

Surgical Hip Dislocation Technique in Treatment of Patients with Slipped Capital Femoral Epiphysis

P.S. Vvedenskiy, N.A. Tenilin, M.V. Vlasov, A.B. Bogosyan, A.V. Novikov

Privolzhsky Research Medical University, Nizhny Novgorod, Russian Federation

Abstract

Purpose: to evaluate the efficiency of modified Dunn procedure for treatment of severe slipped capital femoral epiphysis. **Materials and Methods.** The authors used the modified Dunn procedure for treatment of 6 patients with SCFE aged from 10 to 13 years and displacement degree over 55°. Chronic disease form was reported in one patient, acute displacement along the chronic process was reported in 5 patients. All patients had a stable form of SCFE by Loder classification. Surgical procedure was performed within 6 to 12 months from the onset of disease. **Results.** Normal anatomical relations in the hip joint were restored in all patients. During follow up from 18 until 48 months the patients did not demonstrate aseptic femoral head necrosis or chondrolysis. Adolescents did not complain on pain or hip motion limitations. Treatment outcomes assessment by Harris hip score was 97 points. **Conclusion.** Based on outcomes of the modified Dunn procedure the authors conclude that the method provides for complete restoration of the anatomical relations between femoral neck and epiphysis and, thus, the hip joint biomechanics. Femur dislocation allows to form an extended flap to ensure epiphysis perfusion which improves overall blood supply in the femoral head and consequently decreases the risk of aseptic necrosis and chondrolysis.

Keywords: juvenile slipped capital femoral epiphysis, surgical hip dislocation, open reduction of epiphysis, femoral head necrosis.

Competing interests: the authors declare that they have no competing interests.

Funding: the authors have no support or funding to report.

Publishing ethics: legal representatives of children given the informed consent to clinical cases publication.

Introduction

The choice of surgical technique for treatment of patients with juvenile slipped capital femoral epiphysis (SCFE) with significant degree of epiphysis displacement remains a pressing issue. Advocates of extra-articular correction, namely, intertrochanteric and higher corrective osteotomies speak for avoidance of intervention into the deformity area not to aggravate the critical level of epiphysis perfusion [1–4]. However, performance of extra-articular osteotomies with

three-plane reorientation of proximal femur does not always provide for achievement of correct placement of epiphysis in acetabulum [5]. Impingement syndrome developing at this stage leads to early coxarthrosis and later to a complicated hip arthroplasty due to significant alterations in proximal femur anatomy [6].

Advocates of intra-articular correction — open alignment of epiphysis or corrective osteotomy of femoral neck — speak for maximally possible restoration of anatomy and

Cite as: Vvedenskiy P.S., Tenilin N.A., Vlasov M.V., Bogosyan A.B., Novikov A.V. [Surgical Hip Dislocation Technique in Treatment of Patients with Slipped Capital Femoral Epiphysis]. *Travmatologiya i ortopediya Rossii* [Traumatology and Orthopedics of Russia]. 2018;24(4):64-71. (In Russ.). DOI: 10.21823/2311-2905-2018-24-4-64-71.

✉ Petr S. Vvedenskiy; e-mail: petr_v@mail.ru

Received: 22.08.2018. Accepted for publication: 17.10.2018.

biomechanics of the hip joint. However, intra-articular procedure poses a high risk of damaging the epiphysis perfusion with further development of aseptic head necrosis and chondrolysis.

In the last century the open reduction of epiphysis or corrective osteotomy of the femoral neck resulted in aseptic necrosis of femoral neck or chondrolysis in up to 100% of cases [7-19]. A significant breakthrough in this area was achieved by a technique of an open epiphysis reduction proposed by English surgeon Dunn in 1964 who described 63 cases of its application [20, 21].

The key aspect of Dunn procedure is formation of a feeding flap from periosteum of femoral neck by its accurate detachment from the bone. Periosteum of femoral neck on the posteromedial surface contains ascending branches of medial circumflex femoral artery which mainly ensure perfusion of femoral epiphysis. Dunn reported that aseptic necrosis and chondrolysis rate was decreased up to 10% in cases of chronic epiphyseolysis and up to 30% in acute epiphyseolysis along the chronic disease [21].

