Results of Hallux Abducto Valgus Surgical Correction Using Two 1.1mm Mini TightRope Constructs

MIHAI NICA1,2, CORINA PANAITESCU1, BOGDAN CRETU1, PANTI ZSOMBOR1,2, CAMELLA TECU3, AUGUSTIN SEMENESCU2, DRAGOS ENE2,5, GABRIELA SOARE3,4, CATALIN CIRSTOIU1,2, RAZVAN ENE1,2

1Emergency University Hospital of Bucharest, Orthopedics and Traumatology Department, 169 Splaiul Independentei, 050098, Bucharest, Romania
2University of Medicine and Pharmacy Carol Davila Bucharest, 8 Eroi Sanitari Str., 050474, Bucharest, Romania
3University Politehnica of Bucharest, 313 Splaiul Independentei, 060042, Bucharest, Romania
4Emergency Clinical Hospital of Bucharest, Ortopedics and Traumatology Department, 169 Splaiul Independentei, 050098, Bucharest, Romania
5University of Medicine and Pharmacy Carol Davila Bucharest, 8 Eroii Sanitari Str., 050474, Bucharest, Romania

Hallux valgus represents an acquired foot deformity defined by medial deviation of the first metatarsal bone combined with lateral shift of the hallux and medial metatarsophalangeal joint eminence enlargement. The functional impairment and metatarsalgia generated stem from the biomechanical imbalance which does not allow for normal transfer of weight trough the first ray during walking. The results generated with our experience with the 1.1mm Mini TightRope® Disposable Kit in the treatment of hallux valgus are analyzed in this paper. A total number of 24 feet (12 bilateral cases) with hallux valgus, surgically treated in our department were followed for a period of minimum twelve months and evaluated. The results showed an improvement of the mean preoperative IMA 14.6° to 7.9° postoperatively and 9.2° at six months after surgery. The preoperative measured HVA was reduced from 28.4° to 14.2° at once and 16.1° after six months. The AOFAS hallux metatarsophalangeal-interphalangeal score resulted improvement reflects the functional benefits. These results confirm the good correction potential of the technique and support it as a valid treatment option for mild to moderate severity hallux valgus.

Keywords: Hallux valgus, intermetatarsal angle, metallic button, suspension system

Hallux abducto valgus is one of the most prevalent foot deformities addressed in orthopedic and pediatric practice. It comprises the medial eminence expansion of the first metatarsal head and the biomechanical deficiency of the first ray in supporting body weight throughout the push-off step of normal gait.

This biomechanical imbalance is the expression of first metatarsophalangeal joint alignment disruption, with medial deviation of the metatarsal bone and lateral deviation of the corresponding phalanx combined with lateral displacement of the sesamoids. The inability of the first ray to transfer weight in a physiological manner generates overloading, mainly of the second metatarsal head and the other subsequent metatarsals manifested as metatarsalgia. Pain also results from the expanded medial eminence (bunion) conflicting with the footwear and the abnormal weight bearing on its head. The aesthetics concern prompted by the resulted deformity is another important element that weighs in on the decision for surgical correction.

Nowadays the etiology of hallux valgus is considered to be multifactorial and it involves a multitude of intrinsic and extrinsic factors. The suggested intrinsic factors are: genetic predisposition, first ray hypermobility, metatarsus primus varus, ligamentous laxity, metatarsal formula, metatarsal anatomy, pes planus and female gender. Out of the extrinsic factors, probably inadequate footwear is the most important issue that can exacerbate the abnormality, but does not represent a clear triggering factor [1-5].

