A comparison between the Felix von Luschan Skin Color Scale Test and Invasive Neonatal Jaundice Measurement Methods

Yenidoğan Sarılık Ölçüm Yöntemleri ile Felix von Luschan Deri Rengi Skalasının Karşılaştırılması

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ABSTRACT

Objective: This study aimed to compare invasive neonatal jaundice measurement methods (total bilirubin from venous blood, total bilirubin in blood gas, and microcapillary neonatal bilirubin from the heel) with the non-invasive Felix von Luschan skin color scale test.

Material and Methods: The study was performed on 110 newborns admitted to the neonatal intensive care unit of Adiyaman University Training and Research Hospital, Turkey, because of jaundice. The non-invasive Felix von Luschan skin color scale test was compared with other, more invasive neonatal jaundice measurement methods.

Results: The Felix von Luschan skin color scale test was found to have a significant relationship with other diagnostic methods ($p<0.001$) and deemed practical for the diagnosis of this disease.

Conclusion: The timely diagnosis and management of neonatal jaundice are essential to prevent acute bilirubin encephalopathy and kernicterus. The Felix von Luschan skin color scale test is a non-invasive method that is reliable, fast and inexpensive. This method can be used for the diagnosis of neonatal jaundice.

Key Words: Bilirubin, Felix von Luschan skin color scale test, Neonatal jaundice, Non-invasive

ÖZ

Amaç: Bu çalışmanın amacı invaziv neonatal sarılık ölçüm yöntemleri (venöz kandan toplam bilirubin, kan gazındaki toplam bilirubin ve topuktan mikrokapiller neonatal bilirubin) ile invaziv olmayan Felix von Luschan Deri Rengi Skalasını karşılaştırmak.

Gereç ve Yöntemler: Bu çalışma, Adıyaman Üniversitesi Eğitim ve Araştırma Hastanesi, yenidoğan yoğun bakım ünitesine sarılık nedeniyle başvuran 110 yenidoğan üzerinde gerçekleştirildi. İnvaziv olmayan Felix von Luschan Deri Rengi Skalası diğer invaziv yenidoğan sarılık ölçüm yöntemleriyle karşılaştırıldı.

Bulgular: Felix von Luschan deri renk skalası testinin diğer tanı yöntemleri ile anlamlı bir ilişkisi olduğu ($p <0.001$) ve bu hastalık tanısında yararlı olduğu bulunmuştur.

Sonuç: Yenidoğan sarılıklarının zamanında teşhis ve tedavisi, akut bilirubin ensefalopatisini ve kernikterusu önlemek için gereklidir. Felix von Luschan ten rengi testi, güvenilir, hızlı ve ucuz bir yöntem olan, invaziv olmayan bir yöntemdir. Bu yöntem yenidoğan sarılığı tanısı için kullanılabilir.

Anahtar Sözcükler: Bilirubin, Felix von Luschan Deri Rengi Skalası, Yenidoğan sarılığı, Non-invaziv

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INTRODUCTION

Neonatal jaundice, a yellowish discoloration of the sclera and skin in newborn babies due to serum bilirubin levels above 5 mg per dL, is a frequently encountered problem (1). Neonatal jaundice is one of the most common conditions in newborn infants, occurring in approximately 60% of full-term infants in the first two weeks of life (2).

Severe hyperbilirubinemia or jaundice increases the risk of complications or brain disorders in neonates. These complications include a wide range of mild-to-severe clinical conditions such as bilirubin-induced neurologic dysfunction, bilirubin encephalopathy or acute bilirubin encephalopathy, and kernicterus (3). Consequently, the early diagnosis of infants at high risk of severe hyperbilirubinemia plays an important role in facilitating the timely and appropriate prevention of disease within the first 14 days of birth (4).

Bilirubin levels can be checked by biochemical methods, a bilimeter, or a transcutaneous bilirubinometer (5). Spectrophotometry is the basis of the bilimeter, which assesses total bilirubin in the serum (6). The transcutaneous bilirubinometer is a noninvasive method based on the principle of multi- or two-wavelength spectral reflectance meters. The accuracy of the instrument may be affected by variations of skin pigmentation and thickness (5, 6). The other diagnostic method is the Felix von Luschan test. This is a reproduction of the von Luschan chromatic scale made by anthropologist Felix von Luschan. The test is an inexpensive, easy, and non-invasive method used to determine skin color (7, 8).

