THE DEVELOPMENT AND SIGNIFICANCE OF MINIMALLY INVASIVE SURGERY: METHODS, RESULTS, AND PROSPECTS

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Abstract. By lowering hospital stays, recovery times, and patient trauma while preserving or improving procedural efficacy, minimally invasive surgery, or MIS, has revolutionized the field of surgery. The history, evolution, fundamental methods, advantages, drawbacks, and potential future directions of MIS are all examined in this thesis. The research evaluates the effects of robotic surgery, single-incision techniques, and cutting-edge imaging technologies while looking at a variety of applications in disciplines including general surgery, gynecology, orthopaedics, proctology, and cardiology. An examination of current developments and the possibilities for artificial intelligence to further advance MIS is included in the thesis' conclusion.

Keywords: trauma, robotic surgery, surgery, orthopedics, artificial intelligence.

РАЗВИТИЕ И ЗНАЧЕНИЕ МИНИИНВАЗИВНОЙ ХИРУРГИИ: МЕТОДЫ, РЕЗУЛЬТАТЫ И ПЕРСПЕКТИВЫ

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Аннотация. Сокращая пребывание в больнице, время восстановления и травматизм пациентов при сохранении или улучшении эффективности процедуры, минимально инвазивная хирургия, или MIS, произвела революцию в области хирургии. История, эволюция, основные методы, преимущества, недостатки и потенциальные будущие направления MIS рассматриваются в этой диссертации. Исследование оценивает эффекты роботизированной хирургии, методов одноразрезного хирургического вмешательства и передовых технологий визуализации, рассматривая при этом различные приложения в дисциплинах, включая общую хирургию, гинекологию, ортопедию, проктологию и кардиологию. В заключение диссертации включен анализ текущих разработок и возможностей искусственного интеллекта для дальнейшего развития MIS.

Ключевые слова: травматизм, роботизированная хирургия, хирургия, ортопедия, искусственный интеллект.

INTRODUCTION BACKGROUND

A summary of traditional surgery versus minimally invasive surgery (MIS), including the factors that led to the move to less invasive techniques; Definition and Scope: An explanation of what minimally invasive surgery is and the range of techniques that qualify under this category; Goals: Determining goals like lowering surgical risks, enhancing recovery, and minimizing patient trauma.

TECHNOLOGICAL MILESTONES

The impact of technological advancements such as fiber optics, imaging systems, and the evolution of surgical tools that allowed more complex procedures to be performed minimally invasively; Acceptance and Adoption: How MIS became the standard in many surgical fields; and the role of medical societies and regulatory bodies in its adoption. Historical Development of Minimally Invasive Surgery Early Innovations: The birth of laparoscopy and endoscopy, including the groundbreaking work in the 20th century that laid the foundation for MIS.

Core Techniques in Minimally Invasive Surgery Laparoscopy: Analysis of abdominal surgery techniques, such as appendectomy, cholecystectomy, and complex gynecological surgeries; Endoscopy: Review of endoscopic techniques, commonly utilized in gastrointestinal and pulmonary surgeries; Single-Port Surgery (SPS): Single incision for multiple instruments; benefits and drawbacks; Robotic-Assisted Surgery: Information on how robotics improve precision, provide 3D visualization, and help with complex procedures; this section will also cover the latest robotic systems, such as da Vinci. Miniaturization of Surgical Instruments: Summary of specialized instruments made for precise operations through tiny incisions.

Imaging and Navigation's Role in MIS Preoperative Imaging Techniques such as CT, MRI, and 3D reconstructions that enable accurate planning and risk assessment; Intraoperative Imaging: The contribution of real-time imaging, such as fluoroscopy and ultrasound, to increasing accuracy; Augmented Reality (AR) and Virtual Reality (VR): New applications of AR and VR to overlay important information during procedures and improve spatial awareness.

PATIENT RESULTS AND MIS ADVANTAGES

Decreased Trauma and Pain: Because of smaller incisions, there is a lower incidence of pain and trauma, which lessens the need for post-operative analgesics. Quicker Recovery: Shorter hospital stays and a quicker return to everyday activities. Reduced Infection Rates and Complications: Research shows that MIS reduces the risk of infections and other complications following surgery. Patient Contentment: improved patient satisfaction as a result of aesthetic advantages, quicker recuperation, and lower medical expenses.

Limitations and Difficulties with the Minimally Invasive Surgery Learning Curve An examination of the education, experience, and difficulties faced by surgeons switching from open surgery. Technical limitations include those pertaining to the intricacy of the treatments, the absence of tactile input in robotic surgery, and the restricted scope of some complicated or high-risk surgeries. Expenses and Availability: Higher upfront expenses for specialized tools and robotic systems, as well as restricted accessibility in underserved or isolated areas. Intraoperative Risks: Possible MIS-specific side effects, include trocar injuries or complications with CO2 insufflation during laparoscopy.