The extent on which every factor influences the initiation of the deformity is still debated, but there is a general consensus on the multi-stepped and intricate pathogenesis of this malformation. A loss of axial alignment and stability ensues due to an altered balance between the dynamic and static stabilizers of the first metatarsophalangeal joint. The sequence of events leading to a symptomatic deformation includes: failure of the medial stabilizing structures (medial collateral ligament and sesamoid) of the joint; lateral sliding (subluxation or luxation) of the sesamoid plate relative to the medially displaced metatarsal head (metatarsus varus); valgization of the phalanx reinforced by the adductor hallucis tendon, flexor and extensor hallucis longus tendons; pronation and elevation of the medialized metatarsal head which is

*email: mick99n@gmail.com
no longer capable of supporting plantar pressure [6-18]. In the management of hallux valgus the conservative options suggested usually include physiotherapy, accommodative footwear, insoles, separators, splints or orthoses. The results of these treatment methods have been proven questionable at best, regarding the radiological parameters and perceived deformity. Also it seems that conservative treatment does not alter the progression of the disease, with only limited positive effect on the symptoms [19-23].

In addition to a thorough history and physical examination with focus on some specific elements (tarso-metatarsal and metatarso-phalangeal mobility and static foot deformities), evaluation of affected patients involves radiographic examination with anteroposterior and weight-bearing views and specific measurements. The two most important measured angles that are taken into consideration for severity classification and management algorithm are the intermetatarsal angle (IMA) and hallux valgus angle (HVA). The first one is described between the diaphyseal axes of the first and second metatarsals with a pathological value over 9 degrees and the hallux valgus angle formed by the axis of the proximal phalanx and the diaphyseal axis of the corresponding metatarsal, with normal values under 15 degrees [24,25]. The present paper follows the results generated with our experience with button and wire cortical suspension systems in the treatment of hallux valgus.

**Experimental part**

**Materials and methods**

A number of 12 cases of bilateral hallux valgus, surgically treated in our department were followed for a period of minimum twelve months during this study. All the patients were females with ages ranging from 26 to 64 years old. This encompasses a total number of 24 feet managed using the 1.1mm Mini TightRope® Disposable Kit with two constructs per foot after failure of a trial, non-operative course of treatment. The exclusion criteria were a diagnosis of severe deformity defined by an IMA greater than 20° and/or a HVA greater than 40°, arthritic involvement of the metatarsophalangeal or tarsometatarsal joint, coexisting neuromuscular or rheumatic pathology. The evaluation process consisted of radiographic examination and HVA and IMA measurements before and after surgery, at six weeks and six months. Also, assessment using the American Orthopedic Foot and Ankle Society (AOFAS) hallux metatarsophalangeal-interphalangeal scale before correction and at six months postoperatively was performed. We encountered two cases with associated hammertoe which had to be addressed during surgery.

The applied surgical technique combines a soft tissue procedure on the first metatarsophalangeal joint with correction of the enlarged intermetatarsal angle using two fixed loop suspension systems. Every 1.1mm Mini TightRope® Disposable Kit contains 2 constructs, each with two preloaded 2.6 mm oblong buttons on the 2.0 FiberWire® suture loops made of ultra high molecular weight polyethylene and polyester, with silicone elastomer coating, two free oblong buttons and multiple 1.1 mm suture passing K-wires.

The first step was the release of the tight lateral capsule at the level of firstmetatarsophalangeal joint combined with release of the deep transverse ligament and the adductor hallucis phalangeal insertion. The fibular sesamoid is also freed of any adhesions and detached from the capsule allowing the return of the sesamoid plate to the normal position during the realignment of the ray. All this is achieved through a dorsal skin incision in the first metatarsal webspace. Using a medial approach of the joint.bunionectomy and excision of the redundant capsule is carried out, with care not to remove the sesamoid groove by excessive resection. A small, third incision for access to the lateral second metatarsal neck is centered in the second web space. Trough dorso-planter adjustments and under fluoroscopic guidance a 1.1mm tapered suture passing K-wire is inserted through the second metatarsal starting at a point centered on the shaft, at 2-3 millimeters proximal to the neck and then through the first metatarsal, exiting just proximally to the resection surface of the medial eminence. A number two suture wire is passed from lateral to medial using the end loop of the K-wire and then the free end of the Mini TightRope construct is passed back from medial to lateral, allowing for the knots over the second button to be places laterally in the intermetatarsalwebspace. A second construct is placed at 5-7 millimeters proximal to the first one and, after correcting the IMA under fluoroscopic control the systems are tightened and secured with a minimum of three knots. The postoperative recovery protocol allows walking with only heel weight-bearing for the first six weeks because the achieved stability is dependent to some extent on soft tissues scarring to preserve correction and unload the device. If early weight-bearing on the first ray is initiated, because of the high tension on the system, the second metatarsal may react comparably to a stress fracture with pain and prolonged edema.

