



Preoperative hematological assessment of pediatric patients with cerebral palsy

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Objectives: Nutritional deficiencies and use of antiepileptic drugs can lead to alterations in the hematological status of children with cerebral palsy (CP), which may increase the risk of intra-operative or postoperative hematological complications. In this retrospective study, we evaluated the preoperative routine blood tests of CP patients with different levels of walking ability, who were scheduled to undergo orthopedic procedures.

Methods: Hemoglobin level, hematocrit, red blood cell count, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, red cell distribution width, white blood cell count, platelet count, prothrombin time, activated partial thromboplastin time, and plasma fibrinogen concentration were compared between 62 consecutive CP patients [28 girls, 34 boys; mean age 8.8 years (range 2-16 years)] and 130 consecutive orthopedic patients as control [64 girls, 66 boys; mean age 9.2 years (range 2-16 years)] who did not have any skeletal, cranial, thoracic, abdominal or major soft tissue injuries, or any other infectious, metabolic, hematological or malignant tumor disorders.

Results: CP and control groups were similar with regard to the above-mentioned hematological parameters. In the CP group, no difference was found between Gross Motor Function Classification System for Cerebral Palsy (GMFCS) level I/II patients and GMFCS level III/IV patients in terms of these hematological parameters.

Conclusion: Preoperative blood tests results of pediatric CP patients, walking with or without any supportive devices and undergoing orthopedic interventions, are similar to those of other orthopedic patients. Advanced preoperative hematological tests can only be recommended for CP patients with abnormal blood test results.

Key words: Cerebral palsy; hematological tests; orthopedic surgery.

Although cerebral palsy (CP) is defined as a disorder of movement and posture; associated problems such as seizures, visual impairments, intellectual impairment, learning disabilities, hearing problems, communication problems and dysarthria, oromotor dysfunction, gastrointestinal problems and nutrition, teeth problems, respiratory dysfunction, bladder and bowel problems, and social and emotional distur-

bances are as important as movement and posture problems.^[1] Orthopedic surgery is widely used in the management of children with CP to prevent or correct certain musculoskeletal problems. However, children with CP require special preoperative consideration because of the above-mentioned problems.^[1] For example, it has previously been stated that nutritional deficiencies, use of antiepileptic

drugs and some other factors can lead to alterations in the hematological status of children with CP. These alterations may increase the risk of intraoperative or postoperative complications.^[2-7] This issue may encourage surgeons to perform a complex preoperative hematological assessment in children with CP. Therefore, we initially hypothesized that CP patients undergoing orthopedic interventions would display results on routine preoperative blood tests that differed from those of other orthopedic patients. Such a difference would allow additional sophisticated preoperative hematological tests, the results of which could be used to minimize the intraoperative or postoperative complications due to hematological alterations in CP patients.

The aim of this retrospective study was to evaluate the preoperative routine blood tests of CP patients with different grades of walking ability to clarify the hematological risks during and after the operation and to compare the test results of these patients with those of control patients undergoing other orthopedic interventions.

Patients and methods

We retrospectively evaluated the medical files of patients who were between 2 and 16 years of age and treated in the Orthopedics Department of our hospital, within a two-year period. Any patient who had undergone surgical intervention within the last 12 months was not included in the study. The study group comprised CP patients who were able to walk with or without an assistive mobility device and who had received either intramuscular injections of botulinum toxin type A or a surgical intervention (soft tissue and/or bony procedure) under general anesthesia. Sixty-two CP patients (28 girls and 34 boys) with mean age of 8.8 ± 3.3 years (range 2-16 years) met the mentioned criteria and were included in the study. According to the clinical classification of CP,^[1] 56 patients had spastic-type CP, two had hypotonic-type CP, and four had mixed-type CP. According to the geographic classification of CP,^[1] 56 patients were diplegic, five were hemiplegic, and one was triplegic. All patients were able to feed orally. However, retrospective file analysis of the patients revealed that feeding status, history of

seizures and antiepileptic drug use records were not complete for all patients. The control group comprised pediatric patients who did not have any skeletal, cranial, thoracic, abdominal or major soft tissue injuries and were operated on due to orthopedic disorders, excluding infectious, metabolic, hematological or malignant tumor disorders, under general anesthesia. The excluded factors were considered to influence one or more than one of the preoperative routine blood tests. Overall, 130 children (64 girls and 66 boys) with a mean age of 9.2 ± 4.6 years (range 2-16 years) met the criteria outlined above and were included in the study.