Russian surgeons A.R. Pulatov and V.V. Mineev in 2010 proposed a method of intra-articular correction of femoral epiphysis positioning in cases of juvenile SCFE (patent of Russian Federation 2405489). The method consists of a wedge resection of femoral neck along anterolateral surface with preservation of ascending branches of the medial circumflex femoral artery on the posterior surface. The authors of this method used the technique in 18 patients and reported that aseptic necrosis of the femoral head developed in 16% [22]. A disadvantage of proposed technique is the failure to gain full correction of deformity.

M. Leunig et al in 2007 proposed a modified Dunn technique of open reduction for femoral epiphysis and described treatment outcomes obtained in 30 clinical cases [23]. The key distinction of proposed procedure is the use of surgical femur dislocation which ensures free access to epiphysis, to femoral

neck and allows to form an extended perfusion flap from periosteum of femoral neck and distally from periosteum, posterior capsule elements, piriformis muscle. This allows to prevent critical damage to perfusion of femoral epiphysis. The clinic at Bern University which originated the technique reported 2% rate of above mentioned complications [24].

Purpose of the study – to evaluate the efficiency of modified Dunn procedure for treatment of severe juvenile slipped capital femoral epiphysis.

Materials and Methods

The authors used the modified Dunn procedure for treatment of 6 patients with SCFE, aged from 10 to 13 years and displacement degree over 55°. Chronic disease form was reported in one patient, acute displacement along the chronic process was reported in 5 patients. All patients had a stable form of SCFE by Loder classification.

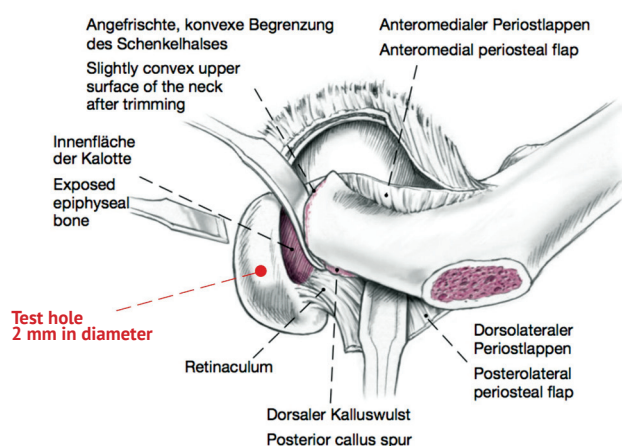
Procedure was performed within 6 to 12 months from the onset of disease in accordance with technique described by M. Leunig et al [23]. With patient in a lateral positioning the authors made a linear incision on lateral femur, dissected *tractus iliotibialis*, detached the greater trochanter with its mobilization and anterior abduction together with attached *m. vastus lateralis*, *m. gluteus medius* and *m. gluteus minimus*. Hip joint capsule was approached in the interval between *m. gluteus minimus* and *m. piriformis* through a Z-form capsulotomy. Lig. teres was detached and femoral head was dislocated. A control hole of 2 mm in diameter was made in anterior lateral quadrant of epiphysis to visualize epiphysis perfusion. Then femoral head was reduced into the acetabulum, and synovial flap was formed. Synovium was dissected on femoral neck and detached along anterior and posterior surfaces with detachment of posterior fragment of the greater trochanter and detachment of rotator tendons from their attach-

ment to the femur. After secondary femur dislocation epiphysis was separated from femoral neck with periosteum detachment along its posterior and medial surfaces. The newly formed callus was removed from the posterior surface of femoral neck (Fig. 1).

After reduction the epiphysis was fixed by threaded wires of 2,5mm in diameter. Special attention was given to avoid strain and twisting of the flap after reduction and fixation of epiphysis. Status of perfusion was controlled through a preliminary formed hole in femoral epiphysis. When procedure technique is observed blood loss from control hole in the femoral head continues during the whole surgery or is resumed after reduction and fixation of epiphysis to the femoral neck.