**Results and discussions**

In terms of radiology correction results, the mean preoperative IMAof 14.6°± 2.6° was improved to 7.9°± 2.2° postoperatively and maintained a mean value of 9.2°± 2.4° registered at six months after surgery. The preoperative
measured HVA was reduced from $28.4^\circ \pm 8.6^\circ$ to $14.2^\circ \pm 6.3^\circ$ after surgery with a mean improvement after six months at $16.1^\circ \pm 6.8^\circ$. These values confirm the good correction potential of the technique, with the minimal loss of reduction registered after the first six months being attributed to redistribution and final setting of the tension which is gradually and partially taken up by the soft tissues healing.

Fig. 1 Preoperative and postoperative measurements of IMA angles show good correction and improved position of the sesamoid bones - 42 years old female

Although some small changes in the position of the metallic buttons can be detected no important displacement was noted or failure of the constructs. One case presented subsidence of a single distal, first metatarsal button because of the tunnel exit point was placed in the area of exostosectomy, where the remaining cancellous bone cannot support the pressure concentration under the button. No second metatarsal fracture occurred in our series maybe because we gave special attention to surgical technique accuracy which states that precise placement of the bone tunnels, especially through the second metatarsal, at equal distance between the dorsal and plantar cortex ensures the lowest risk for this specific complication.

Fig. 2 Case: 26 year old patient: aesthetic results at six weeks after surgical correction

The American Orthopaedic Foot and Ankle Society (AOFAS) hallux metatarsophalangeal-interphalangeal scale before correction showed an overall value of 54.76 (40-73) with an improvement at six months postoperatively to 92.21 (83-98). The patient satisfaction reflected by these numbers was fairly distributed between all of the score subcomponents like pain perception, function and alignment. Two patients experienced persistent metatarsalgia with one case of complete resolution after a few months after surgery. No repeated interventions were needed to this moment for recurrence or other critical complications except for one case that needed excision of reactive soft tissue developed over one of the medial buttons.

Choosing the optimal surgical treatment of hallux valgus is done on individual basis after considering the severity of the malformation, joint congruency, bone morphology, degenerative status of the metatarsophalangeal joint, tarsometatarsal hypermobility and comorbidities. There is still controversy regarding the most appropriate surgical treatment algorithm and ideal technique out of more than one hundred options described in the literature. Despite this great variety of correction techniques, a few basic concepts incorporate all these variations: metatarsophalangeal or tarsometatarsal joint arthrodesis (modified Lapidus procedure), metatarsal osteotomies (chevron, Mitchell, crescentic, scarf) or soft tissue procedures (modified McBride) [26-32]. The last two decades have brought an increasing appeal for minimally invasive

Rev. Chim. ♦ 71 ♦ no. 2 ♦ 2020 ♦ https://revistadechimie.ro 54 https://doi.org/10.37358/RC.20.2.7891
surgical techniques like Bosch or SERI techniques, which promise consistent results with least complications. Despite the promising results longstanding and comparative evaluation of this group of interventions needs to be performed [33-35].