This study aimed to investigate the effectiveness of the scale by comparing invasive neonatal jaundice measurement methods (total bilirubin from venous blood, total bilirubin in blood gas, and microcapillary neonatal bilirubin from the heel) and the non-invasive Felix von Luschan skin color scale (FvL-SCS).

MATERIALS and METHODS

This cross-sectional study was conducted on 110 term newborn babies admitted to the neonatal intensive care unit of Adıyaman University Training and Research Hospital for jaundice after written consent was obtained from their parents. The ethical committee of the medicine faculty of Adiyaman University approved the study (protocol no: 2016/6-4). Babies were hospitalized and treated using the Bhutani nomogram according to the phototherapy limits recommended by the American Academy of Pediatrics.

Each newborn was carefully examined, and the related demographic and clinical data were registered in the checklist. The information recorded in the study included gestational age, birth type, nutrition type, postnatal age, blood group, and blood incompatibility.

Biochemistry values such as total serum bilirubin (TSB), direct bilirubin (DB), indirect bilirubin (IB), aspartate transaminase (AST), alanine transaminase (ALT), sodium (Na), potassium (K), chlorine (Cl), and calcium (Ca) were analyzed using an Abbott C8000 (Abbott Laboratories, Abbott Park, IL, USA) device on all serum samples. The analysis was done according to the manufacturer's protocol. Hematological data such as white blood cell count (WBC), hemoglobin (HGB), hematocrit (HCT), mean corpuscular volume (MCV), mean platelet volume (MPV), and platelet (PLT) values were analyzed with a whole blood counting device CELL-DYN Ruby (USA). The blood gas data of patients were measured with an ABL 700 instrument (Bronshoj/Denmark) and the bilirubin values were used as data. The blood of all neonates was analyzed with an Ortho Autovue Innova (New Jersey, USA) device. In addition, microcapillary heel blood samples were analyzed with a neonatal bilirubin analyzer (Bilimeter 3, Neuburg an der Donau, Germany) and the bilirubin levels of all patients were determined.

In this study, the non-invasive FvL-SCS was used to measure the severity of jaundice in neonates. The FvL-SCS is a scale in which skin color ranges from 1 to 36 (1 corresponds to light skin and 36 to dark skin) with intra-rater (r=0.984) and inter-rater reliability (r=0.964) evaluators (Figure 1). The skin color of each patient was measured by a trained investigator on sternum anatomical skin sites. The skin color evaluation method was determined using our protocol in a room with fluorescent lighting, no interference from sunlight, and skin colors selected from the FvL-SCS.

Statistical Analysis

Statistical analysis of the data was performed using Pearson tests in the SPSS-20 (IBM, Somers, NY, USA) software to determine any significant differences between FvL-SCS and the other methods. The Pearson test was used for data analysis and P-values $p<0.05$ were considered significant.

RESULT

A total of 110 neonatal jaundice cases were analyzed using invasive and non-invasive diagnostic methods at the neonatal intensive care unit of the Adiyaman University Training and Research Hospital. No transfusion was performed on any baby included in this study.

Out of the 110 neonatal jaundice cases, 69.1% (76/110) were male and 30.9% (34/110) female. Male neonatal jaundice patients were significantly more common than females. 56.4% (62/110) of neonates were delivered by cesarean section (C/S) and 43.6% (48/110) through vaginal birth. 17.3% of the babies treated for jaundice were admitted between 48 and 72 hours postnatally. In addition, when the patients were evaluated in terms of blood group, the Rh (+) blood group was found

Table I: Demographic characteristics of the neonates and their blood group distribution

