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Analysis of leukocyte indices in patients with revision hip arhtroplasty

E.L. Matveeva, A.G. Gasanova✉, E.S. Spirkina, A.M. Ermakov

Ilizarov National Medical Research Centre for Traumatology and Orthopedics, Kurgan, Russian Federation

Corresponding author: Anna G. Gasanova, gasanova.08@mail.ru

Abstract

Introduction The widespread application of large joint arthroplasty is accompanied by an increase in the complications associated with periprosthetic infection. Currently, treating patients with infectious complications in the area of large joint arthroplasty remains a relevant issue. **Purpose** To determine the prognostic value of leukocyte indices in patients with revision hip arthroplasty. **Materials and methods** The study involved 88 patients with revision hip arthroplasty hospitalized at the Ilizarov National Medical Research Centre for Traumatology and Orthopedics. The patients were divided into two groups: group 1 (n = 77) were patients without periprosthetic infection (mean age 60.1 ± 1.5 years) and group 2 (n = 11) were patients with periprosthetic infection (age 55,2 ± 4.7 years). An analysis of the preoperative results of determining the number of leukocytes and leukocyte formula was carried out with the calculation of the leukocyte index of intoxication and the resistance index of the organism. The reliability of differences in indicators in groups was determined. According to the odds ratio, the probability of developing an infectious process was estimated. **Results** The level of leukocytes in the blood serum and the leukocyte index of intoxication of patients of groups 1 and 2 had no significant differences. In patients with an infectious process, their level was higher by 19.7 %, however, not going beyond the normal range. Differences in the index of intoxication in patients of groups 1 and 2 were not noted. In the 2nd group of patients, the resistance index of the organism significantly exceeded that of the 1st group, remaining within the normal range in both groups. When calculating the prognosis for the development of infectious complications, the value of the odds ratio for the resistance index of the organism is exactly an order of magnitude higher than this indicator for leukocytes and the leukocyte index of intoxication. **Conclusion** The prognosis of the clinical situation in revision hip arthroplasty should consider not only local changes and the general condition of the patient, but also an assessment of laboratory parameters, in particular, the resistance index of the body.

Keywords: hip joint, revision arthroplasty, blood, leukocyte indices

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INTRODUCTION

The widespread application of large joint arthroplaty is accompanied by an increase in the complications associated with periprosthetic infection (PJI) [1-4]. According to literature data, infection rates after primary joint replacement are 0.2-3 % [5, 6], and periprosthetic infection recurrence have been reported in up to 52 %, despite the improvement of treatment methods, technologies, and revision implants [7, 8]. At present, the problem of treating patients with infectious complications in the area of large joint implants remains relevant [9-12].

The index of the number of leukocytes in the blood is one of the main signs to evaluate the severity of the purulent inflammatory process. However, there are situations in which clinical manifestations do not correspond to the index of the number of leukocytes [13-15]. For a correct assessment of the clinical situation, the leukocyte indices were proposed [16, 17]. Leukocyte indices are the percentage of different types of leukocytes that can be determined by counting them in a stained blood swab under a microscope. Leukocyte indices based on the interpretation of leukocyte formula data are most often used in surgery [18-20].

The **aim** of the study was to determine the prognostic value of the leukocyte indices in patients with revision hip arthroplasty.

MATERIALS ANNND METHODS

A continuous single-center study of infectious complications in revision hip arthroplasty was conducted to analyze data from the documentation of patients treated at the Clinic of Osteoarticular Infection (Purulent Osteology) based on the medical care monitoring department. The study was retrospective. The analyzed period during which patients were included in the study was 2019-2020. The study included 88 patients aged 34 to 80 years with revision hip arthroplasty performed at the clinic of osteoarticular infection, 27 (31 %) men and 61 (69 %) women among them.

Group 1 was 77 patients without PJI: 55 females and 22 males aged 60.1 ± 1.5 years.

Group 2 were 11 patients with PJI, 6 females and 5 males aged 55.2 ± 4.7 years. Patients that did not meet requirements of age and had no complete data records were excluded.

According to the generally accepted method for calculating the odds ratio [18, 19, 21], a four-field contingency table was built for each factor, and using statistical programs [22, 23], such indicators as OR and confidence interval were calculated at the 95 % significance level.

