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Predictive Factors for Successful Penile Augmentation via Suspensory Ligament Release

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ABSTRACT

BACKGROUND: Modifying the shape and size of the genitalia has been a relevant concern since ancient times. Surgical penile augmentation may improve quality of life in appropriately selected patients. Identifying predictors of success in penile augmentation surgery is an important and practically relevant task in surgical andrology.

AIM: To identify predictive factors for successful penile augmentation to support the selection and optimization of surgical approach.

METHODS: We analyzed anatomical and topographic data from 66 patients who underwent penile augmentation at the National Medical Research Center for Obstetrics, Gynecology and Perinatology named after academician V.I. Kulakov between 2022 and 2025. The procedure involved suspensory ligament release with V–Y skin plasty, Heineke–Mikulicz plasty, and lipectomy.

RESULTS: Based on the obtained data, it was determined that the effectiveness of penile augmentation surgery was significantly influenced by the thickness of the subcutaneous fat in the pubic area and the length of the penile suspensory ligament.

CONCLUSION: Preoperative assessment of anatomical structures may support the selection of the optimal surgical technique and help form adequate and realistic expectations in patients regarding surgical outcomes.

Keywords: penile lengthening; ligamentolysis; penile suspensory ligament; penile augmentation surgery.

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Прогностические факторы успешной аугментации полового члена с помощью пересечения его подвешивающей связки

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АННОТАЦИЯ

Обоснование. Изменение формы и размеров гениталий является актуальным вопросом еще с древних времен. Хирургическое увеличение полового члена может улучшить качество жизни у должным образом отобранных пациентов. Выявление предикторов успешности аугментационной хирургии полового члена — важная и практически значимая задача хирургической андрологии.

Цель — выявление прогностических факторов успешной аугментации полового члена для выбора и оптимизации хирургической тактики.

Материалы и методы. Нами был проведен анализ анатомо-топографических данных 66 пациентов, обратившихся в Национальный медицинский исследовательский центр акушерства, гинекологии и перинатологии им. акад. В.И. Кулакова с 2022 по 2025 г., которым выполняли аугментацию полового члена путем рассечения подвешивающей связки полового члена с использованием V-Y-образной кожной пластики, пластики по Гейнеке–Микуличу и липэктомией.

Результаты. На основании полученных данных определено, что на эффективность аугментационной хирургии полового члена в значительной степени влияют толщина подкожно-жировой клетчатки в области лобка и длина подвешивающей связки полового члена.

Заключение. Оценка анатомических структур перед операцией может обеспечить выбор оптимальной хирургической техники и помочь формированию у пациента адекватных и реалистичных ожиданий от результата.

Ключевые слова: удлинение полового члена; лигаментотомия; подвешивающая связка полового члена; аугментационная пенильная хирургия.

Как цитировать

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BACKGROUND

Surgical penile augmentation in appropriately selected patients may improve quality of life and psychological well-being [1]. However, during preoperative counseling, it is not always possible to establish realistic expectations regarding surgical outcomes. This also applies to the release of the penile suspensory ligament [2]. The limited number of published results complicates the application of evidence-based medicine in this matter [3]. Surgical outcomes may be influenced by both anatomical and surgical factors. Anatomical factors include the topography of the pubic region and the size and configuration of the penile suspensory ligament, which can be assessed preoperatively using magnetic resonance imaging [4]. Identifying predictors of successful penile augmentation surgery is an important and practically relevant task in surgical andrology.

The study aimed to identify predictive factors for successful penile augmentation.

METHODS

With the aim to identify predictors of effective penile lengthening through suspensory ligament release, we analyzed surgical outcomes of 66 patients treated at the Department of Andrology and Urology of the National Medical Research Center for Obstetrics, Gynecology and Perinatology named after Academician V.I. Kulakov between 2022 and 2025.

During preoperative assessment, penile length was recorded in both the flaccid and stretched states (median: 6.75 cm and 12 cm, respectively). Penile length in erection was measured by the patient at home (median: 12.5 cm). All patients underwent pelvic magnetic resonance imaging (MRI) to assess the topographic anatomy of the penile suspensory apparatus preoperatively. The following parameters were recorded: length and width of the suspensory ligament (median: 2.7 cm and 1.4 cm, respectively), thickness of the subcutaneous fat layer (median: 2.85 cm), angle of ligament divergence in the frontal plane (median: 65.8°), and the angle between the corpora cavernosa and the pubic symphysis (median: 17.42°) (Fig. 1–Fig. 5).