Complete blood count, including hemoglobin (Hgb) level, hematocrit (Htc), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW), white blood cell count (WBC) and platelet count (PLT), as well as clotting parameters including prothrombin time (PT), activated partial thromboplastin time (aPTT), and plasma fibrinogen concentration (FIC) were routinely studied in all patients, at least 24 hours prior to the surgical intervention. All parameters were measured at the same hematology laboratory.

Functional status of the CP patients was evaluated using the Gross Motor Function Classification System for Cerebral Palsy (GMFCS) that was developed by Palisano et al.^[8] According to this system, GMFCS level I and II patients have the ability to walk without any assistive mobility device. GMFCS level III and IV patients have limited walking ability when using assistive mobility devices, such as crutches or walkers, and have independent mobility with wheelchairs. Level V patients have no means of independent mobility. Level V patients were not included in the study to obtain a more uniform study group, as it has widely been accepted that such severely involved CP patients have the highest risk of significant associated problems.^[1]

Statistical analysis of the data was performed in the SPSS software (SPSS for Windows 13.0, Chicago, IL, USA). The t-test for independent samples was used to compare the means, and the chi-square test was used to assess the association

between categorical variables. A p value less than 0.05 was considered significant.

Results

The study group included 23 GMFCS level I/II patients and 39 GMFCS level III/IV patients. Study and control groups were similar with respect to mean age ($p=0.512$) and gender ($p=0.598$). There was no significant difference between study and control groups regarding hematological parameters investigated (Table 1). In the CP group, no difference was found between GMFCS level I/II patients and GMFCS level III/IV patients in terms of these hematological parameters (Table 2).

Discussion

Orthopedic surgeons should consider the potential intraoperative and postoperative complications in CP patients. Hematological problems, such as anemia, increased intraoperative bleeding, and inherited thrombophilia, can be seen in CP patients undergoing surgical intervention.^[2-7,9,10] In the present study, we focused on the assessment of hematological problems using preoperative routine blood tests in CP patients with different grades of walking ability. We sought to determine whether sophisticated preoperative hematological tests rather than routine tests should be performed in such patients.

All children with CP are at risk for malnutrition, and this risk is not related to the degree of motor impairment.^[6] Nutritional status can be poor, especially in severely impaired children, due to inadequate oral intake. Such children have a higher risk of wound infection and hospitalization after orthopedic procedures.^[5,6] Poor nutrition increases the risk of iron deficiency anemia in patients with cerebral palsy; both inadequate iron intake and decreased iron absorption are the main causes.^[7] We did not screen iron deficiency in the present study. However, we could not detect any findings regarding anemia in the routine blood tests of CP patients when compared with those of control patients. Functional level was not correlated with the development of anemia among CP patients with the ability to walk.

Poor nutritional status can also result in poor protein synthesis, which negatively affects factor production leading to increased intraoperative bleeding in CP patients.^[2] Although CP patients undergoing posterior spinal fusion were reported to have preoperative PT and aPTT values within normal limits, these measurements were significantly different from those obtained in healthy subjects. These parameters showed significant alterations early in the course of major operative procedures, as compared to measurements from normal patients.^[2] In the

Table 1. Preoperative hematological parameters of the study and control groups (mean±SD).

	Study group (n=62)	Control group (n=130)	p value
Hemoglobin (g/dL)	13.4±1.2	13.1±1.2	0.147
Hematocrit (%)	39.0±3.4	38.4±3.3	0.189
Red blood cell count ($\times 10^6/\text{mm}^3$)	4.8±0.4	4.7±0.4	0.598
Mean corpuscular volume (fL)	81.0±4.1	80.5±5.8	0.541
Mean corpuscular hemoglobin (pg/cell)	27.8±1.7	27.5±2.2	0.389
Mean corpuscular hemoglobin concentration (%)	34.2±0.9	34.1±1.0	0.450
Red cell distribution width (%)	13.5±0.9	13.7±1.5	0.161
White blood cell count ($\times 10^3/\text{mm}^3$)	7.8±1.9	8.2±2.2	0.262
Platelet count ($\times 10^3/\text{mm}^3$)	309.0±77.1	314.4±70.4	0.634
Prothrombin time (sec)	11.5±0.8	11.8±1.1	0.060
Activated partial thromboplastin time (sec)	31.7±3.9	31.1±3.1	0.254
Fibrinogen concentration (mg/dL)	293.2±67.0	299.4±74.0	0.722

Table 2. Preoperative hematological parameters of the subjects in study group with different functional status according to the Gross Motor Function Classification System for Cerebral Palsy (GMFCS) (mean±SD).