Based on the idea that varization of the first metatarsal represents an essential element of the disease pathogeny and its stability plays an important role in the recurrence of hallux valgus the majority of correction techniques aim to address these issues. Furthermore the fact that the overall results do not prove absolute superiority for any given technique, attention has been given to the development of soft tissue approaches which would achieve correction, stabilization and avoid recurrence, without the added complications and invasiveness of the osteotomy techniques. The prototype for this group of procedures is the so called syndesmosis procedure which relies on osteodesis (fibrous connection) between the first two metatarsals combined with cerclage for maintaining the correction of the intermetatarsal angle. [36-38] The latest variation of this surgical correction principle which has gained popularity nowadays is the technique that combines a soft tissue procedure (modified McBride) with fixation of corrected IMA using a system of buttons and high strength suture loop attached like MTR (Mini TightRope®, AthrexInc, Naples, Florida), acting as a intermetatarsal cerclage.

Usually the disease severity dictates the two main classical concepts for surgical correction. For mild to moderate deformities the treatment option can rely on soft procedure alone or in conjunction with a distal metatarsal osteotomy. For moderate to severe cases the most frequently deployed strategy is either metatarsal base osteotomy or tarsometatarsal fusion. All these procedures carry a consistent risk of various complications like malunion, nonunion, transfer metatarsalgia, recurrence, excessive metatarsal shortening or avascular necrosis of the first metatarsal head [39]. The MTR surgical technique used for cases of mild to moderate hallux valgus (HVA<40° and IMA<20°) not only manages to correct the deformity without the use of osteotomies, avoiding the associated risks, but also deals with the challenge of high recurrence rates related to soft tissue procedures alone and the problem of first metatarsal stabilization.

Stemming from our experience with this specific surgical technique and also based on the published results in the literature it is clear that the corrective potential have been demonstrated by the improved radiological parameters that maintain a fair degree of reliability, at least on the observed term. Also the functional, aesthetic and life quality improvements have been validated by the specific score results assessments. The important debate comes from the particular complications associated with this technique. So far the main, specific complications recognized are: second metatarsal fracture, loss of correction due to implant failure or button migration, overcorrection with subsequent hallux varus and persistent forefoot edema. A 2015 published paper by Dayton et al. performs a systematic review of the results and especially of the complications reported in 9 journal articles, regarding the use of Mini TightRope implants for hallux valgus correction. It highlighted a 25% overall complication rate and 13.6% incidence rate for second metatarsal fracture, out of 132 cases. It presumed that this type of intervention would not be a very satisfactory surgical option due to mainly a high percent of complications [40]. This conclusion is in our opinion questionable at least. The main reasons which make a relevant conclusion impossible are: the variations in surgical technique used in the pooled studies, the low number of reported cases and the relative novelty of the implants, procedure with short follow-up time periods.

The same kind of suture loop and button constructs have been used with good results for stabilization of acromioclavicular and ankle syndesmotic injuries and applied for a long time in knee cruciate ligaments reconstruction surgery. Similar suture materials combined with different types of anchors have been used for repair of shoulder Bankart lesions and for reconstruction of medial patellofemoral ligament. The implementation of the materials and construct principles in hallux valgus correction surgery rely on the long-term experience with this type of systems and the proven reliability in terms of material resistance and biocompatibility. The low profile of the implants eliminates the need for a second removal procedure and allows magnetic resonance imaging and any other kind of imaging technique, which sometimes can be required for non-tumoral or tumoral pathology later in life [41-45]. Amidst the unique complications associated with MTR the second metatarsal fracture is the most frequent and most scrutinized. Combining the published information and gained experience it can be fairly stated that this problem is much more complex than perceived and its elucidation is unachievable at this moment. First of all, multiple types of solutions used for hallux valgus have changed and present some variations. The first generation of implants needed a 2.7mm diameter drill hole in the metatarsal bone for passage of only one construct per forefoot that supported all the tension, and the majority of papers associated with the highest number of second metatarsal fractures used this solution. A decrease to 1.1mm for the suture bone tunnels diameter in the new generation of implants minimizes the induced fragility of the second metatarsal shaft [46-49]. Another improvement of the system design aimed at reducing the risk for fracture is the addition of a special metallic, 43 millimeters long buttress plate on which the two 2.6 millimeters lateral buttons disperse the pressure on a higher supporting surface which is placed between them and the second metatarsal cortical bone. A well recognized element of surgical technique is the careful placement of the bone tunnel, centered on the second metatarsal diaphysis in order not to increase the risk for iatrogenic fracture. Furthermore the bone quality of the patient associated with advanced age can be of concern when
analyzing the fracture risk. The paper reporting the largest number of second metatarsal fractures, written by Weatherall et al. also includes the patients population with the highest mean age and presumably the lowest bone quality [50].