Reconstructive penile surgery for traumatic amputation, oleogranuloma, or squamous cell carcinoma had previously been performed in 9 of the 66 patients. In 24 patients, ligamentolysis was supplemented with V–Y skin plasty using polyglactin sutures. In 36 patients, Heineke–Mikulicz plasty was performed: a horizontal incision in the infrapubic area was closed vertically at the end of the procedure using an intracutaneous polypropylene suture. In 6 patients, the operation was carried out via a penoscrotal approach. In 37 cases, lipectomy of the pubic subcutaneous fat was performed to increase the visible length of the penile shaft.

The statistical analysis was performed using SPSS software. The distribution of variable values was assessed using the Shapiro–Wilk test. None of the variables followed a normal distribution; therefore, data were presented as medians and interquartile ranges [IQR]. Nonparametric statistical methods (Wilcoxon test) were applied, and categorical variables were compared using the chi-square test and Fisher's exact test. To identify predictors of surgical efficacy, a univariate analysis was first performed with patients stratified by tertiles, followed by logistic regression modeling using variables that demonstrated statistical significance ($p < 0.05$). Regression results are presented as odds ratios (ORs) with 95% confidence intervals (95% CI). A positive surgical outcome was defined as an increase in penile length of ⩾50% compared to baseline flaccid length and ⩾25% compared to baseline erect length.

RESULTS

The median flaccid penile length after surgery was 9.5 cm [8.5; 10.7]. This difference was statistically significant ($p < 0.0001$). In 42 patients (63.6%), the increase in length was ⩾50% compared to baseline (mean gain of 3.5 cm), which indicated relative surgical success.

Table 1 presents the results of univariate analysis of potential predictors of flaccid penile length gain. Surgical outcomes differed significantly depending on stretched penile length ($p = 0.023$) and erect penile length ($p = 0.023$). Outcomes were also associated with

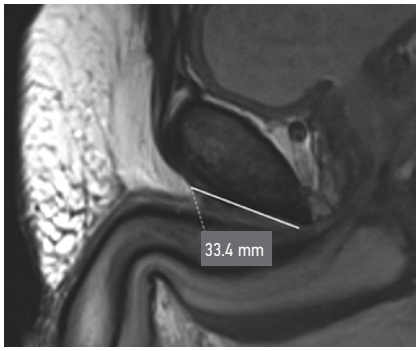

Fig. 1. Length of the penile suspensory ligament.

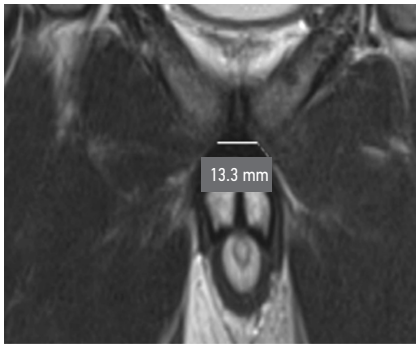

Fig. 2. Width of the penile suspensory ligament.

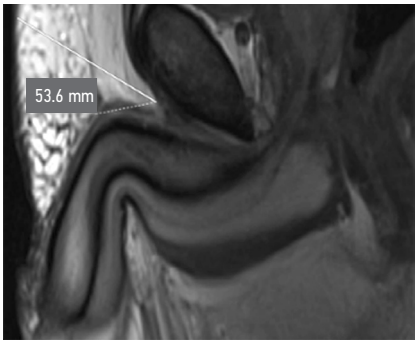

Fig. 3. Thickness of the subcutaneous fat.

