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ADVANTAGES OF THE SUBVASTUS APPROACH IN PRIMARY KNEE ARTHROPLASTY: A SYSTEMATIC LITERATURE REVIEW

This systematic review evaluates the effectiveness of the subvastus approach (SVA) in primary total knee arthroplasty compared to the medial parapatellar approach (MPA). The analysis includes 15 studies with a sample size exceeding 10,000 patients. The SVA demonstrated significant advantages in the early postoperative period: reduced pain syndrome, accelerated recovery of extension function, improved range of motion, and higher functional scores. A reduction in intraoperative blood loss was noted, although operative duration may increase. In the long-term period, differences between methods become negligible. The SVA demonstrates safety comparable to MPA without increasing complication risks. When combined with enhanced recovery protocols, this method facilitates early mobilization and reduces hospitalization duration.

Keywords: knee arthroplasty, subvastus approach, early rehabilitation, PRISMA.

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Introduction. Total knee arthroplasty (TKA) represents a highly effective treatment method for terminal stages of gonarthrosis, providing sustained relief of pain syndrome and restoration of joint function. Numerous studies demonstrate long-term improvement in patients' health-related quality of life following this intervention [13, 24, 35].

The medial parapatellar approach (MPA), first described by Langenbeck in 1879 [45], has remained the gold standard for performing TKA for decades. This approach provides excellent visualization of the surgical field and optimal conditions for implantation of prosthetic components [31, 40]. Despite its widespread use, the parapatellar approach involves incision of the quadriceps femoris tendon, which inevitably leads to trauma of the knee joint extensor mechanism. Consequences of such intervention may include excessive scarring, muscle weakness, and persistent anterior knee pain [15, 38].

As an alternative to the traditional approach, quadriceps-sparing surgical approaches have been developed, among which the subvastus approach (SVA) occupies a special position due to complete preservation of the anatomical integrity of the extensor mechanism. This technique allows minimization of soft tissue trauma while maintaining adequate exposure of the surgical field [8, 22].

Modern Enhanced Recovery After Surgery (ERAS) protocols have optimized perioperative management of patients after major joint arthroplasty, providing significant reduction in hospitalization length and decrease in postoperative complications [10, 29, 33]. The combination of SVA with ERAS principles demonstrates a synergistic effect, allowing achievement of faster restoration of joint range of motion after TKA, early straight leg raise, and reduction of intraoperative blood loss compared to the traditional parapatellar approach [4].

Analysis of data from the National Joint Registry of England and Wales, including 875,166 operations, revealed a 20% reduction in revision surgery risk when using quadriceps-sparing techniques, which emphasizes not only the clinical but also the economic feasibility of this approach [5]. In the context of the development of the minimally invasive surgery concept and the pursuit of optimization of early functional outcomes of TKA, there is sustained growth of interest in quadriceps-sparing techniques.

Study objective: To conduct a systematic review of current scientific literature in accordance with the PRISMA protocol for comprehensive evaluation of the advantages of the subvastus approach compared to alternative surgical approaches in performing total knee arthroplasty.

Materials and Methods. The systematic review was performed according to PRISMA guidelines [42]. Literature search was conducted from January 2018 to December 2024 in PubMed, Google Scholar, and eLibrary databases.

The search strategy included combinations of key terms: "subvastus approach", "total knee arthroplasty", "medial parapatellar", "surgical approach" and their variations in Russian and English. Additionally, manual search was performed in the reference lists of included studies.

Inclusion criteria: studies of adult patients (≥18 years) with terminal gonarthrosis undergoing TKA, where SVA was compared with other techniques. Randomized controlled trials (RCTs), systematic reviews, and meta-analyses were included. Revision surgeries, unicompartmental knee arthroplasty, and case reports with samples of fewer than 10 patients were excluded. Extracted data encompassed study characteristics, demographic parameters, clinical outcomes, and follow-up period. The search methodology is presented in Figure 1.