The second most frequent complication, in the form of hardware failure (an overall 7.6% in the literature review) has been attributed to hardware failure. This designation can be argued because sometimes it is hard to differentiate pure material failure from deficient surgical technique with knot untting. Also the application of two construct for every case can may lead, in our opinion to a more reliable and stable fixation with a decreased future risk for hardware failure, because of load sharing. [51-55]

Relative novelty and progressive evolution of the technique have not yet established a steady learning curve and a stable set of rules in order to have conclusive overall results on the medium and long-term. Our experience shows that, at present time a good level of confidence can be maintained in this technique and its advantages but also we accept and support the need for further testing and analysis of results of homogenous case series.[56-58] Some of the characteristic problems that need to be studied, in our opinion are: standardization of the implant characteristics and kits, clearer surgical indication rules based on radiological parameters, age, bone mineral density and coexisting forefoot deformities, soft tissue reactivity to the long term presence of the systems (biocompatibility) and employment of implant removal rules and salvage procedures. All these can ensure the implementation of a uniform surgical technique and learning curve and will allow an accurate evaluation process of the results on the long run, relative to other procedures.

Conclusions
The good short-term, functional and radiological results combined with a better understanding and improvement of the implants and technique maintains a good potential for this osteotomy sparing method. Until long-term follow-ups and extensive implementation of the matured surgical technique are not available, this remains a promising treatment option for mild to moderate severity hallux valgus.