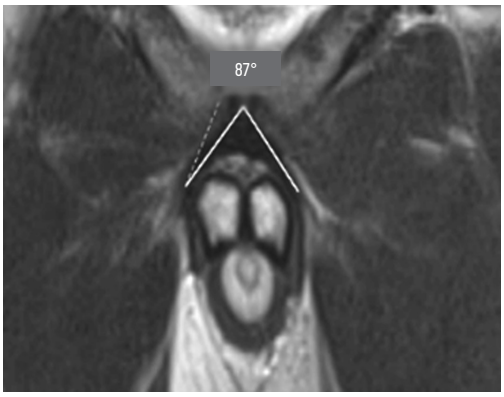

Fig. 4. Divergence angle of the ligament fibers.

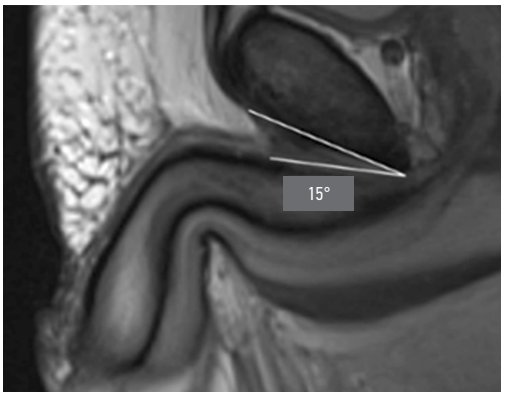

Fig. 5. Angle between the corpora cavernosa and the pubic symphysis.

suspensory ligament length (p = 0.002) and thickness of subcutaneous fat tissue (p = 0.00001). When a penoscrotal approach was used, the success rate of surgery was significantly lower than with the suprapubic approach (14.2% vs 69.4%, p = 0.007). Moreover, outcomes were better when excess subcutaneous fat was removed (83.7% vs 37.9%, p = 0.0002).

The logistic regression analysis demonstrated that the only predictor of flaccid penile length gain was subcutaneous fat thickness (Table 2). A fat thickness greater than 2.5 cm was identified as an independent statistically significant predictor (OR = 6.8844, 95% CI 1.9688–24.0733; p = 0.0025).

The median erect penile length after surgery was 15.5 cm [13.7; 17.4]. This difference was statistically significant (p < 0.0001). In 45 patients (68.2%), the increase in erect penile length exceeded 25% of the baseline size (mean gain of 3.5 cm). In such cases, the procedure was considered successful.

Potential predictors of surgical success were suspensory ligament length (p = 0.0005) and subcutaneous fat thickness (p = 0.0001), as measured by MRI (Table 3). Outcomes were significantly poorer in patients operated via the penoscrotal approach compared with the suprapubic approach (28.5% vs 72.8%; p = 0.02). Surgery was also more effective when subcutaneous fat in the pubic region was removed (90.9% vs 36.3%; p = 0.00001).

The logistic regression analysis (Table 4) showed that significant predictors of erect penile length gain following surgery were suspensory ligament length >3 cm (OR = 21.3885, 95% CI 1.9441–235.3076; p = 0.0123), subcutaneous fat thickness >2.5 cm (OR = 10.853, 95% CI 2.2683–51.9284; p = 0.0028), and lipectomy (OR = 7.4424, 95% CI 1.4992–36.9466; p = 0.0141).

DISCUSSION

The study results demonstrated that the only significant predictor of flaccid penile length gain was the thickness of the subcutaneous fat in the pubic area. Specifically, when the fat thickness exceeded 2.5 cm, the probability of achieving a clinically significant increase in flaccid penile length was almost seven times higher (OR = 6.8844; 95% CI 1.9688–24.0733). This finding suggests that flaccid penile length gain is determined primarily by the removal of adipose tissue rather than by the release of the corpora cavernosa following suspensory ligament transection. However, for many patients, the primary concern is the increase in penile length in the erect state. This outcome was predominantly influenced by the length of the penile suspensory ligament, as measured on sagittal MRI images. In patients with a suspensory ligament length greater than 3 cm, the probability of achieving a significant postoperative result was 20 times higher compared with those with a ligament length shorter than 3 cm (OR = 21.3885; 95% CI 1.9441–235.3075).