Results and Discussion. Characteristics of studies included in the review. Data from 15 publications were included, collectively encompassing 138 RCTs that compared SVA with alternative surgical approaches in TKA. The total sample of analyzed studies comprised 10,475 patients, which allows the obtained results

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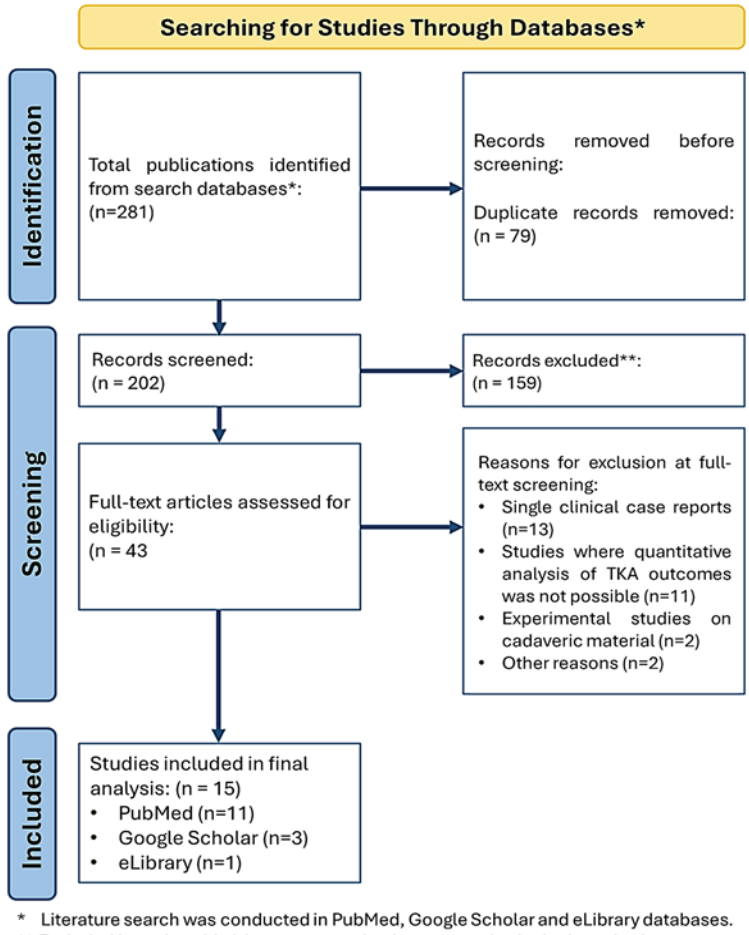
to be considered representative of the general population of patients requiring TKA. The vast majority of included studies were represented by randomized trials of high methodological quality, including several large meta-analyses, which provides a high level of evidence for the obtained data.

The primary object of comparison in most studies was the traditional MPA, which has been considered the gold standard in knee arthroplasty for decades. In a number of studies, comparative analysis was additionally conducted with other quadriceps-sparing techniques, including the midvastus approach (MVA) and mini-incision techniques.

Based on the conducted analysis, key clinical parameters were identified by which SVA demonstrated statistically significant advantages over alternative surgical techniques. These parameters include functional assessment scales for knee joint condition (KSS - Knee Society Score, WOMAC - Western Ontario and McMaster Universities Osteoarthritis Index), range of motion in the operated joint, pain intensity on the visual analog scale (VAS), ability to perform active straight leg raise in the early postoperative period, operative time, length of hospitalization, volume of intraoperative blood loss, and frequency of postoperative complications.

Comprehensive evaluation of study results indicates the presence of substantial advantages of SVA, particularly pronounced in the early postoperative period. A brief characterization of studies included in the systematic review is presented in Table 1.



Block-Flowchart of the literature search conducted according to the PRISMA protocol

