



Rozov and Kessler Tendon Sutures: Common Properties and Differences

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Background. The Kessler suture is one of the most common tendon repair techniques and can be found schematically in most manuals of hand surgery, along with Bunnel and Tsuge sutures. In our country, the seam proposed by V.I. Rozov, while a number of authors believe that Rozov and Kessler sutures are very similar. Both techniques, both the Rozov's suture and the Kessler suture, have a large number of modifications that differ significantly from the originals, but retain the author's names, which confuses and hinders the analysis of the use of various methods for restoring the integrity of the tendons.

The aim – to find the correct author's description of Rozov's suture and Kessler's suture, test original techniques on a tendon model, compare techniques, analyze common properties and differences.

Methods. Information was searched in domestic and foreign literature, manuals on traumatology and orthopedics, monographs, methodical letters, materials of congresses, Internet resources. Approbation of the methods was carried out on a tendon model, which was a silicone rod with a diameter of 1 cm.

Results. The first image of the Rozov's suture discovered by us, dates back to 1958, the original "grasping" technique of flexor tendon repair was proposed by I. Kessler in 1969. These techniques have a number of significant differences in the location of nodes, methods of fixation and planes of threads in the thickness of the tendon.

Conclusion. The data of this study give reason to believe that V.I. Rozov and I. Kessler proposed two different ways of applying a tendon suture.

Keywords: tendon repair, Rozov suture, Kessler suture, history of medicine.

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Сухожильные швы Розова и Kessler: общие свойства и различия

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Актуальность. Шов Kessler является одной из наиболее распространенных методик восстановления сухожилий, а его схематическое изображение можно найти в большинстве руководств по хирургии кисти, наряду со швами Bunnel и Tsuge. В нашей стране такой же популярностью пользуется шов, предложенный В.И. Розовым, при этом ряд авторов считает, что швы Розова и Kessler очень похожи. Как шов Розова, так и шов Kessler имеют большое количество модификаций, существенно отличающихся от оригиналов, но сохраняющих при этом авторские названия, что вносит путаницу и мешает анализу использования различных способов восстановления целостности сухожилий.

Цель исследования — найти корректные авторские описания шва Розова и шва Kessler, апробировать оригинальные техники на модели сухожилия, сравнить методики, проанализировать общие свойства и различия.

Материал и методы. Проведен поиск информации в отечественных и зарубежных публикациях, руководствах по травматологии и ортопедии, монографиях, методических письмах, материалах съездов и конгрессов, интернет-ресурсах. Апробация методик проводилась на модели сухожилия, в качестве которой использовался силиконовый стержень диаметром 1 см.

Результаты. Первое изображение шва В.И. Розова, обнаруженное нами, датируется 1958 г., оригинальная «охватывающая» техника восстановлений сухожилий сгибателей была предложена I. Kessler в 1969 г. Данные методики имеют ряд существенных различий в расположении узлов, способах фиксации и плоскостях проведения нитей в толще сухожилия.

Заключение. Данные выполненного исследования дают основания полагать, что В.И. Розов и I. Kessler предложили два разных способа наложения сухожильного шва.

Ключевые слова: шов сухожилия, шов Розова, шов Kessler, история медицины.

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BACKGROUND

Once every three years, hand surgeons from all countries and continents traditionally gather for an international professional congress. At each congress, a group of the most outstanding specialists is awarded the honorary title of "pioneer of hand surgery". In 2001, at the VIII Congress in Istanbul, Israeli surgeon Isidor Kessler was recognized as one of the "pioneers". The "grasping" technique of tendon repair, proposed by this scientist in 1969, is still one of the most common ways of flexor tendons suturing. Thus, according to a survey of hand surgeons conducted in the UK in 2014, 36% of them used the Kessler technique to repair flexor tendons, which was the most popular result [1]. In our country, the suture proposed by V.I. Rozov has gained similar popularity. And number of authors believe that the Kessler suture is very similar to the Rozov suture [2, 3, 4].