1. Technical Complexity and Training: MIS procedures require specialized skills and significant training for surgeons. These techniques involve advanced equipment and precision, which can be challenging to master. As a result, there can be a steep learning curve, and inexperienced surgeons may face greater risks during complex procedures.

2. Limited Visual Field and Tactile Feedback: Compared to open surgeries, MIS often limits the surgeon's view and tactile feedback. Surgeons rely heavily on cameras and instruments that provide an indirect view, which can restrict their ability to assess tissue characteristics directly and respond to unexpected complications.

3. Higher Cost: The specialized equipment required for MIS, such as robotic systems and high-definition cameras, is often expensive. These costs can make MIS less accessible for some hospitals, and the associated costs may be passed on to patients, making it less feasible in settings with limited resources.

4. Patient Suitability: Not all patients are ideal candidates for MIS. Factors like obesity, certain anatomical variations, or previous abdominal surgeries can limit the feasibility of MIS. For these patients, traditional open surgery might be safer and more effective.

5. Procedure Length and Fatigue: Although MIS can reduce patient recovery time, it may take longer than open surgeries due to the precision and care required. Surgeons may experience

more physical strain due to the ergonomics involved in handling fine instruments for extended periods.

6. Risk of Complications: While MIS generally reduces risks associated with large incisions, complications such as infections, bleeding, and organ damage can still occur. In some cases, an unsuccessful MIS may need to be converted to an open surgery to manage unforeseen issues, increasing the complexity and risk involved.

These limitations highlight the need for careful patient selection and thorough surgeon training to ensure successful outcomes in minimally invasive surgery.

Minimally Invasive Surgery Case Studies General Surgery: Cholecystectomy and laparoscopic appendectomy are two examples. Gynecology: Robotic and laparoscopic hysterectomy and endometriosis procedures. Orthopedics: Arthroscopy in joint operations and ligament restoration. MIS is used in cardiovascular surgery for valve repairs and coronary artery bypass grafting. Endoscopic methods used in brain and spine procedures are known as neurosurgery.

Future Directions and Innovations in Minimally Invasive Surgery Artificial Intelligence (AI) in MIS: AI for preoperative planning, real-time analytics, and improving robotic assistance Nanotechnology and Micro-Robots: Nanoscale robots' potential to perform ultra-precise, targeted procedures; Bioprinting and Tissue Engineering: Combining MIS with regenerative techniques for organ transplantation and tissue repair; Telemedicine and Remote Surgery: The possibility of remote surgeries driven by robotics and real-time data exchange, increasing access to MIS worldwide; Emerging Imaging Technologies: Advanced imaging including holography, high-resolution endoscopy, and functional MRI to improve procedural accuracy.

CONCLUSION

Key Findings Synopsis: summary of MIS's advantages, drawbacks, and developments. Implications for Ethics and Society: Talk about moral issues including the price of robotic systems and guaranteeing that everyone has access to state-of-the-art methods. Prospects for the Future: Concluding remarks about the necessity of continuous innovation and research, as well as the potential for MIS to continue revolutionizing surgical care. Appendices Definitions of Terms: MIS-specific phrase definitions for clarity. Technical Diagrams: Graphical representations of robotic systems, MIS tools, and procedures. Statistical Tables: Information on results, success rates, and comparisons to conventional surgery.

REFERENCES

1. Якубов, Д. Ж., Ахмедов, Я. А., Умаркулов, З. З., & Ким, Т. П. (2023). Мультипараметрическая МРТ В Диагностике Рака Предстательной Железы. *Central Asian Journal of Medical and Natural Science*, *4*(2), 577-587.
2. Умаркулов, З. З., Хамидов, О. А., & Давлатов, С. С. (2023). Диапевтические методы в хирургическом лечении кистозных образований печени. *Журнал гуманитарных и естественных наук*, (6), 108-112.
3. Умаркулов, З. З., Хамидов, О. А., Давлатов, С. С., & Усмонов, А. У. (2023). Роль диапевтических методов в диагностики и результатов хирургического лечения больных паразитарными и непаразитарными кистами печени. *Журнал гепато-гастроэнтерологических исследований*, *4*(3)