Functional outcomes according to KSS and WOMAC scales. SVA, characterized by preservation of the integrity of the quadriceps femoris tendon through dissection of the capsule under the edge of the vastus medialis muscle, demonstrates statistically significant advantages in the early postoperative period [2, 9, 11, 28, 37, 39, 46]. For example, in the study by Dileep et al. [9], on day 3 after surgery, the mean KSS score in the SVA group was 77.15 versus 67.15 in the MPA group ($p<0.00001$). In a prospective cohort study by Aladraii et al. [2], SVA showed statistically significantly better WOMAC assessment scores compared to MPA at 3 and 6 months after TKA ($p<0.05$). This advantage is explained by minimal trauma to the knee joint extensor mechanism with SVA, which promotes earlier restoration of quadriceps femoris function [26, 36]. Similar results are presented in the meta-analysis by Stubnya et al. [39], where SVA and mini-SVA approaches demonstrated the best indicators for both total and functional components of the KSS scale in the early postoperative period. However, long-term results show gradual leveling of differences between surgical approaches. By 3-6 months and beyond after TKA, no statistically significant differences in KSS and WOMAC scales between SVA and other approaches were detected [3, 7, 16, 19, 21]. This is confirmed by the study of Hosseini-Monfared et al. [19], where the use of SVA provided statistically significantly better WOMAC and KSS scores during the first year after surgery. However, in the long term, differences between groups become comparable, indicating the absence of influence of approach selection on the final functional outcome of TKA [6, 12].

Range of motion in the knee joint. Almost all RCTs note that patients who underwent TKA using SVA achieve significantly greater flexion range in the joint in the first days after surgery compared to traditional surgical approaches [4, 7, 9, 28, 39]. Thus, when using SVA within 6 months after surgery, an increase in flexion range of 11.1° was noted compared to MPA ($p<0.05$) [39]. In the study by Geng et al. [14], the difference was noticeable by day 3, and the mean flexion angle was 118.91° in the mini-SVA group versus 107.6° in the MPA group ($p<0.00001$). The advantage in range of motion persisted until day 30 of postoperative observation [14], after which differences became insignificant in the long-term period [9, 14, 21, 25, 46], indicating achievement of comparable functional results with long-term follow-up regardless of the chosen surgical approach.

The mechanism of early functional superiority of SVA is due to preservation of the anatomical integrity of the quadriceps femoris muscle and minimization of trauma to the knee joint extensor mechanism [8, 34]. The absence of the need to incise the quadriceps tendon in SVA promotes faster restoration of muscle strength and coordinated function of the extensor mechanism, which is directly reflected in the range of active movements in the early postoperative period [30, 43].

Pain syndrome in the early postoperative period. Analysis of studies

Brief comparative characteristics of studies included in the review

Author, year	Sample size	Mean age	Compared approaches	Follow-up duration (months)	Main analyzed parameters
Bouché et al., 2020 [7]	5042 (60 RCTs)	Н/Д	SVA, MVA, mini-PA, MPA, QSA	6	KSS scale, WOMAC scale, range of motion, VAS pain, operative time, complications
Stubnya et al., 2023 [39]	1774 (33 RCTs)	67,1±6,8	SVA, MPA, MVA	16,5	KSS scale, range of motion, VAS pain, straight leg raise, operative duration
Berstock et al., 2018 [4]	1694 (20 RCTs)	Н/Д	SVA, MPA	11, 58	KSS scale, range of motion, VAS pain, straight leg raise, operative duration, blood loss volume, com-plications
Wu et al., 2018 [46]	1172 (14 RCTs)	69,14	mini-SVA, MPA	36	KSS scale, range of motion, straight leg raise, op-erative duration, blood loss volume, length of hospitalization, complications
Madadi et al., 2021	50	64,8 ± 3,7	SVA, MPA	12	VAS pain, straight leg raise
Hosseini-Monfared et al., 2024 [19]	60	Н/Д	SVA, MPA	120	KSS scale, WOMAC scale, range of motion, VAS pain, straight leg raise, operative time, blood loss volume, length of hospitalization, complications
Güven et al., 2024 [16]	17	67,11±8,10	SVA, MPA	3	KSS scale, WOMAC scale, straight leg raise
Li et al., 2018 [28]	50	69,0±4,65	mini-SVA, MPA	12	KSS scale, range of motion, VAS pain, straight leg raise, operative time, blood loss volume, length of hospitalization, complications
Geng et al., 2022 [14]	58	65,0 ± 5,11	mini-SVA, MPA	1	Range of motion, VAS pain, straight leg raise, operative time, complications
Jhurani et al., 2021[21]	186	64,6±7,9	SVA, MPA	12	KSS scale, range of motion, VAS pain, straight leg raise, blood loss volume, length of hospitalization
Badawi et al., 2024 [3]	60	62,8±4,14	SVA, MPA	6	WOMAC scale, VAS pain, timing of straight leg raise, operative time, blood loss volume, compli-cations
Dileep et al., 2022 [9]	54	65,89±5,46	SVA, MPA	12	KSS scale, VAS pain, range of motion, timing of straight leg raise
Aladraii et al., 2024 [2]	98	63,9±7,5	SVA, MPA	12	WOMAC scale
Sood et al., 2024 [37]	100	62,52±6,75	SVA, MPA	12	KSS scale, WOMAC scale, VAS pain, length of hospitalization
Fahim et al., 2024 [11]	60	64,2±5,02	SVA, MPA	12	KSS scale, WOMAC scale, VAS pain, timing of straight leg raise, operative time, blood loss vol-ume, length of hospitalization, complications