	GMFCS I/II (n=23)	GMFCS III/IV (n=39)	p value
Hemoglobin (g/dL)	13.7±1.1	13.2±1.1	0.061
Hematocrit (%)	40.1±3.0	38.4±3.5	0.050
Red blood cell count (x10 ⁶ /mm ³)	4.9±0.3	4.7±0.5	0.071
Mean corpuscular volume (fL)	81.4±3.8	80.7±4.3	0.515
Mean corpuscular hemoglobin (pg/cell)	27.9±1.5	27.7±1.8	0.633
Mean corpuscular hemoglobin concentration (%)	34.2±0.8	34.2±1.0	0.895
Red cell distribution width (%)	13.4±0.8	13.5±0.9	0.554
White blood cell count (x10 ³ /mm ³)	8.0±2.1	7.7±1.9	0.568
Platelet count (x10 ³ /mm ³)	299.3±68.3	314.7±82.1	0.453
Prothrombin time (sec)	11.6±0.9	11.4±0.8	0.414
Activated partial thromboplastin time (sec)	32.5±4.2	31.2±3.6	0.203
Fibrinogen concentration (mg/dL)	317.5±76.8	282.4±61.3	0.224

present study, no significant coagulation abnormality due to factor deficiency or thrombocytopenia was detected in the routine blood test results of CP patients.

Concurrent treatment with antiepileptic drugs, such as valproic acid, may lead to increased intraoperative bleeding due to thrombocytopenia.^[2,4] Increased intraoperative blood loss and the need for increased transfusion due to valproic acid use were already demonstrated in CP patients undergoing spine surgery or femoral osteotomy.^[3,4] Such patients had normal preoperative Hgb, Htc, PT, and aPTT values, but a higher rate of thrombocytopenia occurrence and prolonged bleeding time.^[3,4] In the present study, although a detailed history of antiepileptic drug use was not present in all CP patients, PLT was similar between CP and control groups.

The relationship between inherited thrombophilia and CP was previously reported.^[9,10] However, thrombophilia can be considered as a risk factor for the development of CP rather than a condition that increases the risk of intraoperative or postoperative hematological complications. We did not perform preoperative sophisticated hematological tests to evaluate inherited thrombophilia in CP patients.

We conclude that CP patients with different grades of walking ability and undergoing orthopedic

procedures display similar results on routine preoperative blood tests, when compared with those of other orthopedic patients. The functional level of these patients does not significantly influence the results obtained with routine blood tests. Based on the results of the present study, we recommend performing sophisticated preoperative hematological tests and preoperative hematology consultation in patients with one or more abnormal parameter in routine preoperative blood tests. However, this conclusion is not valid for CP children who have no means of independent mobility.

Conflicts of Interest: No conflicts declared.

References

1. Yağın S, Berker N. The help guide to cerebral palsy. İstanbul: Mart Printing Co. Ltd.; 2005.
2. Brenn BR, Theroux MC, Dabney KW, Miller F. Clotting parameters and thromboelastography in children with neuromuscular and idiopathic scoliosis undergoing posterior spinal fusion. *Spine (Phila Pa 1976)* 2004;29:E310-4.
3. Carney BT, Minter CL. Is operative blood loss associated with valproic acid? Analysis of bilateral femoral osteotomy in children with total involvement cerebral palsy. *J Pediatr Orthop* 2005;25:283-5.
4. Chambers HG, Weinstein CH, Mubarak SJ, Wenger DR, Silva PD. The effect of valproic acid on blood loss in patients with cerebral palsy. *J Pediatr Orthop* 1999;19:792-5.

5. Jevsevar DS, Karlin LI. The relationship between preoperative nutritional status and complications after an operation for scoliosis in patients who have cerebral palsy. *J Bone Joint Surg Am* 1993;75:880-4.
6. Kuperminc MN, Stevenson RD. Growth and nutrition disorders in children with cerebral palsy. *Dev Disabil Res Rev* 2008;14:137-46.
7. Papadopoulos A, Ntaios G, Kaiafa G, Girtovitis F, Saouli Z, Kontoninas Z, et al. Increased incidence of iron deficiency anemia secondary to inadequate iron intake in institutionalized, young patients with cerebral palsy. *Int J Hematol* 2008;88:495-7.
8. Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Dev Med Child Neurol* 1997;39:214-23.
9. Őenbil N, Yüksel D, Yılmaz D, Gürer YK. Prothrombotic risk factors in children with hemiplegic cerebral palsy. *Pediatr Int* 2007;49:600-2.
10. Yehezkely-Schilkraut V, Kutai M, Hugeirat Y, Levin C, Shalev SA, Mazor G, et al. Thrombophilia: a risk factor for cerebral palsy? *Isr Med Assoc J* 2005;7:808-11.