Both methods, both the Rozov suture and the Kessler suture, have a large number of modifications that differ significantly from the originals, but at the same time retain the author's names, which confuses and interferes with the analysis of the use of various methods for restoring the integrity of tendons.

The aim of the study was to find correct author's descriptions of the Rozov suture and the Kessler suture, to test original techniques on a tendon model, to compare techniques, to analyze common properties and differences.

METHODS

Information was searched in domestic and world databases (eLibrary, PubMed, Google Scholar), manuals on traumatology and orthopedics, monographs, methodical letters, materials of congresses, Internet resources.

The approbation of the techniques was carried out on a tendon model, which used a silicone rod of circular cross-section with a diameter of 1 cm. The seams were applied with a polypropylene thread with a thickness of 0 USP (3.5 metric) on a piercing needle.

RESULTS AND DISCUSSION

The first image of V.I. Rozov's technique was discovered by us on the pages of the collection of

abstracts "New methods of diagnosis and treatment, instruments, apparatuses and devices in traumatology and orthopedics" in 1958 [5]. At the same time, in the sources previously referred to by other authors (V.I. Rozov's dissertation for the degree of Doctor of Medical Sciences (1950), his monograph "Injuries of the tendons of the hand and fingers and their treatment" (1952) and the article "Topical issues of the primary suture of the fingers flexor tendons" (1958), any mention the author's method of suturing was not revealed [2, 3]. Proceeding from this, we dare to assume that for the first time the original technique of suturing Rozov was presented in the section "Variant of the tendon suture" of this collection (Fig. 1).

In his abstract, Rozov notes that the variant of the suture he proposed is essentially a simplification of the technique proposed by Bloch and Bonnet (Fig. 2) [5].

An interesting fact is that in the illustration, the transverse component of the suture is depicted as a solid line, which gives the impression that the thread in this area is located outside the tendon. The author of the suture himself does not give a detailed method of its application in the text, limiting himself only to the presented drawing. In the later works of the Leningrad Research Institute of Traumatology and Orthopedics, when depicting this suture, the thread is already displayed throughout with a dotted line, which suggests that it was carried out inside the core (Fig. 3) [6].

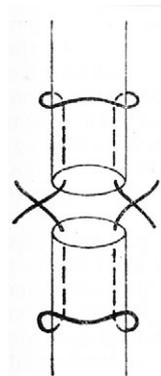


Fig. 1. Scheme of Rozov suture (1958) [5]

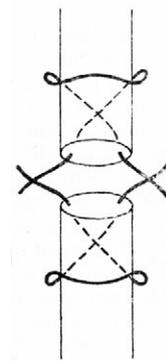


Fig. 2. Scheme of Bloch-Bonnet suture 1958 [5]

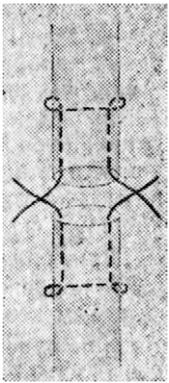


Fig. 3. Scheme of Rozov suture (1960) [6]

When applying the Rozov suture, each end of the injured tendon is sutured with a separate thread, while only two small fragments of suture material remain on its sliding surface along the "side" surfaces, and the free ends of the threads are brought into the plane of rupture (Fig. 4).

The disadvantage of the Rozov suture is the fact that its intra-tendon component is located only in one plane – the frontal one, on the basis of which the probability increases that with increasing load the thread will cut through the tendon. In addition, when using this technique, the nodes are located between the ends of the restored tendon, which, according to recent data, is associated with a high risk of suture failure [7, 8, 9, 10].

