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Clinical Effectiveness and Complications of Minimally Invasive and Percutaneous Surgical Techniques in Forefoot Deformity Correction

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Abstract Minimally invasive and percutaneous surgical techniques have gained widespread use in the correction of forefoot deformities due to their potential to reduce postoperative pain, shorten rehabilitation, and improve cosmetic outcomes. Despite these advantages, arthroscopic and percutaneous correction of hallux valgus and lateral ray deformities remains technically demanding, requiring advanced surgical training and intraoperative fluoroscopic control. This study analyzes the principles, indications, and clinical outcomes of minimally invasive foot surgery, focusing on metatarsal head osteotomies, PASA corrections, and surgical approaches for deformities of the fifth ray. Although minimally invasive interventions demonstrate outcomes comparable to traditional open techniques, a significant rate of postoperative complications persists, including delayed wound healing, neurovascular impairments, pseudarthrosis, metatarsophalangeal joint stiffness, recurrence of deformity, and, in rare cases, aseptic necrosis of metatarsal heads. The recurrence of deformities is frequently associated with inadequate surgical planning and insufficient correction of angular parameters. Overall, minimally invasive techniques represent a promising approach offering early mobilization and functional recovery; however, careful patient selection, surgeon training, and adherence to postoperative protocols are essential to minimize complications and achieve optimal outcomes.

Keywords Minimally invasive surgery of the forefoot, Research methods of static deformations of the human foot

1. Introduction

There are several types of minimally invasive surgeries: minimally invasive (minimally invasive), percutaneous (percutaneous) operations, and arthroscopy. Arthroscopic surgery for valgus deformity of the forefoot is, of course, not a standard procedure. This is a responsible and time-consuming process that carries a potential risk of damage to the interdigital nerve. Minimally invasive foot surgery appeared in the mid-1970s in the United States. Many techniques are still under development, and the published results of some authors remain controversial. Good results were recorded after correction of the hallux valgus deformity of the first toe, but a high incidence of complications and relapses was found. Encouraging results have been shown in percutaneous surgery of static metatarsalgias. The main purpose of these percutaneous techniques is to provide rapid postoperative recovery with similar results to those achieved with traditional surgery [1,3,5,7,9,11].

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2. Results and Analyzes

The so-called head osteotomy technique has become the initial one for all percutaneous operations to correct deformities in the forefoot. The disadvantage of the percutaneous technique is that the operation is performed without direct visualization of various tissue layers and intraoperative X-ray is mandatory. The operation is performed using a high-speed drill. At the same time, minimally invasive operations (operations with minimal skin incision) are devoid of the above disadvantages. Training in minimally invasive techniques is lengthy, for several reasons: – the surgeon must learn how to use special complex tools that differ from those used in routine practice; – it is necessary to get acquainted with the specific tactile sensations associated with the various stages of the operation. The force applied by the drill to the bone is crucial to ensure good postoperative results.; – the application and interpretation of intraoperative fluoroscopy requires some experience. The surgeon must complete several theoretical and practical cadaver courses in order to gain practical skills with specific instruments. Minimally invasive surgery allows you to achieve good results through the lowest possible working incision without direct visualization of deep structures. Minimally invasive methods, which are described in the scientific literature,

can be used in the treatment of hallux valgus deformity of the first and lateral toes, Morton's neuroma. The obvious advantages of minimally invasive foot surgery compared to traditional open methods are: less postoperative pain, better cosmetic results, shorter surgery and hospital stay, lower costs related to surgery time and surgical supplies/implants, lower risk of infection [2,4,6,8,10,12,14,16].