included in the systematic review demonstrates substantial advantages of SVA regarding the severity of pain syndrome in the early postoperative period. This pattern is traced in most of the analyzed studies and is confirmed by meta-analysis results [3, 4, 7, 9, 14, 28, 37, 39]. In the meta-analysis by Stubnya et al. [39], it was established that the use of mini-subvastus technique is accompanied by a statistically significant reduction in pain intensity on the visual analog scale (VAS) during the first week after TKA. Similar results were obtained in a prospective randomized study by Geng et al. [14], where patients operated using mini-SVA demonstrated significantly lower pain scores both at rest and during active movements in the first days after TKA compared to the medial parapatellar approach (2.67 versus 3.38, $p<0.05$). An important feature revealed during analysis of literature data is the gradual leveling of differences in pain intensity between compared surgical approaches as the follow-up period increases. After 1-6 months following surgery, statistically significant differences in VAS scores between SVA and traditional parapatellar approach groups were absent in most studies [11, 14, 19, 21, 25, 28]. In studies by Madadi et al. [25] and Jhurani et al. [21], the severity of pain syndrome in SVA and MPA groups showed no statistically significant difference at 6 and 12 months after TKA.

The identified advantages of SVA regarding early postoperative pain syndrome can be explained by features of the surgical technique. Preservation of the integrity of the quadriceps femoris tendon and minimization of soft tissue

trauma with the subvastus approach contribute to reduction of nociceptive stimulation and inflammatory response in the early postoperative period. This creates favorable conditions for faster patient activation and early initiation of rehabilitation measures [17, 18, 30].

The absence of significant differences in the long-term period indicates that with adequate surgical technique and complete rehabilitation, long-term functional outcomes are determined primarily by the quality of prosthesis implantation and individual patient characteristics, rather than by the choice of surgical approach [1, 23, 47].

Restoration of quadriceps femoris function. One of the key advantages of SVA is faster restoration of knee joint extensor mechanism function. The most significant differences between subvastus and traditional approaches were observed in the early postoperative period [3, 4, 9, 11, 14, 19, 21, 28, 39, 46].

The straight leg raise (SLR) functional test served as the main objective criterion for assessing restoration of quadriceps strength in most analyzed RCTs. Wu et al. [46] in their study showed that in the mini-SVA group, patients could raise a straight leg after TKA on average 2.35 days earlier than in the MPA group (p=0.003). In the study by Hosseini-Monfared et al. [19], the median time to first successful performance of the straight leg raise test was 1.8 days in the SVA group versus 3.6 days in the parapatellar approach group (p<0.001). Similar results were shown by Geng et al. [14], where the mean time to restoration of the ability to raise a straight leg was 1.17 days in the SVA group versus 3.09 days in the MPA group (p<0.0001). This confirms the thesis of earlier quadriceps activation when its integrity is preserved. However, after 1-6 months following TKA, differences become insignificant [3, 4, 14, 28, 39, 46].