Features	n (%)
Gender	
Male	76 (69.1)
Female	34 (30.9)
Birth Type	
Vaginal (V)	48 (43.6)
Cesarean section (C/S)	62 (56.4)
Nutrition	
Breast milk	85 (77.3)
Breast milk+ formula	25 (22.7)
Water Supply	
Yes	16 (14.5)
No	94 (85.5)
Postnatal Age	
0-24 hour	16 (14.5)
24-48 hour	10 (9.1)
48-72 hour	19 (17.3)
72-96 hour	16 (14.5)
96-120 hour	8 (7.3)
120-144 hour	10 (9.1)
>120 hour	31 (28.2)
Blood Group	
ARH(+)	55 (50)
BRH(+)	25 (22.7)
ORH(+)	23 (20.9)
ABRH(+)	4 (3.6)
ARH(-)	2 (1.8)
Blood Incompatibility	
No	61 (55.5)
ABO incompatibility	35 (31.8)
Rh incompatibility	10 (9.1)
Rh+ABO incompatibility	4 (3.6)

to comprise 50% (55/110). When investigating in terms of blood group incompatibility, ABO incompatibility was the most common at 31.8% (35/110), Rh was 9.1% (10/110) and Rh + ABO incompatibility was 3.6% (4/110). No blood incompatibility was detected in 55.5% (61/110) of the patients. In terms of nutrition, 77.3% (85/110) were fed only breast milk and 22.7% (25/110) both breast milk and formula. 14.5% (16/110) of the neonates were also given water. The demographic characteristics of the neonates are shown in Table I.

When the mean blood count and biochemistry parameters of the cases were examined, it was found that they were compatible with the normal hemogram and biochemistry parameters of newborns (Tables II and III). The mean total serum bilirubin level in all patients was found to be 17.5± 4.2 (5.6-25.8) mg/dL. Table IV shows the bilirubin values of all patients measured using biochemical and blood gas instruments. The mean value of DB was found to be 0.5 ± 0.14 mg/dL and the mean value of indirect bilirubin was found to be 16.9 ± 4.1 mg/dL. Therefore, the mean values of blood gas and microcapillary neonatal bilirubin were detected as 17.2 ± 4.9 mg/dL and 16.2 ± 4.1 mg/dL, respectively. In our case, comparisons of FvL-SCS and SD values of total bilirubin values were obtained from total serum, blood gas, and microcapillary measurements.

Table II: The hematological values of newborns included in this study and normal blood values in humans.

Blood Count Unit (Normal value)	Mean Value± SD* (Min-Max)
WBC 10^3/µL (5-34)	12.9±4.8 (6.2-36.0)
HGB g/dL (13.5-22)	17.5±2.7 (10.0-23.0)
HCT % (30-60)	50.4±8.1 (29.0-73.0)
MCV fL (86-120)	101.6±7.96 (82.0-121.7)
MPV fL (6.8-10.8)	7.5±1.4 (4.9-11.0)
PLT 10^3/µL (150-450)	273.9±95.1 (64.0-665.0)

* ***SD:*** *Standard deviation*

Table III: The results of biochemistry values of neonatal jaundice in this study.

Biochemistry values (Normal Value)	Mean value ± SD(Min-Max)
Na mmol/L (135-145)	139.6±3.5 (133.0-151.0)
K mmol/L (3.5-5.5)	5.1±0.6 (3.7-6.6)
Cl mmol/L (95-110)	108.9±3.5 (103.0-115.0)
Ca mg/dL (8.4-10.8)	9.5±0.9 (7.0-12.1)
AST U/L (35-140)	53.4±27.6 (20-193)
ALT U/L (10-90)	19.8± 12.3 (6-63)

In this study, it was determined that the distribution of the data conformed to the normal distribution. Therefore, the Pearson correlation analysis method, which is a parametric correlation analysis test, was used and is presented in Table V. The relationship between invasive methods (blood gas bilirubin, microcapillary neonatal bilirubin, and TSB values) and the non-invasive FvL-SCS method was found to be significant ($p < 0.001$) (Table V). In this study, correlation analysis of blood gas and TSB values was performed. A positive high correlation was found between the samples ($r^2 = 0.806$) and this result was significant ($p < 0.001$) (Figure 2). However, when the correlation analysis of microcapillary neonatal bilirubin value and TSB values was performed, a high correlation between the two values ($r^2=0.832$) was found and this value was detected as significant ($p < 0.001$). Also, correlation analysis of blood gas and microcapillary neonatal bilirubin values was performed, and a positive correlation was found between samples ($r^2= 0.776$). When these three measurement methods were compared, the r^2 value was found to be the highest ($r^2= 0.832$) between TSB and microcapillary neonatal bilirubin. The correlation between TSB and microcapillary neonatal bilirubin results obtained by the FvL-SCS method was compared in our study. The r^2 value was found to be less than 0.5 and this value was found to be significant ($p < 0.001$). When FvL-SCS and blood gas bilirubin values were compared, a positive correlation was found (Figure 2). This value was found to be significant ($p < 0.001$).