Specialists performing penile augmentation often have concerns about the risk of secondary penile shaft retraction due to fibrotic changes in the area of ligamentolysis. To prevent this phenomenon, several techniques have been proposed, such as interposing a silicone implant or tissue layer to prevent reattachment of the transected ligament, or using a penile extender in the postoperative period [5]. A research group from the United Kingdom reported higher surgical success rates with the use of a silicone buffer; however, their own data did not confirm this advantage (the mean penile length gain was 1.4 cm after ligamentolysis alone, whereas it was 0.7 cm after ligamentolysis with interposition) [6]. In our study, the efficacy of such measures was not assessed because of specific surgical techniques: advancing the stump of the ligament anteriorly to form a new penopubic angle eliminates the need for interposition. The only exception was in patients undergoing surgery via the penoscrotal approach. In all such patients, a silicone testicular implant was left in the ligamentolysis zone as a buffer. Taking this into account, the use of interposition was not analyzed as a separate variable.

An important step of the surgery is skin plasty, aimed at covering the released segment of the corpora cavernosa with skin. Although these maneuvers do not contribute to penile shaft lengthening, it is difficult to visually

Table 1. Results of univariate analysis of predictors of effective penile length gain in the flaccid state

Variables		Patient proportion	*p*
Flaccid penile length, cm	2–6	77.2% (17/22)	0.17
	6.1–7.0	63.6% (14/22)	
	>7	50% (11/22)	
Stretched penile length, cm	4.0–11.5	77.2% (17/22)	0.023
	11.6–13.0	72.7% (16/22)	
	13.1–17.0	40.9% (9/22)	
Erect penile length, cm	4.0–11.5	77.2% (17/22)	0.023
	11.6–13.0	72.7% (16/22)	
	13.1–17.0	40.9% (9/22)	
Suspensory ligament length, cm	1.8–2.5	40.9% (9/22)	0.002
	2.6–2.9	59% (13/22)	
	3.0–3.5	90.9% (20/22)	
Subcutaneous fat thickness, cm	1.8–2.5	27.2% (6/22)	0.00001
	2.6–3.4	63.6% (14/22)	
	3.5–4.5	100% (22/22)	
Suspensory ligament width, mm	1.0–1.3	72.7% (16/22)	0.55
	1.4–1.5	59% (13/22)	
	1.6–2.0	59% (13/22)	
Angle between corpora cavernosa and pubic symphysis, degrees	10.5–15.0	68.1% (15/22)	0.55
	15.1–20.0	54.5% (12/22)	
	20.1–28.2	68.1% (15/22)	
Suspensory ligament divergence angle, degrees	40.0–63.5	68.1% (15/22)	0.55
	64.0–67.3	68.1% (15/22)	
	67.4–99.0	54.5% (12/22)	
Previous surgery	Yes	77.7% (7/9)	0.468
	No	61.4% (35/57)	
V-Y-plasty	Yes	70.8% (17/24)	0.43
	No	59.5% (25/42)	
Heineke–Mikulicz skin plasty	Yes	66.6% (24/36)	0.61
	No	60% (18/30)	
Penoscrotal approach	Yes	14.2% (1/7)	0.007
	No	69.4% (41/59)	
Lipectomy	Yes	83.7% (31/37)	0.0002
	No	37.9% (11/29)	
Suture placement	Interrupted	62% (18/29)	0.815
	Intradermal	64.8% (24/37)	

Table 2. Results of multivariate analysis of predictors of effective penile lengthening in the flaccid state

Predictor	Odds ratio (95% confidence interval)	*p*
Stretched penile length	–	0.9977
Erect penile length	35638.9634	0.9978
Penile suspensory ligament length	22.2247 (0.8575–576.0550)	0.0619
Subcutaneous fat thickness	6.8844 (1.9688–24.0733)	0.0025
Penoscrotal approach	0.0595 (0.0031–1.1427)	0.0613
Lipectomy	1.4413 (0.2494–8.3312)	0.683

Table 3. Results of univariate analysis of predictors of effective penile length gain in the erect state