Minimally invasive surgery of lateral "rays" Deformations of lateral "rays" are indications for the use of minimally invasive and percutaneous technologies. Access is performed along the back of the foot in the desired metatarsal space. With the help of a drill, a distal metatarsal minimally invasive osteotomy PASA is performed, allowing the heads of the metatarsal bones to be moved upward and proximally, thereby eliminating excessive stress on them. The drilling speed is important for a safe osteotomy of the metatarsal bones. We have not found any studies in the available literature confirming the safe rotation speed of the drill router, however, there are recommendations from well-known specialists in minimally invasive surgery to adhere to a rotation speed of 8000 to 15,000 revolutions per minute. Osteotomies should be performed extraarticularly through the distal metaphysis with minimal drill pressure on the bone. It is important to verify that the osteotomy is completed by applying traction and compressive forces along the axis of the finger in order to mobilize the distal fragment. Operations on the fifth ray Deformity of the fifth ray of the foot (Taylor's deformity) is less common than the hallux valgus deviation of the first toe. Most often, the correction is performed by chevron osteotomy of the fifth ray, which reduces the angle M4–M5. Percutaneous osteotomies have shown similar results to conventional open methods. However, a number of authors note the advantages of minimally invasive correction techniques. The development of minimally invasive surgery is radically changing the treatment strategies used in foot surgery. Minimally invasive surgery allows for early rehabilitation and early resumption of the patient's previous activities. However, despite the "minimization" of surgical operations, some signs of the "ideal method" should be considered with some caution. Small ray anomalies are good indications for minimally invasive surgery [11,13,15,16]. Good results are achieved quickly, with a small percentage of iatrogenic complications. Percutaneous technique is especially good in elderly patients, allowing correction of even severe deformities with a lower risk of complications. Despite the rapid development of forefoot surgery, the percentage of complications reaches 55% according to various authors. Postoperative complications include surgical area infections, keloid scars, bleeding, thrombosis, and cardiovascular complications. These are complications that are extremely rare in foot surgery, but they are possible, as with any other operation. More frequent postoperative complications during forefoot surgery include long-term non-healing postoperative wounds (18%), neurovascular disorders (29%), false joints (9%), aseptic necrosis of the head of the first metatarsal (2%), under-correction or recurrence of deformity, increased pain, stiffness of the metatarsophalangeal and interphalangeal sutures, deep vein thrombosis and pulmonary embolism, prolonged edema, difficulty walking and loss of foot function.

Complications of anesthesia are quite rare, since most operations with hallux valgus are short–term interventions performed under conduction anesthesia or spinal anesthesia. Careful medical history collection helps to reduce the risk of postoperative complications. Detection of concomitant, especially comorbid pathology in elderly and senile people can significantly reduce the risk of complications of surgical treatment. Thromboembolic complications: the incidence of deep vein thrombosis is less than 5%, and the risk of pulmonary embolism is minimal. The risk of these complications can be reduced through early mobilization and anticoagulant prophylaxis. The development of wound infection varies from 0 to 10%, while minimally invasive operations have a lower risk. The recurrence of deformity occurs in 5-20% of cases. The causes of the recurrence of deformity are the shortcomings of preoperative planning, violation of the technique of surgery and the postoperative orthopedic regime. At the same time, the main causes of relapse are considered to be insufficient correction of the PASA angle, as well as inadequate correction of the M1M2 angle, and non-compliance with the postoperative protective regime. Aseptic necrosis of osteotomized metatarsal heads occurs in 1% of cases, while most cases of aseptic necrosis are asymptomatic, but sometimes lead to symptomatic osteoarthritis and the need for arthrodesis of the joint. False joints occur more often due to overloads of the heads of the small metatarsal bones. He was the first to describe hallux varus as a complication after his surgery with a frequency of up to 0.5%, developing as a result of excessively radical medial exostosectomy, lateral sesamoidectomy, as well as disorders of the tendon-ligament balance of PFS 1 as a result of excessive lateral release and medial capsulography. Modern researchers report 2-17% of these complications, while if elastic varus deformity of the first toe is well tolerated by patients, then revision surgical treatment is required in combination with hallux rigidus. Metatarsalgia recurrence occurs in 5-40% of cases. The factors provoking metatarsalgia recurrence are: excessive shortening of the first ray, under-correction of the metatarsal parabola, aseptic necrosis of osteotomized fragments of the metatarsal bones, while in most patients the metatarsalgia that occurs after surgery can be managed by careful selection of shoes or orthopedic insoles. Stiffness of the metatarsophalangeal and interphalangeal joints: may occur after any procedure. Excessively radical release of soft tissues increases the risk of developing stiffness. Other causes include the presence of polyarthritis and joint subluxation in patients. Operations for hallux valgus often result in damage to the medial branch of the dorsal cutaneous nerve of the foot, the branch of the superficial fibular nerve, which leads to loss of skin sensitivity in patients.