References
1. COUGHLIN, M.J, MANN, R.A., SALTZMAN, C.L., editors. Surgery of the foot and ankle. 8th ed. Philadelphia: Mosby; 2007. Hallux valgus; p 283-362.
2. PERERA, A.M, MASON, L., STEPHENS, M.M., The pathogenesis of hallux valgus. JBJS. 2011 Sep 7;93(17):1650-61.
3. COUGHLIN, M.J., THOMPSON, F.M., The high price of high-fashion footwear. InstrCourse Lect. 1995;44:371-7.
4. SIM-FOO, K.L., HODGSON, A.R., A comparison of foot forms among the non-shoe and shoe-wearing Chinese population. J Bone Joint Surg Am.1958;40:p1058-62.
5. KATO, T., WATANABE, S., The etiology of hallux valgus in Japan. ClinOrthopRelatRes. 1981;157,p78-81.
6. STEPHENS, M.M., Pathogenesis of hallux valgus. Eur J Foot Ankle Surg. 1994;1,p7-10.
7. EASLEY, M.E, TRNKA, H.J, Current concepts review: hallux valgus part 1: patho mechanics, clinical assessment and non-operative management. Foot Ankle Int.2007;28,p654-9.
8. SNIDERS, C.J, SNJDER, J.G, PHILIPPENS, M.M, Biomechanics of hallux valgus andspread foott. Foot Ankle. 1986;7,p26-39.
9. HEREFF, M.J, Pathophysiology, anatomy, and biomechanics of hallux valgus. Orthopedics. 1990;13,p939-45
10. ROOT ML, ORIEN WP, WEED JH., Normal and abnormal function of the foot. Vol 2. Los Angeles: Clinical Biomechanics; 1977. Forefoot deformity caused by abnormal subtalar joint pronation; p 349-460.
11. SHIBUYA, N., ROUKIS, T.S, JUPITER, D.C., Mobility of the first ray in patients with or without hallux valgus deformity: systematic review and meta-analysis. The Journal of Foot and Ankle Surgery. 2017 Sep 1;56(5),p1070-5.
12. ROUKIS, T.S, LANDSMAN, A.S., Hypermobility of the first ray: a critical review of the literature. J Foot Ankle Surg. 2003;42, p377-90.
13. PHILLIPS, D., Biomechanics in hallux valgus and forefoot surgery. In: HetheringtonVI, editor. Hallux valgus and forefoot surgery. New York: Churchill and Livingstone:2000.
14. UCHIYAMA, E., KITAOKA, H.B, LUO, Z.P, GRANDE, J.P, KURA ,H., AN.K.N., Pathomechanics of hallux valgus: biomechanical and immunohistochemical study. Foot Ankle Int.2005;26,p732-8.
15. COUGHLIN, M.J, JONES, C.P. Hallux valgus and first ray mobility. A prospectivestudy. J Bone Joint Surg Am. 2007;89,p1887-98.
16. COUGHLIN, M.J, JONES, C.P, VILADOT, R., GLANO, P., GREBING, B.R, KENNEDY ,M.J, SHURNAS, P.S, ALVAREZ, F., Hallux valgus and first ray mobility: a cadaveric study. Foot Ankle Int.2004;25,p537-44.
17. VAN GHELUWE,B., DANANBERG,H.J, HAGMAN, F., VANSTAEEN, K., Effects of hallux limitus on plantar foot pressure and foot kinematics during walking. J Am Podiatr MedAssoc. 2006;96,p428-36.
18. DREEBEN, S., MANN, R.A., Advanced hallux valgus deformity: long-term resultsutilizing the distal soft tissue procedure and proximal metatarsal osteotomy. FootAnkle Int.1996;17,p142-4.
19. FARZADI, M., SAFAEIEPOUR, Z., MOUSAVI, M.E., SAEEDI, H., Effect of medial arch support foot orthosis on plantar pressure distribution in females with mild-to-moderate hallux valgus after one month of follow-up. Prosthetics and orthotics international. 2015 Apr;39(2),p134-9.
20. MILACHOWSKI, K.A, KRAUSS, A., Comparing radiological examinations between hallux valgus night brace and a new dynamic orthosis for correction of the hallux valgus. Fuss Sprunggelenk. 2008 Feb;61,p14-8.
21. PLAASS, C., KARCH, A., KOCH, A., WIEDERHOEFT, V., ETTINGER, S., CLAASSEN, L., DANILIDIS, K., YAO, D., Stukenborg-Colsmann C. Short term results of dynamic splinting for hallux valgus—A prospective randomized study. Foot and Ankle Surgery. 2019 Jan 21.
22. VOELLMICKE, K.V, deland Jt. Manual examination technique to assess dorsal instability of the first ray. Foot Ankle Int2002;23,p1040-1.
23. COUGHLIN, M.J, FREUND, E., The reliability of angular measurements in hallux valgus deformities. Foot & ankle international. 2001 May;22(5),p369-79.

24. STEEL, M.W, JOHNSON, K.A, DEWITZ ,M.A, ILSTRUP ,D.M., Radiographic measurements of the normal adult foot. Foot & ankle. 1980 Nov;1(3),p151-8.

25. SALTZMAN, C.L, BRANDSER, E.A, BERBAUM, K.S, DEGNOIRE, I., HOLMES, J.R, KATCHERIAN DA, TEASDALL RD, ALEXANDER II. Reliability of standard foot radiographic measurements. Foot & ankle international. 1994 Dec;15(12),p661-5.

26. COETZEE, J.C, WICKUM, D., The Lapidus procedure: a prospective cohort outcome study, Foot Ankle Int. 25 (2004),p 526-531.