Upon completion of procedure the authors performed suturing of periosteum, capsule, screw fixation of the greater trochanter, suturing of *tractus iliotibialis* and skin.

Rehabilitation was started next day after surgery including passive motions in hip joint on Artromot system under prolonged epidural anesthesia. Weight load on the operated limb was allowed 6 months postoperatively.



Results

Evaluation of treatment outcomes was made in the period from 18 months to 4 years after the surgery (Table).

Active motion in hip joints was restored in terms from 2 to 3 weeks after the surgery and continued almost with full range during the whole follow up period. During examination of patients a barely noticeable limping was observed. Shortening of affected limb was up to 1 cm. The patients did not complain of pain or hip motion limitations. No aseptic necrosis or chondrolysis of the femoral head was observed. X-rays of three patients at follow up of 3 and 4 years demonstrated dystrophic changes corresponding to coxarthrosis of grade 1 manifesting by irregular joint gap and subchondral sclerosis of acetabulum. Harris hip score was 97 points in patients with and without roentgenological signs of dystrophy.

The clinical case is presented below. Female patient of 10 year old. Hip joint pain and limping manifested in July 2014. Outpatient clinic diagnosed osteochondropathy of the femoral head. The authors diagnosed a chronic juvenile slipped capital femoral epiphysis of the left femur. Roentgenography and computer tomography (Fig. 2) were used to confirm epiphysis displacement at 90°.

The patient underwent an open reduction of epiphysis according to modified Dunn procedure 11 months after the onset of disease, in August of 2015 (Fig. 3).

Fig. 1. Separation of femoral epiphysis, formation of the flap – detachment of periosteum from posterior and medial surfaces of femoral neck (Figure from article of M. Leunig et al (2007), was modified upon consent of the authors)

Table

Treatment outcomes

Patient, age, gender	Form of SCFE	Displacement degree of epiphysis, °	Follow up after the surgery, months	Pain syndrome	Range of motion in hip joint, °	Dystrophic changes	Harris Hip Score
13 y.o., m	O+X	87	48	No	S – 10/0/135, F – 40/0/30, H – 45/0/20	Moderate	97
10 y.o., f	O+X	90	30	No	S – 10/0/135, F – 50/0/30, H – 45/0/35	No	97
13 y.o., f	O+X	65	18	No	S – 5/0/120, F – 30/0/20, H – 25/0/20	Moderate	97
12 y.o., f	X	55	32	No	S – 10/0/140, F – 50/0/30, H – 45/0/30	No	97
13 y.o., f	O+X	60	27	No	S – 0/0/120, F – 30/0/20, H – 25/0/20	Moderate	97
13 y.o., f	O+X	80	36	No	S – 10/0/135, F – 40/0/30, H – 45/0/20	No	97

X – chronic form of SCFE; O+X – acute situation along chronic form of SCFE.