One of the indices calculated by us was the index of Kalf-Kalifa [16, 18], named by the author as the leukocyte index of inflammation (*LII*):

$$LII = \frac{(4MC + 3Yo + 2P + C) \times (Pl.class + 1)}{(Lymph + Mon) \times (E + 1)},$$

where *MC* are myelocytes, *Yo* – young, *P* – stab cells, *C* – segmented, *Pl.class* – Plasma cells of the Türk, *Lymph* – lymphocytes, *Mon* – monocytes, *E* – eosinophils. Normal *LII* is 1 ± 0.5.

In addition to LII, we calculated the body resistance index (*IRI*), it is calculated by the formula:

$$IRI = \frac{L}{A \times LII},$$

where *L* – are leukocytes (thousands per 1 liter), *A* – age of the patients and *LII* is the index of Kalf-Kalifa.

For each study group, the median values and interquartile ranges of 0.25 and 0.75 percentiles were calculated. The significance of differences in the compared groups was assessed using the nonparametric Wilcoxon test, using licensed programs. A p-value < 0.05 was considered statistically significant.

RESULTS

Table 1 shows the indicators of the total number of leukocytes, the leukocyte index of intoxication according to Ya.Ya. Kalf-Kalifu, and an index of organism resistance.

Table 1

Leukocyte and leukocyte indices in patients with and without periprosthetic infection (median values and interquartile ranges)

Parameter	Group 1 (n = 77)	Group 2 (n = 11)
Leukocytes	6.30 (5.0;7.93)	7.54 (4.42;8.51)
LII	0.78 (0.51;1.19)	0.59 (0.46;0.88)
IRO	**0.11 (0.08;0.19)**	**0.17 (0.16;0.21)***

Note:* – significant differences are marked

The content of leukocytes in the blood serum of patients of groups 1 and 2 had no significant differences. The leukocyte index of intoxication had no statistically significant differences in patients of groups 1 and 2.

We noted that the resistance index of the organism in the 2nd group of patients was statistically significantly higher than that of the 1st group.

The value of the odds ratio for the resistance index of the organism is OR = 10.811 [1.3-88.6], which is an order of magnitude higher than this indicator for leukocytes and the leukocyte index of intoxication (OR = 0.78 [0.2-3.2] and OR = 1.324 [0.2-11.6], respectively). The results of calculating the odds ratio are presented in Tables 2, 3, 4.

Table 2

Odds ratio of leukocyte indices in the development of infectious complications in patients with revision hip arthroplasty

Relative risk factor in group 2	0.375
Relative risk factor in group 1	0.481
Odds ratio (OR)	0.780
Standard error of odds ratio (S)	0.719
Lower level 95 % CI	0.190
Upper level 95 % CI	3.195

Table 3

Odds ratio of the leukocyte index of intoxication in the development of infectious complications in patients with revision hip arthroplasty

Relative risk factor in group 2	10.000
Relative risk factor in group 1	7.556
Odds ratio (OR)	1.324
Standard error of odds ratio (S)	1.107
Lower level 95 % CI	0.151
Upper level 95 % CI	11.592

Table 4

Odds ratio of the body resistance index in the development of infectious complications in patients with revision hip arthroplasty

Relative risk factor in group 2	10.000
Relative risk factor in group 1	0.925
Odds ratio (OR)	10.811
Standard error of odds ratio (S)	1.073
Lower level 95 % CI	1.319
Upper level 95 % CI	88.612

DISCUSSION

The data from the current literature on the development of acute inflammatory and purulent diseases use different modifications of leukocyte indices based on the interpretation of leukocyte formula data [24, 25]. The Kalf-Kalif index, called by the author the leukocyte index of intoxication, in fact, shows a quantitative expression of the shift in the leukocyte formula [16]. It represents the ratio of the level of cells, the number of which increases during inflammatory and purulent processes, and cells, the number of which may decrease during these processes. In addition to LII, in various modifications, an index is proposed, in which LII is included as one of its components. This index is the IRO, which is the ratio of the total number of leukocytes to the product of LII and the age of the patient. Its values, which add up to normal indicators, show the optimal level of the body's protective response to the stimulus. It is more sensitive and less prone to errors than LII. The IRO can assess the physiological and functional state of patients, and it was found that its decrease indicates the possibility of developing infectious complications [22].

Integration of a morphological blood test is important, since the adaptive reactions of the body, expressed in quantitative and qualitative changes in the peripheral blood leukocyte formula, allow us to evaluate differences in the mean group values and determine their prognostic significance.