27. SANGEORZAN,B.J, HANSEN JR, S.T., Modified Lapidus procedure for hallux valgus. Foot & ankle. 1989 Jun;9(6),p262-6.

28. BAROUK, L.S., Scarf osteotomy for hallux valgus correction: local anatomy, surgical technique, and combination with other forefoot procedures, Foot Ankle Clin, 5,(2000),p 525-558.

29. WEIL, L.S., Scarf osteotomy for correction of hallux valgus. Historical perspective, surgical technique, and results. Foot and ankle clinics. 2000 Sep;5(3),p559-80.

30. MANN, R.A, PFEFFINGER, L., Hallux valgus repair. DuVries modified McBride procedure. Clinical orthopaedics and related research. 1991 Nov(272):213-8.

31. TRNKA, H.J, HOFSTAAETTER, S., The chevron osteotomy for correction of hallux valgus. Interactive Surgery. 2007 Jul 1;2(1),p52-61.

32. COUGHLIN, M.J, GREBING, B.R, JONES,C.P., Arthrodesis of the first metatarsophalangeal joint for idiopathic hallux valgus: intermediate results. Foot & ankle international. 2005 Oct;26(10),p783-92.

33. BROGAN, K., VOLLER, T., GEE, C., BORBELY, T., PALMER, S., Third-generation minimally invasive correction of hallux valgus: technique and early outcomes. International orthopaedics. 2014 Oct 1;38(10),p2115-21.

34. BÖSCH,P., WANKE, S., LEGENSTEIN, R., Hallux valgus correction by the method of Bösch: a new technique with a seven-to-ten-year follow-up. Foot and ankle clinics. 2000 Sep;5(3),p 485-98.

35. GIANNINI, S., FALDINI, C., NANNI M. D.I., MARTINO, A., LUCIANI, D., VANNINI, F., A minimally invasive technique for surgical treatment of hallux valgus: simple, effective, rapid, inexpensive (SERI). International orthopaedics. 2013 Sep 1;37(9),p1805-13.

36. CAPE, L.I., Intermetatarsal osteodesis: a fresh approach to hallux valgus. The Foot. 1999 Jun 1;9(2):93-8.

37. YIANG, W.U.D. Syndesmosis procedure: a non-osteoectomy approach to metatarsus primus varus correction. Foot & ankle international. 2007 Sep;28(9),p1000-6.

38. WU, D.Y, LAM E.K., Can the Syndesmosis Procedure Prevent Metatarsus Primus Varus and Hallux Valgus Deformity Recurrence? A 5-Year Prospective Study. The Journal of Foot and Ankle Surgery. 2018 Mar 1;57(2),p316-24.

39. LEE, M.S, GROSSMAN, J.P., editors. Complications in Foot and Ankle Surgery: Management Strategies. Springer; 2017 Jul 31.

40. DAYTON, P., SEDBERRY, S., FEILMEIER, M., Complications of metatarsal suture techniques for bunion correction: a systematic review of the literature. The Journal of Foot and Ankle Surgery, 2015 Mar 1;54(2),p230-2.

41. COTTM JIM, HYER CF, PHILBIN TM, BERLET GC., Treatment of syndesmotic disruptions with the ArthrexTightRope: a report of 25 cases.Foot Ankle Int, 2008;29,p 773-80.

42. WALZ, L., SALZMANN, G.M., FABBRO, T., EICHHORN, S.,IMHOFF, A.B., The anatomic reconstruction of acromioclavicular joint dislocations using 2 TightRope devices: a biomechanical study.Am J Sports Med, 2008;36,p2398-2406.

43. SMITH, P.A, DEBERARDINO, T.M., Tibial fixation properties of a continuous-loop ACL hamstring graft construct with suspensory fixation in porcine bone. The Journal of knee surgery. 2015 Dec;28(6),p506-12.

44. CIRSTOIU, C., ENERAZV,A.N, PANTI, Z., ENE, P., CIRSTOIU, M., Particularities of Shoulder Recovery After Arthroscopic Bankart Repair with Bioabsorbable and Metallic Suture Anchors. Mat. Plast., 52, no. 3, 2015, p361-3.