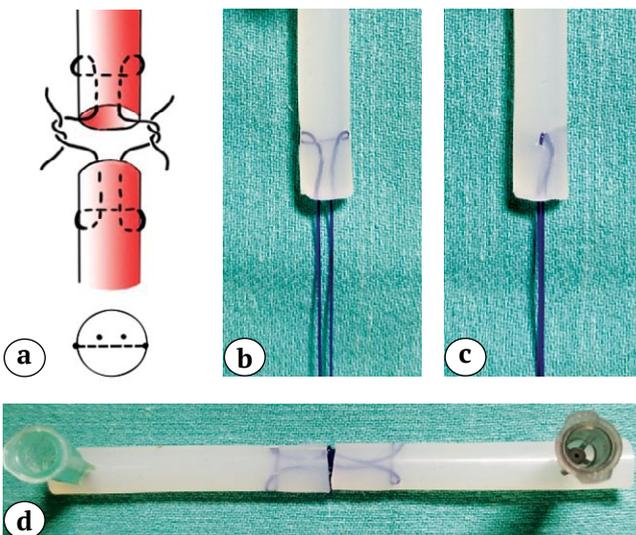


Fig. 4. Rozov suture: scheme of suture (a); the end of the silicone model stitched according to Rozov in frontal (b) and sagittal (c) planes; appearance of Rozov suture on a silicone model (d)

The "grasping technique" of flexor tendon repair was first proposed by Isidor Kessler in collaboration with Fuad Nissim on the pages of the journal *Acta Orthopaedica Scandinavica* in 1969 in an article entitled "Primary restoration of flexor tendons in the tendon canal without immobilization: an experimental and clinical study" [11].

The original Kessler suture technique involves fixing the thread to each end of the restored tendon using two locking loops located on its sliding surface (Fig. 5). This technique prevents the threads from shifting inside the tendon, reducing the likelihood of its ends diverging. Thus, Kessler's "covering" technique is a suture with interlockable loops.

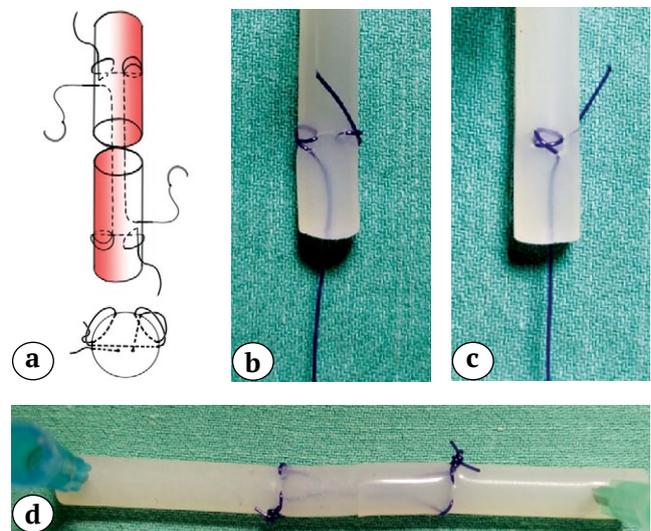


Fig. 5. Kessler suture (1969): scheme of suture (a); the end of the silicone model stitched according to Kessler in frontal (b) and sagittal (c) planes; Appearance of Kessler suture on a silicone model (d)

The video of the Kessler suture stages can be viewed using the QR code (Fig. 6) or by following the link <https://youtu.be/m9V5hp0u4E0>.



Fig. 6. QR code with a link to the video of the Kessler grasping suture

In his article I. Kessler notes that the "grasping" technique is based on the technique proposed by Mason and Allen, which is probably the first blocking technique of suturing tendons [11, 12] (Fig. 7). The disadvantage of the Kessler suture is the location of the nodes fixing the threads on the surface of the tendon, which reduces its sliding properties. In order to neutralize this adverse phenomenon, the authors proposed to partially dissect the tendon channel [11].

The article, which described the Kessler technique for the first time, included preliminary data on testing the new technique on 40 chicken tendons and a description of 7 clinical cases. In 21 out of 40 experiments on a biological model, a suture failure occurred under load, but in all cases the reason for the failure was a thread break, not a tendon eruption. The authors suggested that the high frequency of breaks was due to the weakness of the 0.008 inch (approximately 0.2 mm) thick twisted wire used as a suture material, and expressed hope for the prospects of successful use of the proposed technique in the future [11].