Table IV: Bilirubin values measured using a biochemistry device (*). Microcapillary neonatal bilirubin values taken from the heel and bilirubin values in blood gas.

Bilirubin Values Unit	Mean Value±SD (Min-Max)	Distributon Range (Mean)	Persantil		
			25	50	75
TSB* mg/dL	17.5±4.2 (5.6-25.8)	20.2	15.075	17.500	19.873
DB* mg/dL	0.5±0.1 (0.2-0.9)	0.8	0.448	0.520	0.600
IB* mg/dL	16.9±4.1 (5.2-24.8)	19.6	14.570	16.730	19.148
Blood Gas Bilirubin mg/d	17.2±4.9 (5.0-31.0)	26.0	14.300	16.450	19.600
Mikrocapillary Neonatal Bilirubin mg/dL	16.2±4.1 (5.1-27.0)	21.9	14.000	16.300	19.000

Table V: The Pearson correlation with bilirubin values and FvL-SCS test in this study.

Pearson Correlation		Blood Gas Bilirubin	FvL-SCS	Microcapillary Neonatal Bilirubin	TSB
Blood Gas Bilirubin	r*	1	0.513	0.881	0.898
	p		0.0001	0.0001	0.0001
FvL-SCS	r	0.513	1	0.498	0.474
	p	0.0001		0.0001	0.0001
Microcapillary Neonatal Bilirubin	r	0.881	0.498	1	0.912
	p	0.0001	0.0001		0.0001
TSB	r	0.898	0.474	0.912	1
	p	0.0001	0.0001	0.0001	

***** *Correlation coefficient*

DISCUSSION

More than 85% of newborns develop some degree of jaundice during the first days of life (9). The clinical symptoms of neonatal jaundice are primarily shown in the head and face, and then affect the organs of the trunk and limbs due to increased serum levels of bilirubin (4, 9). Worldwide, it is estimated that extreme neonatal jaundice affects at least 481.000 late-preterm and term newborn infants annually, resulting in 114.000 deaths and more than 63.000 survivors with moderate or severe long-term disability (9). Neonatal jaundice can be fatal, but the mortality rate can be reduced by instant diagnosis and appropriate treatment (10). Neonatal jaundice can usually be diagnosed with clinical examination and confirmed using laboratory methods. However, if jaundice remains unrecognized for a prolonged period, there is a high risk of bilirubin-induced neurological dysfunction and irreversible neurological damage (11, 12). Therefore, rapid and accurate diagnosis of neonatal jaundice is particularly important in treating the disease.

Neonatal jaundice can be diagnosed using invasive diagnostic methods such as total bilirubin from venous blood, total bilirubin in blood gas, and microcapillary neonatal bilirubin. These methods are invasive and require blood collection from infants. Obtaining blood samples from infants requires specially trained personnel and clinical expertise. Also, taking blood samples from infants predisposes them to infections and causes significant distress to the infant. Shah et al. reported that these laboratory tests are expensive and time-consuming, which may cause delays in the initiation of treatment (11). Therefore, there is a need for a more reliable, easy-to-use, cost-effective diagnostic method in neonatal jaundice that also prevents unnecessary pain.

Many researchers have reported that TSB is the gold standard for diagnosing neonatal jaundice. TSB can be measured by the spectrophotometry and modified micro-bilirubin method. In our study, we measured the TSB of patients using biochemistry equipment on all serum samples. These biochemistry diagnostic methods must be performed by skilled technicians and re-examined using scientific instruments, which are rarely available in resource-limited regions. The results of our study support previous studies; these methods are invasive and cause pain, stress, and risk of infection in neonates.