Operative time. Comparative evaluation of operative duration in SVA and MPA revealed heterogeneous results. Most studies noted a statistically significant increase in operative time with SVA [3, 4, 28, 39]. In particular, Li et al. [28] in their study showed a significant increase in operative time with mini-SVA (86.8 min.) compared to MPA (66.6 min.) (p<0.001). The authors emphasize that the clinical advantages of this approach—reduction of pain syndrome, acceleration of mobilization and verticalization of patients, as well as improvement of functional parameters of the knee joint—compensate for the slight prolongation of surgery [28]. At the same time, a number of studies demonstrate comparable duration of TKA with subvastus and traditional approaches [7, 11, 14, 19]. Fahim et al. [11] found no statistically significant differences in operative time between subvastus and parapatellar techniques (p=0.32).

Such variability in obtained results may be due to differences in the experience of orthopedic surgeons and passage through the learning curve, as SVA requires more delicate technique and careful visualization of anatomical structures [20, 30]. Moreover, data heterogeneity may be explained by differences in patient inclusion criteria, especially regarding body mass index and degree of knee joint deformity, which significantly affects the technical complexity of performing the approach [27]. Standardization of surgical technique and accumulation of experience in using SVA contribute to leveling of differences in operative time between compared techniques.

Blood loss. Intraoperative blood loss represents a significant parameter characterizing the degree of surgical intervention invasiveness and associated risks for the patient. Analysis of six comparative studies demonstrated the advantage of SVA in reducing blood loss volume compared to the medial parapatellar approach [3, 4, 21, 46].

Meta-analysis of 20 RCTs, including 1,694 patients, revealed a statistically significant reduction in blood loss when using SVA by 58 ml (95% CI: 10.5–106.4 ml; p = 0.02) compared to the parapatellar approach [4]. At the same time, in individual studies, no statistically significant differences in intraoperative blood loss volume between SVA and standard approaches were detected [7, 11, 19, 28].

The probable mechanism of blood loss reduction with SVA is minimization of musculotendinous structure trauma, which causes reduction of intraoperative tissue bleeding [32, 41, 44].

Length of hospitalization. Comparison of hospitalization length between SVA and MPA revealed no advantages of the subvastus approach [11, 19, 37, 46], and only two studies showed advantages of SVA [21, 28]. Thus, the prospective randomized study by Li et al. [28] showed a statistically significant reduction in hospitalization length in favor of SVA. The mean duration was 4.8±0.9 days (range 3-6 days) in the mini-SVA group versus 6.3±1.1 days (range 5-8 days) in the MPA group (p<0.001). This study shows the most pronounced advantage of SVA for this parameter.

The obtained results most likely reflect the multifactorial nature of hospitalization length, which depends not only on the surgical approach but also on multiple organizational, technical, and population factors. The study by Li et al. [28] stands out for its use of a strictly defined mini-subvastus technique in relatively young patients with unilateral TKA, which may explain the obtained differences.

Postoperative complications. Comparative analysis of postoperative complication rates when using SVA and traditional surgical techniques demonstrates comparable results in most studies. Numerous RCTs revealed no statistically significant differences in overall complication rates between these techniques [3, 4, 11, 14, 19, 28, 46].

The rate of infectious complications, including superficial and deep surgical site infections, remains comparably low in both patient groups. Analysis of randomized controlled trial data confirms the absence of significant differences in development of infectious complications between SVA and MPA [3, 11, 19].

Particular attention should be paid to the results of the study by Jhurani et al. [21], which identified a specific problem associated with SVA. This work documented a statistically significant increase in the frequency of proximal wound dehiscence and delayed soft tissue healing in the SVA group compared to the parapatellar group (p=0.03). The authors associate this complication with technical features of SVA, suggesting that limited incision length and reduced exposure of the surgical field may create excessive tension at wound edges in individual clinical cases.

It should be noted that the described wound healing problems were not confirmed in other studies. The overall rate of early postoperative complications, including hematoma formation, thrombotic complications, and infectious processes, remains comparable between different surgical approaches [19]. In studies by Badawi et al. [3] and Bouche et al. [7], a tendency toward reduction in the number of complications in the SVA group compared to control groups was noted, but these differences did not reach the level of statistical significance.

Thus, accumulated data indicate a comparable safety profile of SVA and traditional surgical techniques in TKA, while the question of potential risk of impaired wound healing requires further study in larger patient samples.