Analysis of the data showed that IRO beyond the normal values reflects a high risk of developing infectious complications in revision hip arthroplasty.

Patients whose IRO is beyond the normal range are 10 times more likely to develop infectious complications than those with leukocytosis or leukopenia (Tables 2 and 4). They need monitoring and dynamic control of their state. If the IRO is altered in the presence of unlikely risk factors (leukocytosis or elevated LII), then an antibiotic strategy should be considered.

CONCLUSION

To predict the clinical situation, the leukocyte indices should be calculated before revision hip arthroplasty. According to our findings, IRO beyond normal values indicates an increase in the chances of developing an infectious process. The calculation of leukocyte indices does not require time and material costs; it can be automated. It can be used to predict periprosthetic infection in combination with other clinical guidelines.

REFERENCES

1. Venediktova A.A., Kvashnina D.V., Blagonravova A.S. Periprosthetic infection risk factors according to a systematic review. *Medical almanac*. 2018;(4):133-137. (In Russ.)
2. Springer BD. The Diagnosis of Periprosthetic Joint Infection. *J Arthroplasty*. 2015;30(6):908-911. doi: 10.1016/j.arth.2015.03.042
3. Nikolaev N.S., Pchelova N.N., Preobrazhenskaya E.V., Nazarova V.V., Dobrovol'skaya N.Yu. ["Unexpected" Infections in Revision Arthroplasty for Aseptic Loosening]. *Travmatologiya i ortopediya Rossii* [Traumatology and Orthopedics of Russia]. 2021;27(3):56-70. (In Russ.) doi: 10.21823/2311-2905-2021-27-3-56-70
4. Diaz-Ledezma C, Lichstein PM, Dolan JG, Parvizi J. Diagnosis of periprosthetic joint infection in Medicare patients: multicriteria decision analysis. *Clin Orthop Relat Res*. 2014;472(11):3275-3284. doi: 10.1007/s11999-014-3492-2
5. Haydarov VM, Tkachenko AN, Kirilova IA, Mansurov DSh. Prediction of surgical site infection in spine surgery. *Hir. Pozvonoc*. 2018;15(2):84-90. (In Russ.) doi: 10.14531/ss2018.2.84-90
6. Ettinger M, Calliess T, Kielstein JT, Sibai J, Brückner T, Lichtinghagen R, Windhagen H, Lukasz A. Circulating biomarkers for discrimination between aseptic joint failure, low-grade infection, and high-grade septic failure. *Clin Infect Dis*. 2015;61(3):332-41. doi: 10.1093/cid/civ286
7. Grishchuk A.N., Leonova S.N., Kameka A.L. Assessing risks of developing and persistence of infectious process in knee joint replacement. *Acta biomedica scientifica*. 2021;6(4):202-212. (In Russ.) doi: 10.29413/ABS.2021-6.4.18
8. Shubnyakov l.l., Bozhkova S.11., Artyukh V.A., Liventsov V.N., Kochisfi A.A., Afanas'ev A.V. Early treatmcnt result in a patient with periprosthetic hip infection. *Vestnik t.ravmatologii i ortopedii im. N.N. Priorova*. 2017;24(4):52-55. (In Russ.)
9. Belova SV, Mamonova IA, Puchinyan DM, Babushkina IV, Gladkova EV, Adilov RG. Prognostic opportunities for infectious inflammatory complications in primary endoprosthesis of large joints. *Saratov Journal of Medical Scientific Research*. 2017;13(3):715-719. (In Russ.)
10. Ivanov P.P., Kornilov N.N., Kulyba T.A. Surgical interventions for treatment of infected total knee arthroplasty (literature review). *Kafedra travmatologii i ortopedii*. 2017;(1):35-43. (In Russ.)
11. Leonova S.N., Kameka A.L., Grishchuk A.N. Choosing tactics of large joints revision replacement at periprosthetic infection. *Sibirskiy meditsinskiy zhurnal* (Irkutsk). 2018;(3):11-14. (In Russ.)
12. Kliushin N.M., Kaminskii A.V., Ababkov Iu.V., Ermakov A.M. A result of the hip replacement after septic arthritis. *Genij Ortopedii*. 2013;(4):103-105. (In Russ.)
13. Ershov A.S., Antropova I.P., Volokitina E.A., Evstigneeva L.P. Hematological parameters of rheumatoid arthritis patients undergoing total hip replacement. *Genij Ortopedii*. 2021;27(5):514-520. doi: 10.18019/1028-4427-2021-27-5-514-520
14. Stogov M.V., Ovchinnikov E.N. Laboratory techniques for diagnosing and risk evaluation for complications after arthroplasty of large joints. An analytical review. *Genij Ortopedii*. 2016;(3)87-93. (In Russ.) doi: 10.18019/1028-4427-2016-3-87-93
15. Ottink KD, Strahm C, Muller-Kobold A, Sendi P, Wouthuyzen-Bakker M. Factors to Consider When Assessing the Diagnostic Accuracy of Synovial Leukocyte Count in Periprosthetic Joint Infection. *J Bone Jt Infect*. 2019;4(4):167-173. doi: 10.7150/jbji.34854
16. Rybdylov D.D., Khitrikheev V.E. Application of leucocyte index of inflammation in purulent surgery. *Vestnik Buryatskogo universiteta*. 2011;(12):62-64. (In Russ.)
17. Rybdylov D.D. Leukocytic index inflammation. *Bulletin of the East Siberian Scientific Center of the Siberian Branch of the Russian Academy of Medical Sciences*. 2010;(2):84-85. (In Russ.)