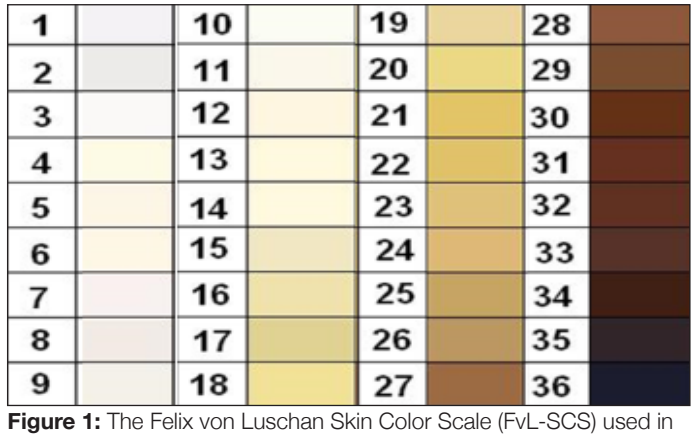

Figure 1: The Felix von Luschan Skin Color Scale (FvL-SCS) used in this study

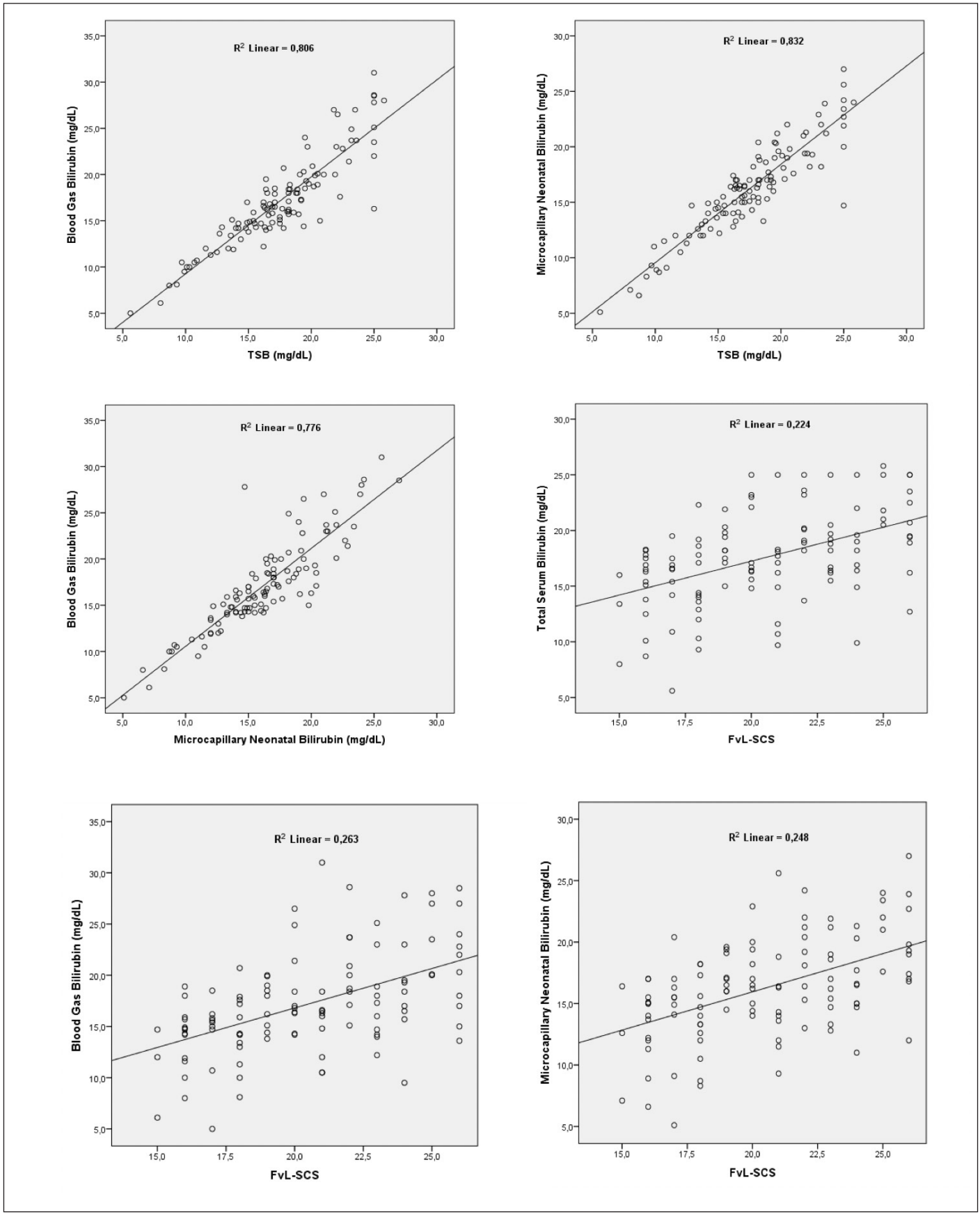

Figure 2: The graphs of the correlation between FvL-SCS test and the other diagnostic methods used in this study.

Cheng et al. (13) reported that the most feasible alternative for jaundice screening is the application of a transcutaneous bilirubinometer (TcB). They assessed neonatal jaundice using the Philips BiliChek system. The results of their study supported the position that TcB can be used in the diagnosis of neonatal jaundice. In addition, they reported that this non-invasive method is easy, safe, and convenient for measuring neonatal jaundice (13). Arman et al. (14) also reported that transcutaneous bilirubin may be useful for the screening and monitoring of jaundice in very preterm newborns. However, an instrument is needed to perform this method.

The FvL-SCS test is a non-invasive method of classifying skin color, which is determined by pigments such as hemoglobin, melanin, bilirubin, and carotene. These can be altered significantly by ultra-violet radiation, temperature, air humidity, pathological conditions and various substances such as drugs and irritants (15). Skin color can be measured using different techniques for different purposes. Clarys et al. (16) measured skin color using Chromameter, DermaSpectrometer and Mexameter methods and compared the results of the three instruments. They reported that these methods can be used to measure skin color. Treesirichod et al. (17) investigated pigment skin disorders using the FvL-SCS test. They found that the FvL-SCS method correlated closely with the results of testing with the Mexameter MX18 and posited that this method can be used