3. Conclusions

Regional pain syndrome occurs in 2% of cases. It is important to warn patients about the development of this complication, as the pain after surgery may eventually be worse than before. Thus, numerous studies have examined various, mainly surgical, methods of treating static deformities of the forefoot. The success of treatment depends on the correct diagnosis of deformity, careful preoperative planning, individual choice of surgical treatment methods, as well as precision technical execution. Given the complexity of diagnosis, identification of risk factors and factors of flatfoot progression, it is necessary to further study this disease and develop new, more advanced and effective treatment regimens.

REFERENCES

[1] Berezhnoy, S. Y. The "underlying" fifth toe (quintus varus intraductus): description of deformity, classification, percutaneous surgical treatment / S. Y. Berezhnoy // Moscow Surgical Journal. – 2012. – № 4 (26). – Pp. 19-23.

[2] Gamolin, S. V. Improvement of surgical tactics in the treatment of patients with transverse flat feet: dis. ... Candidate of Medical Sciences: 14.01.55 / Gamolin Sergey Viktorovich. – St. Petersburg, 2011.

[3] Eremeev O. V., Filimendikov P. V., Shevchuk O. V. Approaches to surgical treatment of hallux valgus deformity of the 1st toe in the Department of Orthopedics / O. V. Eremeev, Filimendikov P. V., Shevchuk O. V. // The Genius of Orthopedics. 2001. No. 2. pp. 103-104.

[4] Zhuravlev, A. A. Surgical treatment of Hallux valgus / A. A. Zhuravlev, B. B. Kudryavtsev // 60 years in the public health service of the Krasnoyarsk Territory: Proceedings of a scientific and practical conference. 2002. pp. 137-138.

[5] Kardanov, A. A. Influence of the angle of inclination of the articular surface of the first metatarsal bone on the result of surgical treatment of hallux valgus (radiological aspect) / A. A. Kardanov, N. V. Zagorodny, L. G. Makinyan, M. P. Lukin // Bulletin of Radiology and Radiology. 2007. pp. 44-48.

[6] Modified McBride surgery in the treatment of patients with hallux valgus deformity of the first toes / N. V. Zagorodny, V. G. Protsko, A. A. Kardanov, V. A. Dirin // Bulletin of the RUDN University. – 2002. – No. 4. – pp. 73-76.

[7] Some aspects of surgical treatment of deformities of the anterior region of the feet / N. V. Zagorodny, A. A. Kardanov, L. G. Makinyan [et al.] // Bulletin of the Rudn University: Medicine series. 2008. No. 6. pp. 151-155.

[8] Surgical treatment of metatarsalgia / N.V. Zagorodny, S. B. Shevchenko, A. A. Kardanov [et al.] // Proceedings of the 3rd International Congress "Modern Technologies in Traumatology and Orthopedics". 2006. p. 270.

[9] Decree of the Government of the Russian Federation dated 07/04/2013 No. 565 (as amended on 12/14/2018) "On approval of the Regulations on military medical examination".

[10] Tertyshnik, S. S. Surgical treatment of deformities of the forefoot in hallux valgus: dis. ... Candidate of Medical Sciences: 14.01.15 / Tertyshnik Sergey Sergeevich. Kurgan, 2011.

[11] Usoltsev, I. V. Problems of diagnosis and surgical treatment of gross deviation of the first toe (literature review) / I. V. Usoltsev, S. N. Leonova // Acta Biomedica Scientifica. – 2017. – Vol. 2, № 6 (118).

[12] A biomechanical comparison of the Z step-cut and basilar crescentic osteoto- mies of the first metatarsal / A. S. Newman, J. P. Negrine, M. Zevovic [et al.] // Foot Ankle Int. – 2000. – Vol. 21. – P. 584–587.

[13] Barouk, L. S. Forefoot reconstruction / L. S. Barouk. – 2nd ed.– Paris: Springer, 2005. – 388 p.

[14] Briggs, T. W. Mitchell's osteotomy using internal fixation and early mobiliza- tion / T. W. Briggs, P. Smith, T. B. McAuliffe // J. Bone Joint Surg. – 1992. – Vol. 74. –P. 137–139.

[15] Coetzee, J. C. Surgical strategies: scarf osteotomy for hallux valgus / J. C. Coetzee, P. Rippstein // Foot Ankle Int. – 2007. – Vol. 28. – P. 529–535.

[16] De Lavigne, C. The treatment of hallux valgus with the mini-invasive technique / C. De Lavigne, S. Guillo, O. Laffen être, M. De Prado // Interactive Surgery. – 2007. – N 2 (1). – P. 31–37.