45. ENE, R., PANTI, Z.A, NICA, M., POPA, M.G, CIRSTOIU, M.M., MUNTEANU, O., VASILESCU, S.L., SIMION, G., VASILESCU, A., DAVIŢOIU, D.V, CIRSTOIU, F.C. Chondrosarcoma of the pelvis–case report. Rom J MorpholEmbryol. 2018 Jan 1;59(3),p927-31.

46. WEST, B.C., Mini TightRope system for hallux abducto valgus deformity: a discussion and case report. Journal of the American Podiatric Medical Association. 2010 Jul;100(4),p291-5.

47. GERBERT, J., TRAYNOR, C., BLUE, K., KIM, U., Use of the Mini TightRope® for correction of hallux valgus deformity. The Journal of Foot and Ankle Surgery. 2011 Mar 1;50(2),p245-51.

48. CANO-MARTÍNEZ, J.A, PICAZO-MARÍN, F., BENTO-GERARD J., NICOLÁS-SERRANO, G. Treatment of moderate hallux valgus with a Mini TightRope® system: a modified technique. Revista Española de CirugíaOrtopédica y Traumatología (English Edition). 2011 Sep 1;55(5),p358-68.

49. KAYAROS, S., BLANKENHORN, B.D, DEHAVEN J., VAN LANCER, H., SARDELLA, P., PASCALIDES,J.T, DIGIOVANNI ,C.W.,Correction of metatarsus primus associated with hallux valgus deformity using the arthrex mini tighttite: a report of 44 cases. Foot & ankle specialist. 2011 Aug;4(4),p212-7.

50. WEATHERALL, J.M, CHAPMAN, C.B, SHAPIRO, S.L. Postoperative second metatarsal fractures associated with suture-button implant in hallux valgus surgery. Foot & ankle international. 2013 Jan;34(1),p104-10.

51. HOLMES, JR GB. Correction of hallux valgus deformity using the mini tighttite device. Techniques in Foot & Ankle Surgery. 2008 Mar 1;7(1),p9-16.

52. BAKER, C.M, CHIODO, C.P, inventors; Brigham, Women's Hospital, ArthrexInc, assignee. Hallux valgus repairs using suture-button construct. United States patent US 8,398,678. 2013 Mar 19.

53. ALMALIKI, T.H, ALRABAI, H.M, ALGARNI, A.D, AL-AHAIDEB, A., Radiological evaluation of hallux valgus after application of Mini TightRope: short-term results. Journal of Taibah University Medical Sciences. 2014 Mar 1;9(1),p41-4.

54. ELATTAR, M., EL NAGAR, A., SAMIR, F.F, FATHI, H., Short term results of osteotomy-sparing technique in management of moderate hallux valgus using TightRope system. Journal of orthopaedics. 2018 Jun 30;15(2),p721-5.

55. WONG, D.W, WU, D.Y, MAN, H.S, LEUNG,A.K. The use of a syndesmosis procedure for the treatment of hallux valgus: Good clinical and radiological results two years post-operatively. The bone & joint journal. 2014 Apr;96(4),p502-7.

56. FILIP, C.R., UNGUREANU,A., MITARIU,M.C.,"Paniful tonic spasms and brainstem involvement in a patient with neuromyelities optica spectrum disorders"Polish Journal of Neurology and Neurosurgery, vol.50,2016, nr. Lp55-58
57. UNGUREANU, A., RUS, L., GLIGOR, F., LAZAROA, E., PRODAN, L., FILIP, C.R., "Intravenous levetiracetam as second line treatment for status epilepticus" Farmacia, vol 64, nr 4, 2017, p. 507-511

58. FILIP, C.R., UNGUREANU, A., PRAVARIU, I., "Balo like lesion associated with psoriasis and autoimmune thyroiditis - case report" Acta Neurologica Belgica, vol 115, nr 4, 2015, p. 793-796

Manuscript received: 14.10.2019