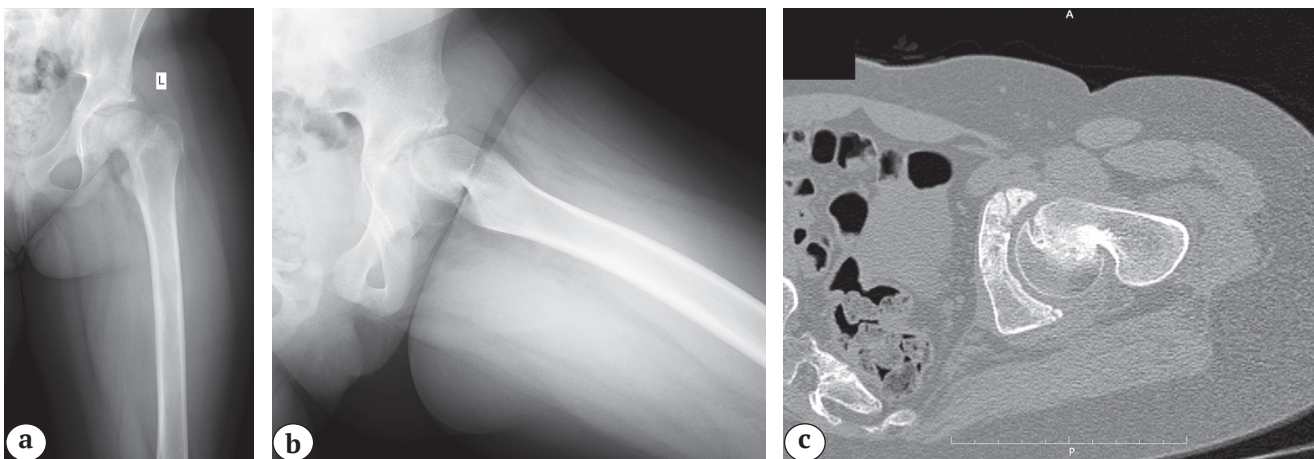


Fig. 2. X-rays of hip of female patient 10 y. o., prior to surgical treatment:
 a – straight AP view;
 b – Lauenstein position: epiphysis displacement at 90°;
 c – computer tomography

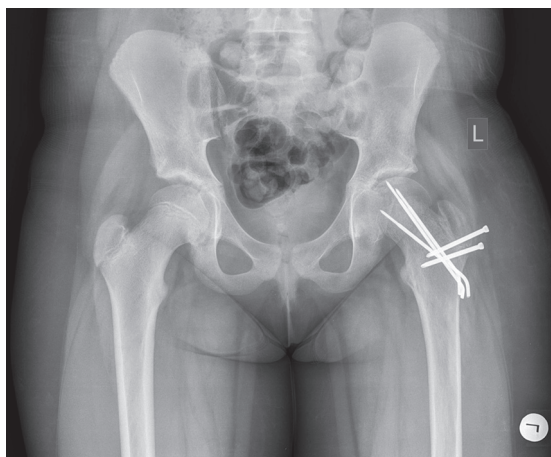


Fig. 3. X-ray of hip joints, female patient, after surgery: restored anatomical relations of epiphysis and femoral neck

Full range of active motion in hip joint was restored in 2 weeks after surgery. The patient was discharged for outpatient follow up in 3 weeks postoperatively. Healing was achieved in 5 months and weight load on the limb was allowed. Threaded wires were removed in one year postoperatively. At control examination in 3 years X-rays demonstrated correct position of femoral epiphysis without dystrophic changes (Fig. 4).

The patient has an active lifestyle and no complaints with full range of motion in the joint.

Discussion

Outcomes of modified Dunn procedure in the authors' clinic for treatment of patients with SCFE were quite promising.

In treatment of patients with severe epiphysis displacement of chronic and acute forms the authors did not observe development of aseptic necrosis of femoral head or chondrolysis. On the one hand, absence of such serious complications is due to rather accurate reproduction of surgical technique, on the other hand, probably, by a small number of cases.

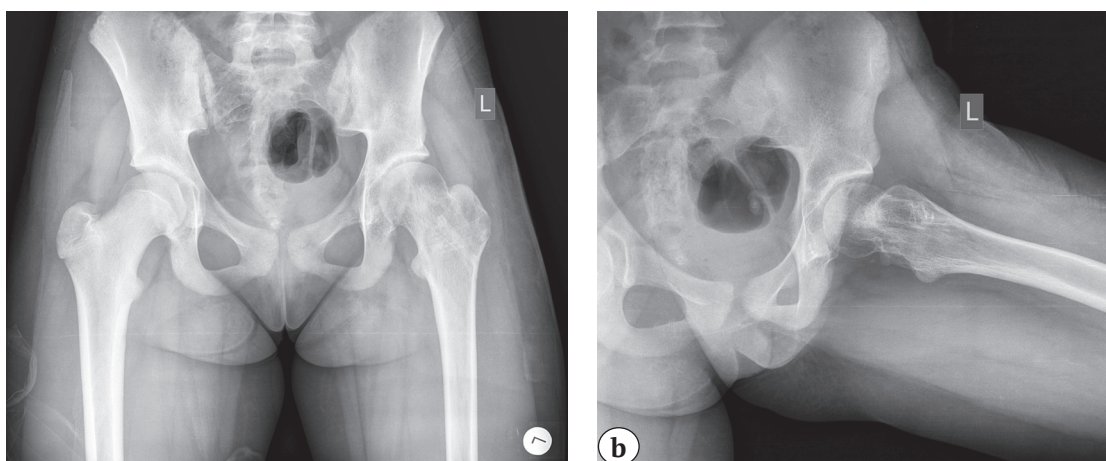


Fig. 4. X-rays of hip joint of female patient, 3 years after surgery in AP view (a) and in Lauenstein position (b): correct positioning of femoral epiphysis, no dystrophic changes