Variables		Patient proportion	*p*
Flaccid penile length, cm	2–6	72.7% (16/22)	0.811
	6.1–7.0	68.1% (15/22)	
	>7	63.6% (14/22)	
Stretched penile length, cm	4.0–11.5	81.8% (18/22)	0.23
	11.6–13.0	63.6% (14/22)	
	13.1–17.0	59% (13/22)	
Erect penile length, cm	4.0–11.5	81.8% (18/22)	0.23
	11.6–13.0	63.6% (14/22)	
	13.1–17.0	59% (13/22)	
Suspensory ligament length, cm	1.8–2.5	40.9% (9/22)	0.0005
	2.6–2.9	68.1% (15/22)	
	3.0–3.5	95.4% (21/22)	
Subcutaneous fat thickness, cm	1.8–2.5	36.3% (8/22)	0.0001
	2.6–3.4	72.7% (16/22)	
	3.5–4.5	95.4% (21/22)	
Suspensory ligament width, mm	1.0–1.3	72.7% (16/22)	0.81
	1.4–1.5	68.1% (15/22)	
	1.6–2.0	63.6% (14/22)	
Angle between corpora cavernosa and pubic symphysis, degrees	10.5–15.0	72.7% (16/22)	0.81
	15.1–20.0	63.6% (14/22)	
	20.1–28.2	68.1% (15/22)	
Suspensory ligament divergence angle, degrees	40.0–63.5	72.7% (16/22)	0.81
	64.0–67.3	68.1% (15/22)	
	67.4–99.0	54.5% (14/22)	
Previous surgery	Yes	88.8% (8/9)	0.2523
	No	64.9% (37/57)	
V-Y-plasty	Yes	79.1% (19/24)	0.17
	No	61.9% (26/42)	
Heineke–Mikulicz skin plasty	Yes	66.6% (24/36)	0.79
	No	70% (21/30)	
Penoscrotal approach	Yes	28.5% (2/7)	0.02
	No	72.8% (43/59)	
Lipectomy	Yes	90.9% (30/33)	0.00001
	No	36.3% (12/33)	
Suture placement	Interrupted	72.4% (21/29)	0.59
	Intradermal	64.8% (24/37)	

Table 4. Results of multivariate analysis of predictors of effective penile lengthening in the erect state

Predictor	Odds ratio (95% confidence interval)	*p*
Penile suspensory ligament length	21.3885 (1.9441–235.3076)	0.0123
Subcutaneous fat thickness	10.853 (2.2683–51.9284)	0.0028
Penoscrotal approach	0.5578 (0.0467–6.6639)	0.6446
Lipectomy	7.4424 (1.4992–36.9466)	0.0141

Fig. 6. Penile length gain after surgery.

assess the achieved effect without them. Various skin plasty techniques borrowed from plastic surgery have been proposed. The most common option is the inverted V–Y plasty. The technique based on the Heineke–Mikulicz principle, involving longitudinal closure of a transverse infrapubic incision, is also considered quite promising [7]. According to our data, the skin plasty technique does not significantly affect the actual penile length (Fig. 6).

In the study by Danino et al. [8], the mean penile length gain in patients with micropenis was 3.4 cm. In their work, the authors also analyzed the anatomy of the penile ligaments using cadaveric material but did not investigate predictors of surgical success. In the clinical part of the study by Protogerou et al. [9], the mean penile length gain was 3.5 cm in the flaccid state and 1.8 cm in the erect state. In the cadaveric dissection part of their work, the authors concluded that the outcomes of ligamentolysis depend on the length of the suspensory ligament, the angle between the penis and the pubis, and the amount of adipose tissue. These findings partially align with our results, although we did not confirm the association between penile length gain and the angle between the corpora cavernosa and the pubic symphysis in the sagittal plane. An attempt to assess morphometric predictors of penile length gain was made by Ramos et al. [10]. In their study, the mean penile length gain was 2.6 cm; the difference compared to our results may be explained by differences in population characteristics, measurement techniques, and surgical approaches. The only statistically significant finding was a negative correlation between preoperative penile length and length gain, meaning that patients with smaller penises could achieve a greater effect after ligamentolysis. All anatomical variables in that study were measured intraoperatively rather than using MRI [10]. Furthermore, in our study, the primary efficacy criterion was the relative rather than the absolute length gain.