The Kessler suture became widely known in 1973, when Doctors Urbaniak, Mortenson and Cahill presented this technique at the annual meeting of the American Society of Hand Surgeons in Las Vegas. J.R. Urbaniak and his colleagues demonstrated the results of their analysis of the tensile strength of five different methods of tendon repair. The methods studied included nodal sutures applied around the circumference and techniques proposed by Nicoladoni, Mason and Allen, Bunnell and Kessler (Fig. 7).

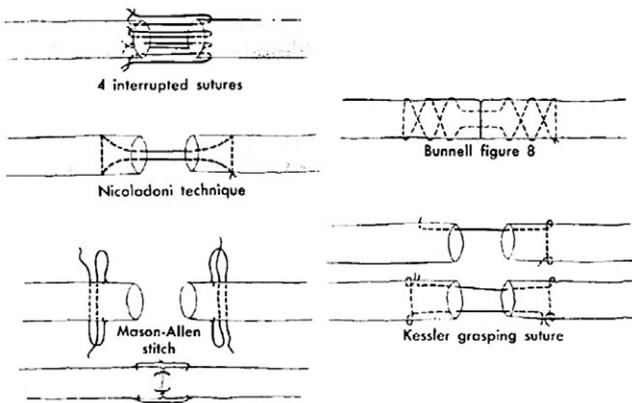


Fig. 7. Tendon repair techniques studied by J.R. Urbaniak et al. [Cited in 12]

In total, each of the five techniques was tested 20 times on the tendons of dogs using 4/0 stainless steel threads. The Mason and Allen technique was recognized as the most reliable, its tensile strength was 4030 g. The Kessler technique was the second with a result of 3970 g. When using both methods, the reason for the failure was the rupture of the threads in 16 cases and the suture cutting in 4 cases. In addition, the strength of the Bunnell technique and the Kessler technique in the postoperative period was compared. On the 5th day after the surgery, the Kessler suture was 3 times stronger than the Bunnell suture [12].

It should be noted that the suture technique used by J.R. Urbaniak et al. in their study differed from the original Kessler technique in that a sliding thread was used instead of a blocked loop at each corner of the restored tendon, therefore, the thread was not fixed in the tendon and could move freely in the tendon tissue (Fig. 8). This technique rather resembled the technique proposed by Kirchmayr in 1917 (fig. 9), than the original Kessler seam [12].

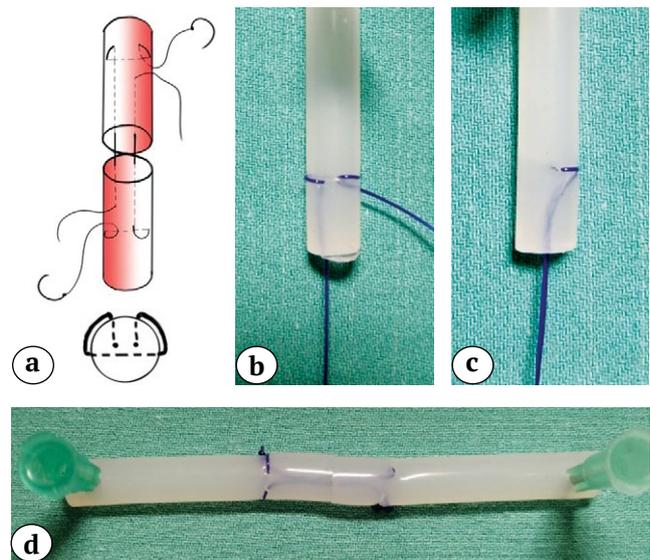


Fig. 8. Kessler suture in Urbaniac modification (1973): scheme of Kessler suture in the Urbaniac modification (a); the end of the silicone model stitched according to Kessler in the Urbaniac modification in frontal (b) and sagittal (c) planes; the appearance of the Kessler suture in the modification of Urbaniac on a silicone model (d)