According to literature the rate of aseptic necrosis and chondrolysis constitutes from 0 to 26%. The lowest rate is reported by orthopaedic clinic of Bern university where the present procedure was developed and initially used, however, with increased number of procedures (from 30 to 43) the rate of aseptic necrosis also increased from 0 to 4% [25, 26, 27].

As the present technique is being spread and reproduced in other orthopaedic centers the rate of aseptic necrosis has increased up to 6–26% [28–34]. Such variations are probably related to severity and pattern of displacement, time elapsed from disease onset, as well as to technical features of procedure, the need for precise fulfillment of all manipulations in a confined space. V. Upasani in his research observed a clear inverse proportion between a surgeon's experience (number and frequency of performed procedures) and rate of complications [30].

Conclusion

A modified Dunn procedure provides for complete restoration of anatomical relations between femoral neck and epiphysis and, thus, of the hip joint biomechanics. Femur dislocation allows to form an extended flap to perfuse epiphysis which significantly improves blood supply to femoral head and decreases the risk of aseptic necrosis and chondrolysis.

Considering the world experience and own cases the authors make a conclusion that use of modified Dunn procedure can currently be the method of choice for treatment of patients with severe juvenile SCFE, however, relatively small number of performed interventions require further research.

All patients (their lawful representatives — parents) gave willful consent to examination, treatment, research analysis and publishing of outcomes in scientific literature.

References

1. Baskov V.E. [Results of treatment of juvenile femoral head epiphysiolysis]. *Ortopediya, travmatologiya i vosstanovitel'naya khirurgiya detskogo vozrasta* [Pediatric Traumatology, Orthopaedics and Reconstructive Surgery]. 2014;2(3):14-17. DOI: 10.17816/PTORS2314-17. (In Russ.).
2. Barsukov D.B., Pozdnyukov I.Yu., Baskov V.E., Krasnov A.I. [Surgical interventions of juvenile femoral head epiphysiolysis]. *Amurskii meditsinskii zhurnal* [Amursky Medical Journal]. 2015;4(12):153-154. (In Russ.).
3. Schai P.A., Exner G.U. Corrective Imhäuser intertrochanteric osteotomy. *Oper Orthop Traumatol.* 2007;19(4):368-388. (In German). DOI: 10.1007/s00064-007-1212-8.
4. Trisolino G., Pagliuzzi G., Di Gennaro G.L., Stilli S. Long-term results of combined epiphysodesis and Imhäuser intertrochanteric osteotomy in SCFE: a retrospective study on 53 hips. *J Pediatr Orthop.* 2017;37(6):409-415. DOI: 10.1097/BPO.0000000000000695.
5. Akhtiamov I., Abakarov A., Beletskii A., Bogosian A., Sokolovsky O. [Hip joint diseases in children. Diagnosis and surgical treatment]. Kazan; 2008. 456 p. (In Russ.).
6. Soni J.F., Valenza W.R., Uliana C.S. Surgical treatment of femoroacetabular impingement after slipped capital femoral epiphysis. *Curr Opin Pediatr.* 2018;30(1):93-99. DOI: 10.1097/MOP.0000000000000565.
7. Tenilin N.A., Batalov O.A. [Method of surgical treatment of unstable severe forms of juvenile femoral head epiphysiolysis]. *Ortopediya, travmatologiya i protezirovanie* [Orthopaedics, Traumatology and Prosthetics]. 1989; (4):50-51. (In Russ.).
8. Hall J.E. The results of treatment of slipped femoral epiphysis. *J Bone Joint Surg Br.* 1957;39-B(4):59-73.
9. Hiertonn T. Wedge osteotomy in advanced femoral epiphysiolysis. *Acta Orthop Scand.* 1955;25(1):44-62.
10. Arnold P., Jani L., Soloniewicz A. [Significance and results of subcapital osteotomy in severe slipped capital femoral epiphysis]. *Orthopade.* 2002;31(9):908-1113. (In German). DOI: 10.1007/s00132-002-0380-3.
11. Ballmer P.M., Gilg M., Aebi B., Ganz R. [Results following subcapital and Imhäuser-Weber osteotomy in femur head epiphysiolysis]. *Z Orthop Ihre Grenzgeb.* 1990;128(1):63-66. DOI: 10.1055/s-2008-1039863.
12. Broughton N.S., Todd R.C., Dunn D.M., Angel J.C. Open reduction of the severely slipped upper femoral epiphysiolysis. *J Bone Joint Surg Br.* 1988;70(3):435-439.