18. Rysbekov T.T. The role of leukocyte indices in the diagnosis of purulent and inflammatory diseases. *Bulletin of surgery in Kazakhstan*. 2009;(4):78. (In Russ.)
19. Morozenko D.V., Leont'eva F.S., Kuznetsova N.V. Study of the clinical and hematological status of patients after arthroplasty of large joints. *Molodiy vcheniy*. 2015;(2):633-636. (in Ukr.)
20. Saitoh Y, Setoguchi T, Yoshioka T, Nishi J, Tanimoto A, Komiya S. Intraoperative evaluation of polymorphonuclear leukocyte during second-stage revision surgery promote overdiagnosis of persistent periprosthetic joint infection. *Acta Orthop Traumatol Turc*. 2018;52(3):191-195. doi: 10.1016/j.aott.2018.02.002
21. Sushchenia H.A. Determination of the influence of predictors and the probability of retinal detachment in children based on the analysis of the odds ratio. *Doklady BGUIR*. 2021;19(7):106-109. (In Russ.) doi: 10.35596/1729-7648-2021-19-7-106-109
22. Marapov D. Medical statistics. 2013. (In Russ.) https://medstatistic.ru/calculators/calcodds.html (accessed 07.10.2022).
23. Kholmatova K.K., Grjibovski A.M. Case-control studies in medicine and public health. *Ekologiya cheloveka* (Human Ecology). 2016;(8):53-60. (In Russ.) doi: 10.33396/1728-0869-2016-8-53-60
24. Miromanov A.M. *Perelomy dlinnykh kostey konechnostey: prognosticheskiye kriterii razvitiya oslozhneniy*. Diss. dokt. med. nauk [Fractures of the long bones of the extremities: prognostic criteria for the development of complications: dissertation. Dr. sci. diss.]. Kurgan. 2013. 246 p. (In Russ.)
25. Sorokin A.A. Design "case – control" and the analysis of the odds ratio in clinical trials. *Medicine of Kyrgyzstana*. 2014;(5):70-74. (In Russ.)

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Information about the authors:

1. Elena L. Matveeva – Doctor of Biological Sciences, matveevan@mail.ru, https://orcid.org/0000-0002-7444-2077, SPIN: 8195-5618;
2. Anna G. Gasanova – gasanova.08@mail.ru, https://orcid.org/0000-0001-7734-2808, SPIN: 4629-2875;
3. Elena S. Spirkina – spirkina.82@mail.ru, https://orcid.org/0000-0003-2506-2657, SPIN: 4971-4902;
4. Artem M. Ermakov – Candidate of Medical Sciences, ema_cab@mail.ru, https://orcid.org/0000-0002-5420-4637, SPIN: 9292-8469.

Contribution of the authors:

Matveeva E.L. – conceptualization; research; writing the original version; scientific editing; control.
Gasanova A.G. – research; validation; formal analysis; data processing; visualization.
Spirkina E.S. – research; formal analysis; data processing.
Ermakov A.M. – conceptualization; methodology; research; scientific editing; project management.

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