in the diagnosis of skin disorders. In our study, we investigated the suitability of the FvL-SCS test for the diagnosis of neonatal jaundice and found that this method is practical. The results of our study confirm that the FvL-SCS method can be applied in clinical practice facilitating early diagnosis and the speedy treatment of neonatal jaundice.

A significant proportion of term and preterm infants develop neonatal jaundice, which is caused by an increase in serum bilirubin levels, largely as a result of the breakdown of red blood cells (18,19). If untreated, it can develop into allergies or other diseases that can prove fatal (20). Early diagnosis and treatment with phototherapy can prevent the development of other diseases (21). There exist various methods for the diagnosis of neonatal jaundice, but these methods are invasive and time-consuming. The FvL-SCS test is a fast, non-invasive, and inexpensive method for the diagnosis of neonatal jaundice.

Looking at the values, as the bilirubin value increases the color numbers marked in the FvL-DRS also increase to dark tones. However, not every bilirubin value corresponds to the same color code on the scale. This shows that FvL-DRS can be used as a screening test, but it is necessary to measure bilirubin values with one of the invasive methods in severe cases.

CONCLUSION

Newborns included in this study were found to have a color distribution of 15 or more in the FvL-SCS. Accordingly, we believe that color 15 in FvL-SCS can be used as a guide for further examination. FvL-SCS values of 18 and above require invasive examination methods. It was concluded that the FvL-SCS method can be used as a screening test. The results obtained in this thesis need to be supported by research with larger patient groups.