13. Clarke H.J., Wilkinson J.A. Surgical treatment for severe slipping of the upper femoral epiphysis. *J Bone Joint Surg Br.* 1990;72(5):854-858.
14. Exner G.U., Schai P.A., Nötzli H.P. [Treatment of acute slips and clinical results in slipped capital femoral epiphysis]. *Orthopade.* 2002;31(9):857-865. (In German). DOI: 10.1007/s00132-002-0374-1/
15. Lefort G., Cottalorda J., Bouche-Pillon M.A., Lefebvre F., Daoud S. [Open reduction by the Dunn technique in upper femoral epiphysiolyis. Report of 14 cases]. *Chir Pediatr.* 1990;31(4-5):229-234. (In French).
16. Martin T., Fayad F. [Severe upper femoral epiphysiolyis. Invasive reduction by Dunn's technic:11 cases]. *Rev Chir Orthop Reparatrice Appar Mot.* 1986;72(8):587-598. (In French).
17. Nishiyama K., Sakamaki T., Ishii Y. Follow-up study of the subcapital wedge osteotomy for severe chronic slipped capital femoral epiphysis. *J Pediatr Orthop.* 1989;9(4):412-416.
18. Rao J.P., Francis A.M., Siwek C.W. The treatment of chronic slipped capital femoral epiphysis by bi-plane osteotomy. *J Bone Joint Surg Am.* 1984;66(8):1169-1175.
19. Velasco R., Schai P.A., Exner G.U. Slipped capital femoral epiphysis:a long-term follow-up study after open reduction of the femoral head combined with subcapital wedge resection. *J Pediatr Orthop B.* 1998;7(1):43-52.
20. Dunn D.M. The treatment of adolescent slipping of the upper femoral epyphysis. *J Bone Joint Surg Br.* 1964;46:621-629.
21. Dunn D.M., Angel D.C. Replacement of the femoral head by open operation in severe adolescent slipping of the upper femoral epyphysis. *J Bone Joint Surg Br.* 1978;60-B(3):394-403.
22. Pulatov A.R., Mineev V.V. [Long-term outcomes of surgical treatment for unstable forms of juvenile slipped femoral epiphysis]. *Genij Ortopedii* [Orthopaedic Genius]. 2012;(3):88-90. (In Russ.).
23. Leunig M., Slongo T., Kleinschmidt M., Ganz R. [Subcapital correction osteotomy in slipped capital femoral epiphysis by means of surgical hip dislocation]. *Oper Orthop Traumatol.* 2007;19(4):389-410. (In German). DOI: 10.1007/s00064-007-1213-7.
24. Tannast M., Jost L.M., Lerch T.D., Schmaranzer F., Ziebarth K., Siebenrock K.A. The modified Dunn procedure for slipped capital femoral. *J Child Orthop.* 2017;11(2):138-146. DOI: 10.1302/1863-2548-11-170046.
25. Ziebarth K., Zilkens C., Spencer S., Leunig M., Ganz R., Kim Y.J. Capital realignment for moderate and severe SCFE using a modified Dunn procedure. *Clin Orthop Relat Res.* 2009;467(3):704-716. DOI: 10.1007/s11999-008-0687-4.
26. Slongo T., Kakaty D., Krause F., Ziebarth K. Treatment of slipped capital femoral epiphysis with a modified Dunn procedure. *J Bone Joint Surg Am.* 2010 Dec 15;92(18):2898-2908. DOI: 10.2106/JBJS.I.01385.