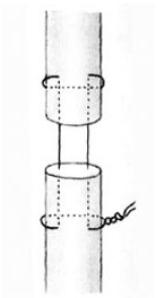


Fig. 9. Scheme of Kirchmayr suture (1917) [12]

It is also interesting that the Bunnel suture presented in the study differs from the original technique proposed by the author in 1918 (Fig. 10) [13]. Thus, the J.R. Urbaniac study compared the modified Kessler suture with the modification of the Bunnel suture.

It is interesting to note that Kessler knew that the suture technique proposed by Urbaniac et al. differs from the original one, and in the same 1973 he published another article in which he gave a detailed description of his "grasping" technique (Fig. 11) [14].

However, two years later, in 1975, an article by J.R. Urbaniac et al. was published, which summarized the theses of the congress of the American Society of Hand Surgeons in 1973, and their interpretation of the Kessler suture became popular and widely known as the true Kessler suture [12].

Another common technique, sometimes mistakenly interpreted as the original Kessler suture, is a variant with symmetrical suturing of the tendon ends and tying knots between them.

According to A.A. Gritsyuk and A.P. Sereda, the authorship of this technique belongs to another "pioneer" of hand surgery — a doctor from Japan Tatsuya Tajima, who used it in his practice even before 1963 [3]. T. Tajima himself, in his article "History, current status and aspects of hand sur-

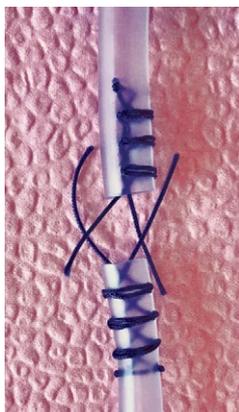


Fig. 10. The original suture proposed by S. Bunnel (Published with the permission of the authors) [13]

gery in Japan" (1984), notes that this technique was first described in 1975 (Fig. 12) [15]. Some authors even use a double eponym: the Kessler – Tajima suture [16].

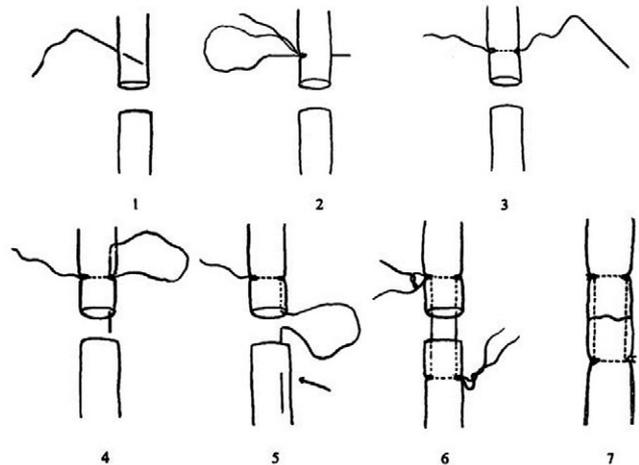


Fig. 11. Stepwise tendon repair technique using Kessler's grasping technique [14]

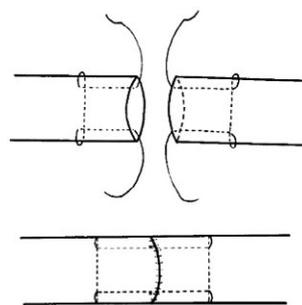


Fig. 12. Scheme of Tajima suture [14]

The Tajima suture is very similar to the Rozov suture, but unlike it, the threads are located internally in two planes: frontal and sagittal and thus cover most of the tendon bundles (Fig. 13).

A detailed comparison of the original tendon sutures of Rozov and Kessler reveals significant differences in the location of nodes, methods of fixation and planes of the location of the threads in the thickness of the tendon (fig. 14).