REFERENCES

1. Porter ML, Dennis BL. Hyperbilirubinemia in the term newborn. Am Fam Physician 2002:65:599-606.
2. Ercan Ş, Özgün G. The accuracy of transcutaneous bilirubinometer measurements to identify the hyperbilirubinemia in outpatient newborn population. Clin Biochem 2018;55:69-74.
3. Fakhri M, Farhadi R, Mousavinasab N, Hoseinimehr SJ, Yousefi SS, Davooddi A, et.al. Preventive effect of purgative manna on neonatal jaundice: a double blind randomized controlled clinical trial. J Ethnopharmacol 2019; 236;240-9.
4. Tavakolizadeh R, Izadi A, Seirafi G, Khedmat L, Mojtahedi SY. Maternal risk factors for neonatal jaundice: a hospital-based cross-sectional study in Tehran. Eur J Transl Myol 2018;28:7618.
5. Ullah S, Rahman K, Hedayati M. Hyperbilirubinemia in Neonates: Types, causes, clinical examinations, preventive measures and treatments: a narrative review article. Iran J Public Health 2016; 45; 558-68.
6. Greco C, Iskander IF, El Houchi SZ, Rohsiswatmo R, Rundjan L, Ogala W, et al. study team. Diagnostic performance analysis of the point-of-care bilistick system in identifying severe neonatal hyperbilirubinemia by a multi-country approach. E Clinical Medicine 2018;1:14-20.
7. Swiatoniowski AK, Quillen EE, Shriver MD, Jablonski NG. Technical note: comparing von Luschan skin color tiles and modern spectrophotometry for measuring human skin pigmentation. Am J Phys Anthropol 2013; 151:325-30.
8. Dark Tichondrias at English Wikipedia. Wikipedia.org. San Francisco: Wikipedia Foundation, Inc.https://en.wikipedia.org/wiki/File:Felix_von_Luschan_Skin_Color_Chart.JPG. Accessed 15 August 2019
9. Mir SE, van der Geest BAM, Been JV. Management of neonatal jaundice in low and lower-middle-income countries. BMJ Paediatr Open 2019;3:e000408.
10. Abbey P, Kandasamy D, Naranje P. Neonatal Jaundice. Indian J Pediatr 2019; 86:830-41.
11. Shah MH, Ariff S, Ali SR, Chaudhry RA, Lakhdir M, Qaiser F, et al. Quality improvement initiative using transcutaneous bilirubin nomogram to decrease serum bilirubin sampling in low-risk babies. BMJ Paediatr Open 2019;3:e000403.
12. Cordero C, Schieve LA, Croen LA, Engel SM, Maria Siega-Riz A, Herring AH, et.al. Neonatal jaundice in association with autism spectrum disorder and developmental disorder. J Perinatol 2020;40:219-25.
13. Cheng NY, Lin YL, Fang MC, Lu WH, Yang CC, Tseng SH. Noninvasive transcutaneous bilirubin assessment of neonates with hyperbilirubinemia using a photon diffusion theory-based method. Biomed Opt Express 2019;10:2969-84.
14. Arman D, Topcuoğlu S, Gürsoy T, Ovalı F, Karatekin G. The accuracy of transcutaneous bilirubinometry in preterm infants. J Perinatol 2020; 40:212-8.

15. Kaur CD, Saraf S. Skin care assessment on the basis of skin hydration, melanin, erythema and sebum at various body sites. Int J Pharm Pharma Sci 2011;3:209-13.
16. Clarys P, Alewaeters K, Lambrecht R. Barel AO. Skin color measurements: comparison between three instruments: The Chromameter, the DermaSpectrometer and the Mexameter. Skin Res Technol 2000;6:230-8.
17. Treesirichod A, Chansakulporn S, Wattanapan P. Correlation between skin color evaluation by skin color scale chart and narrawband reflectance spectrophotometer. Indian J Dermatol 2014; 59:339-42.
18. Mitra S, Rennie J. Neonatal jaundice: aetiology, diagnosis and treatment. Br J Hosp Med (Lond) 2017; 78:699-704.
19. Allen D. Neonatal jaundice. Nurs Child Young People 2016;28:11.
20. Rana N, Ranneberg LJ, Målqvist M, Kc A, Andersson O. Delayed cord clamping was not associated with an increased risk of hyperbilirubinemia on the day of birth or jaundice in the first 4 weeks. Acta Paediatr 2020;109:71-7.
21. Safar H, Elsary AY. Neonatal jaundice: the other side of the coin in the development of allergy. Am J Perinatol 2019;Jul 31. doi: 10.1055/s-0039-1693697.