27. Ziebarth K., Milosevic M., Lerch T.D., Steppacher S.D., Slongo T., Siebenrock K.A. High survivorship and little osteoarthritis at 10-year followup in scfe patients treated with a modified Dunn procedure. *Clin Orthop Relat Res.* 2017;475(4):1212-1228. DOI: 10.1007/s11999-017-5252-6.
28. Sankar W.N., Vanderhave K.L., Matheney T., Herrera-Soto J.A., Karlen J.W. The modified Dunn procedure for unstable slipped capital femoral epiphysis:a multicenter perspective. *J Bone Joint Surg Am.* 2013;95(7):585-591. DOI: 10.2106/JBJS.L.00203.
29. Madan S.S., Cooper A.P., Davies A.G., Fernandes J.A. The treatment of severe slipped capital femoral epiphysis via the Ganz surgical dislocation and anatomical reduction:a prospective study. *Bone Joint J.* 2013;95-B(3):424-429. DOI: 10.1302/0301-620X.95B3.30113.
30. Upasani V.V., Matheney T.H., Spencer S.A., Kim Y.J., Millis M.B., Kasser J.R. Complications after modified Dunn osteotomy for the treatment of adolescent slipped capital femoral epiphysis. *J Pediatr Orthop.* 2014;34(7):661-667. DOI: 10.1097/BPO.000000000000161.
31. Souder C.D., Bomar J.D., Wenger D.R. The role of capital realignment versus in situ stabilization for the treatment of slipped capital femoral epiphysis. *J Pediatr Orthop.* 2014;34(8):791-798. DOI: 10.1097/BPO.000000000000193.
32. Novais E.N., Hill M.K., Carry P.M., Heare T.C., Sink E.L. Modified Dunn procedure is superior to in situ pinning for short-term clinical and radiographic improvement in severe stable SCFE. *Clin Orthop Relat Res.* 2015;473(6):2108-2117. DOI: 10.1007/s11999-014-4100-1.
33. Persinger F., Davis R.L. 2nd, Samora W.P., Klingele K.E. Treatment of unstable slipped capital epiphysis via the modified Dunn procedure. *J Pediatr Orthop.* 2018;38(1):3-8. DOI: 10.1097/BPO.0000000000000737.
34. Elmarghany M., Abd El-Ghaffar T.M., Seddik M., Akar A., Gad Y., Ragheb E., Aprato A., Massè A. Surgical hip dislocation in treatment of slipped capital femoral epiphysis. *SICOT J.* 2017;3:10. DOI: 10.1051/sicotj/2016047.

INFORMATION ABOUT AUTHORS:

Petr S. Vvedenskiy — Cand. Sci. (Med.), orthopaedic surgeon, Pediatric Orthopaedics Department, University Clinic, Privolzhsky Research Medical University, Nizhny Novgorod, Russian Federation

Nikolay A. Tenilin — Dr. Sci. (Med.), leading researcher, Pediatric Orthopaedics Department, University Clinic, Privolzhsky Research Medical University, Nizhny Novgorod, Russian Federation

Maxim V. Vlasov — Cand. Sci. (Med.), head of Pediatric Orthopaedics Department, University Clinic, Privolzhsky Research Medical University, Nizhny Novgorod, Russian Federation

Alexandr B. Bogosyan — Dr. Sci. (Med.), leading researcher, Pediatric Orthopaedics Department, University Clinic, Privolzhsky Research Medical University, Nizhny Novgorod, Russian Federation

Alexandr V. Novikov — Dr. Sci. (Med.), chief researcher, Consultation and Rehabilitation Department, University Clinic, Privolzhsky Research Medical University, Nizhny Novgorod, Russian Federation