stage 1 operation were not statistically significantly different compared to those of the hybrid procedure; which was used as an alternative to the Norwood stage 1 operation in some centers. Postoperative prognosis in single ventricle patients is more likely related to patient-associated preoperative risk factors compared to the surgical technique used for intervention[20,21]. In the study conducted by Mascio et al., it was shown that; considering the gradual decline in mortality over the last 15 years, prognosis continued to depend on patient-associated preoperative risk factors more than the use of advanced surgical techniques and a hybrid approach. That study showed that postoperative mortality increased proportionally to the increase in the number of patient-specific risk factors (3 or more accompanying risk factors)[22]. In our retrospective cohort study, we found that postoperative mortality was higher when the gestational age was 38.8 weeks and lower.

It is difficult to adjust the balance of pulmonary and systemic blood flow in patients born at an earlier gestational age with low birth weight. When 3.5 mm diameter modified Blalock-Taussig shunt grafts are used in such patients, the pulmonary shunt causes pulmonary blood flow to increase extensively resulting in overflow. However, 3 mm grafts cause thrombosis and technical difficulties[23]. In our patient group, we mostly used 5 mm pulmonary shunt grafts extending from the right ventricle to the pulmonary artery. We used 3.5 mm modified Blalock-Taussig shunt grafts in only fourteen patients.

Risk factors are not limited to premature birth and low birth weight in HLHS patients. Need for extracorporeal membrane oxygenation (ECMO) after the Norwood operation, postoperative need for emergency surgery, preoperative organ dysfunctions, and infections are the factors acting on prognosis. The Norwood operation should be scheduled as soon as possible in single ventricle patients because it is not a pathology compatible with life. The single ventricle anomaly does not allow the patient to gain weight and mature after birth. Therefore; the higher the gestational age, the more chances the patient will have[22-24]. In our study; despite the lack of significant differences in the change between preoperative and postoperative values of ALT, AST, creatinine, and platelets by term pregnancies, these parameters were found to be correlated with the gestational week. This finding probably results from the difference in patient distribution patterns across the groups in the study.

Familial genes and environmental factors act significantly on postoperative outcomes across similar gestational ages because; despite similarities, intrauterine development varies from one infant to another depending on genetic factors[25-27]. Furthermore; infections due to postoperative ECMO, open sternum, surgical resection of the thymus, and immaturity of the immune system in the newborn act on mortality and morbidity[28-30]. Although we have not found a correlation between the postoperative need for inotropes (VIS scores) and the gestational week in our study, we think that this finding resulted from the combination of more than one factor including bypass and CC times, genetic characteristics of patients, birth weight, preoperative cardiac conditions, and infections.

LIMITATIONS

This cohort has a heterogeneous data distribution pattern obtained from 54 patients, who underwent stage 1 Norwood operation. The gestational age and other patient data were retrieved from patients' medical files retrospectively. Many factors act on the prognosis after the Norwood operation. The gestational week is just one of these parameters. Because prognosis may be affected by other factors such as infection and ECMO support, further large-scale studies are needed.

CONCLUSION

In conclusion, preoperative risk factors act on prognosis more strongly than the surgical technique and the treatment approach in patients with a functional single ventricle. In our study; the gestational week, as a preoperative risk factor, was found to be actively acting on the postoperative prognosis of stage 1 Norwood operation as mortality declined significantly after the 38.8th gestational week (272 gestational days).

Ethics Committee Approval: The study protocol was approved by the local ethics committee. The study was conducted in accordance with the principles of the Declaration of Helsinki (2021/4/457).

Informed Consent: Informed consent was obtained.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept/Design - EA; Analysis/Interpretation - KK; Data Collection - AH; Writing - EA, KK; Critical Revision - BT; Final Approval - HC; Statistical Analysis - FI, ET; Obtained funding - ÖŞ; Overall Responsibility - NÇ, HC.

Conflict of Interest: The authors have no conflicts of interest to declare

Financial Disclosure: The authors declared that this study has received no financial support.

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