4. Умаркулов, З. З., Хамидов, О. А., & Давлатов, С. С. (2023). Результаты анализа хирургического лечения больных кистозными образованиями печени. *Журнал гуманитарных и естественных наук*, (6), 133-137.
5. Умаркулов, З. З., Хамидов, О. А., Давлатов, С. С., & Усмонов, А. У. (2023). Роль диапевтических методов в хирургическом лечении кистозных образований печени. *Журнал гепато-гастроэнтерологических исследований*, *4*(3).
6. Умаркулов, З. З. (2024). ПРЕИМУЩЕСТВА УЛЬТРАЗВУКОВОЙ ЭЛАСТОГРАФИИ ПРИ РАКЕ МОЛОЧНОЙ ЖЕЛЕЗЫ. *THEORY AND ANALYTICAL ASPECTS OF RECENT RESEARCH*, *3*(26), 1-4.
7. Умаркулов, З. З. (2023). Визуализация Множественной Миеломы. *Central Asian Journal of Medical and Natural Science*, *4*(3), 906-916.
8. Умаркулов, З., Усмонов, А., Арзиев, А., & Атоева, М. (2023). МЕСТО ДИАПЕВТИЧЕСКИХ МЕТОДОВ В ХИРУРГИЧЕСКОМ ЛЕЧЕНИИ КИСТОЗНЫХ ОБРАЗОВАНИЙ ПЕЧЕНИ. *Development of pedagogical technologies in modern sciences*, *2*(12), 120-128.
9. Умаркулов, З. З., & Сувонов, З. К. (2023). СОВРЕМЕННЫЕ РАЗВИТИЯ ЛУЧЕВОЙ ДИАГНОСТИКИ. *Journal the Coryphaeus of Science*, *5*(5), 237-251.
10. Умаркулов, З. З., & Хакимов, М. Б. (2023). Совместный Выпот Коленного Сустава: Возможности И Ограничения Узи. *Diversity Research: Journal of Analysis and Trends*, *1*(3), 244-253.
11. Ugli, Nurmurzaev Zafar Narbay, Nodirov Kosimjon Komilzhonovich, and Abduraxmanov Diyor Shukurullaevich. "TENSIONED HERNIOPLASTY AND ABDOMINOPLASTY IN PATIENTS WITH MORBIDE OBESITY." *Research Focus* 3.4 (2024): 94-105.
12. Ugli, Nurmurzaev Zafar Narbay, Usarov Mukhriddin Shukhratovich, and Akobirov Matlabbek Talat Ugli. "SOME FEATURES OF TREATMENT OF DIAPHRAGM HERNIAS WITH THE USE OF LAPAROSCOPIC ANTI-REFLUX METHODS." *Research Focus* 3.4 (2024): 106-110.
13. Ugli, Nurmurzaev Zafar Narbai, and Shodikulova Parvina Shukhratovna. "BILIARY PERITONITIS AS A COMPLICATION OF CHRONIC CALCULAR CHOLECYSTITIS." *Research Focus* 3.4 (2024): 111-116.
14. Matlabbek, Akobirov, and Nurmurzaev Zafar. "CHECKING THE CONDITION OF THE CORONARY ARTERIES OF THE HEART BY THE METHOD OF MULTISPIRAL COMPUTED TOMOGRAPHY." *AMALIY VA FUNDAMENTAL TADQIQOTLAR JURNALI| JOURNAL OF APPLIED AND FUNDAMENTAL RESEARCH* 2.5 (2023): 26-29.
15. Ugli, Nurmurzaev Zafar Narbay, and Dusmuradova Dildora Khushmuradovna. "DIAPEUTIC METHOD OF TREATMENT OF VARICOCELE." *JOURNAL OF APPLIED MEDICAL SCIENCES* 6.5 (2023): 80-85.
16. Ugli, Nurmurzaev Zafar Narbay, Gaibullaev Sherzod Obid Ugli, and Mukhiddinov Adham Ahmadjon Ugli. "INTRAOPERATIVE ENDOSCOPIC CORRECTION OF CHOLEDOCHOLITHIASIS." *Research Focus* 3.4 (2024): 89-93.
17. Ugli, Nurmurzaev Zafar Narbay, and Dusmuradova Dildora Khushmuradovna. "DIAPEUTIC METHOD OF TREATMENT OF VARICOCELE." *JOURNAL OF APPLIED MEDICAL SCIENCES* 6.5 (2023): 80-85.
18. Ugli, Nurmurzaev Zafar Narbay, et al. "DIAGNOSIS AND SURGICAL TREATMENT OF ECHINOCOCCAL CYST OF THE LIVER." *Research Focus* 3.4 (2024): 76-81.

19. Ugli, Nurmurzaev Zafar Narbay, et al. "EARLY DIAGNOSTICS OF INFECTED PANCREONEKROSIS." *Research Focus* 3.4 (2024): 71-75.
20. Ugli, Nurmurzaev Zafar Narbai, Khamidov Obid Abdurakhmonovich, and Utaeva Ugilbibi Akbaralievna. "ROLE OF ENDOSCOPIC, DIAPEUTIC METHODS AND X-RAY SURGERY IN THE TREATMENT OF COMPLICATED FORMS OF CHOLELITHIASIS." *JOURNAL OF APPLIED MEDICAL SCIENCES* 6.5 (2023): 30-35.