The main differences are presented in Table 1.

Common in the discussed methods of tendon suture can be considered the parallel arrangement of the main threads in the tendon tissue, the presence of two strands crossing the rupture area, and the fact that the thread is fixed by two nodes. However, these are common properties characteristic of a large number of other tendon sutures.

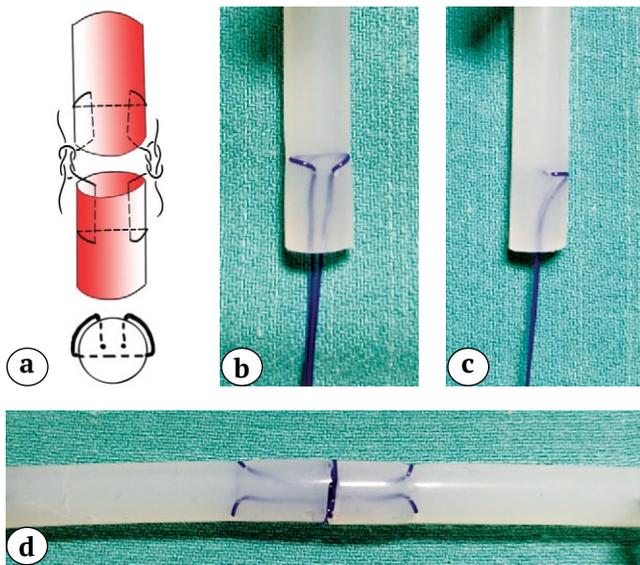


Fig. 13. Tajima suture (1975): scheme of Tajima suture (a); the end of the silicone model stitched according to Tajima in frontal (b) and sagittal (c) planes; the appearance of the Takima suture on a silicone model (d)

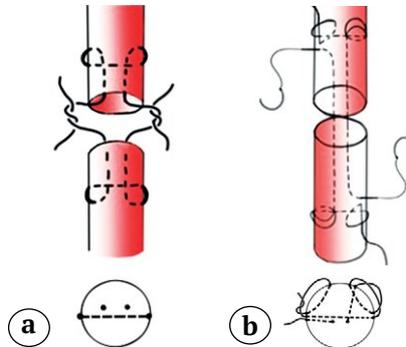


Fig. 14. Schemes of (a) original Rozov suture and original Kessler suture (b)

Table 1

Comparative characteristics of the examined sutures

Suture features	Rozov suture 1958–1960	Kessler suture 1969
Knots location	Between the ends of the injured tendon	On the surface of the tendon
Thread fixation	Blocking loops	Non-blocking loops
Core threads location	In one plane (frontal)	In two planes (frontal and sagittal)
Number of thread inlets and outlets at the one end of the tendon	6	9

In this article, we did not set ourselves the task of analyzing in order to find out which method is the best. We can only assume that Kessler's "grasping" technique is more reliable due to blocking loops, however, this statement requires confirmation by conducting additional research.

CONCLUSION

The original techniques of Rozov and Kessler are different ways of connecting the ends of injured tendons. The suture technique used by modern surgeons in their practice and described as the Rozov suture or the Kessler suture may differ significantly from the classical version proposed by these authors.

DISCLAIMERS

Author contribution

Berezin P.A. — research concept and design, the collection and processing of material, writing the draft, editing.

Zolotov A.S. — analysis and statistical processing of data, editing.

Volykhin R.D. — the collection and processing of material.

Evdokimova E.N. — the collection and processing of material.

Morozov L.I. — the collection and processing of material.

Lazarev I.A. — the collection and processing of material.

All authors have read and approved the final version of the manuscript of the article. All authors agree to bear responsibility for all aspects of the study to ensure proper consideration and resolution of all possible issues related to the correctness and reliability of any part of the work.

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Competing interests. The authors declare that they have no competing interests.

Ethics approval. Not applicable.

Consent for publication. Not required.

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