Conclusion. The systematic analysis conducted according to the PRISMA protocol demonstrates that the subvastus approach provides statistically significant improvement in functional outcomes on the KSS and WOMAC scales,

greater range of motion in the joint, early restoration of extension, and lower pain intensity in the early postoperative period. The advantages of this approach are not accompanied by an increase in intraoperative risks. After 3-6 months, differences between approaches level out, with the KSS and WOMAC functional scales showing comparable results. It should also be noted that the subvastus approach is particularly significant for the ERAS protocol, contributing to reduction of hospitalization period and economic costs. Limitations of the review include study heterogeneity and lack of long-term data.

Thus, the subvastus approach represents an effective alternative to the traditional approach, providing advantages in early recovery without deterioration of long-term outcomes.

The authors declare no conflict of interest.

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DIAGNOSTIC CHALLENGES OF A RARE KASABACH–MERRITT SYNDROME IN AN INFANT

The article is devoted to topical issues of the complexity of the diagnosis of a rare pathology – Kazabach–Merritt syndrome in infants. Against the background of progressive bilateral polysegmental pneumonia, the child retained thrombocytopenia and consumptive coagulopathy. Syndrome-by-syndrome treatment was performed in the intensive care units of the perinatal and pediatric centers of the republican hospital. The patient received a large amount of blood replacement therapy, and the pleural and abdominal cavities were repeatedly drained. In this clinical case, there were no external manifestations of the disease in the form of a tumor on the skin. Initially, the formation was not diagnosed on early CT scans. Kaposiform hemangioendothelioma complicated by Kasabach–Merritt syndrome was suspected by the exclusion method, which was confirmed at the Federal Center. Properly prescribed complex chemotherapy led to an improvement in the baby's condition. In clinical practice, there are often situations where the symptoms of the disease can be masked by other conditions, such as infectious processes or other hemorrhagic disorders. This highlights the importance of a multidisciplinary approach in the diagnosis and treatment of this disease.

Keywords: Kasabach–Merritt syndrome, kaposiform hemangioendothelioma, thrombocytopenia, consumptive coagulopathy, retroperitoneal formation, newborn, clinical case

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Introduction. Kaposiform hemangioendothelioma (KHE) is a rare congenital vascular tumor manifesting in infancy, histologically resembling Kaposi's sarcoma but not etiologically associated with herpesvirus type 8. According to the ISSVA classification, this tumor is classified as an intermediate malignancy with infiltrative growth and no metastatic potential. The most severe complication of KHE is the development of Kasabach–Merritt syndrome, which occurs in 80-90% of cases and manifests from birth in 50% of cases. The clinical signs of the syndrome are related to the size of the tumor. Kasabach–Merritt syndrome is a symptom complex characterized by the presence of a vascular tumor and associated consumptive coagulopathy and thrombocytopenia. Currently, due to the lack of randomized clinical trials, there is no standardized clinical protocol for the treatment of this disease.

The syndrome was first described by Kasabach and Merritt in 1940, and since then over 200 cases have been registered worldwide [5]. The incidence in the Russian Federation has not been reliably established [1, 2]. Among all vascular tumors, Kasabach–Merritt syndrome accounts for 1.0% in global pediatric practice [2, 5]. Mortality from this disease is quite high due to heart failure, infections, disseminated intravascular coagulation syndrome, and thrombocytopenia leading to massive bleeding, reaching 10-37.4% [1, 2, 5].

Treatment is primarily conservative, including propranolol, corticosteroids, vincristine, sirolimus [2, 3, 5, 8, 9]. Surgical treatment is often impossible due to coagulopathy, thrombocytopenia, and the infiltrative growth of the lesion [1].

Aim: To demonstrate the diagnostic challenges of a rare clinical case – Kasabach–Merritt syndrome in an infant during the first months of life.

Materials and Methods: We present the medical history of a patient who received inpatient treatment in the ICU of the Perinatal Center and later in the ICU of the Pediatric Center of the republican hospital.

Life History. A boy born in 2024. The child is from the 3rd pregnancy, which proceeded without complications. Pre-