MRI assessment of penile anatomy has been used for quite some time [11–13]. However, evaluation of the individual characteristics of the penile ligamentous apparatus for predicting the outcomes of augmentation has not yet been incorporated into clinical practice. Chen et al. [14] described the MRI anatomy of the penile ligaments. Mariani et al. [15] correlated MRI images with cadaveric studies and proposed a nomenclature, describing the characteristics of the suspensory, fundiform, and arcuate ligaments. Wang et al. [16] used MRI data to create an animated 3D model clearly demonstrating the process and outcome of suspensory ligament release. This work is interesting, but the feasibility of creating a 3D animation for each patient during preoperative counseling remains questionable.

CONCLUSION

Preoperative assessment of anatomical structures is a critical step that ensures both the selection of the optimal surgical technique and the formation of adequate and realistic patient expectations regarding outcomes.

In this study, we analyzed various anatomical and surgical parameters and their impact on the success of penile augmentation surgery. Based on the obtained data, we identified two key parameters exerting the most significant influence on surgical efficacy: the thickness of subcutaneous fat in the pubic region and the length of the penile suspensory ligament.

ADDITIONAL INFO

Author contributions: K.S. Guluzade: data curation, formal analysis, writing—original draft, writing—review & editing, visualization; S.I. Gamidov: writing—original draft, writing—review & editing; T.V. Shatylko: formal analysis, writing—original draft, writing—review & editing; N.P. Naumov: data curation, investigation, visualization; N.G. Gasanov: data curation, investigation. All the authors approved the version of the draft to be published and agreed to be accountable for all aspects of the work, ensuring that issues related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics approval: The study was approved by the local ethical committee of First Moscow State Medical University named after I.M. Sechenov (protocol No. 12-25 dated 2025 May 22). All study participants signed an informed voluntary consent form before inclusion in the study.

Consent for publication: Written informed consent was obtained from the patients for the publication of personal data, including photographs, in a scientific journal and its online version between 2022 and 2025. The scope of the published data was approved by the patients.

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Data availability statement: All data generated during this study are available in this article.

Generative AI: Generative AI technologies were not used for this article creation.

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ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. К.С. Гулузаде — сбор, систематизация и интерпретация данных литературы по теме статьи, научное редактирование, анализ статистических данных, написание текста статьи, оформление библиографии; С.И. Гамидов — участие в написании статьи, научное редактирование; Т.В. Шатылко — написание текста статьи, анализ статистических данных, научное редактирование статьи; Н.П. Наумов — сбор данных, обзор публикаций по теме статьи, оформление библиографии; Н.Г. Гасанов — сбор данных, обзор публикаций по теме статьи. Авторы одобрили версию для публикации, а также согласились нести ответственность за все аспекты работы, гарантируя надлежащее рассмотрение и решение вопросов, связанных с точностью и добросовестностью любой ее части.

Этическая экспертиза. Исследования одобрено локальным этическим комитетом ФГАОУ ВО «Первый Московский государственный медицинский университет им. И.М. Сеченова» (протокол № 12-25 от 22.05.2025). Все участники исследования подписали форму информированного добровольно согласия на участие в исследовании.

Согласие на публикацию. Авторы получили письменное информированное добровольное согласие пациентов на публикацию персональных данных, в том числе фотографий, в научном журнале, включая его электронную версию с 2022 по 2025 г. Объем публикуемых данных с пациентами согласован.

Источники финансирования. Отсутствуют.

Раскрытие интересов. Авторы заявляют об отсутствии отношений, деятельности и интересов за последние три года, связанных с третьими лицами (коммерческими и некоммерческими), интересы которых могут быть затронуты содержанием статьи.

Оригинальность. При создании настоящей работы авторы не использовали ранее опубликованные сведения (текст, иллюстрации, данные).

Доступ к данным. Все данные, полученные в настоящем исследовании, доступны в статье.

Генеративный искусственный интеллект. При создании настоящей статьи технологии генеративного искусственного интеллекта не использовали. В рецензировании участвовали два внешних рецензента, член редакционной коллегии и научный редактор издания.

Рассмотрение и рецензирование. Настоящая работа подана в журнал в инициативном порядке и рассмотрена по обычной процедуре. В рецензировании участвовали один рецензент (член редакционной коллегии, член редакционного совета или внешний рецензент), рецензирование двойное слепое.

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