

## A short report on the current landscape of Artificial Intelligence (AI) in vascular surgery in Pakistan

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### Abstract

This study focuses on the current applications, potential, and challenges to Artificial Intelligence (AI) integration in vascular surgery with specific emphasis on its relevance in Pakistan. Despite the benefits of AI in vascular surgery, there is a substantial gap in its adoption in Pakistan compared to global standards. In our context with limited resources and a scarcity of vascular surgeons, AI can serve as a promising solution. It can enhance healthcare accessibility, improve diagnostic accuracy, and alleviate the workload on vascular surgeons. However, hurdles including the absence of a comprehensive vascular surgery database, a shortage of AI experts, and potential algorithmic biases pose significant challenges to AI implementation. Despite these obstacles, the study underscores the imperative for continued research, collaborative efforts, and investments to unlock the full potential of AI and elevate vascular healthcare standards in Pakistan.

**Keywords:** Artificial Intelligence, Health Care, Surgeons, Vascular Surgical Procedures, Bias, machine learning, vascular surgery, peripheral arterial disease, abdominal aortic aneurysm.

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### Introduction

Artificial Intelligence (AI) is a broad term which includes the utilization of computers to simulate intelligent actions with limited human intervention.<sup>1</sup> It has the ability to analyse complicated medical data.<sup>2</sup> AI includes well defined areas including machine learning, natural language processing, artificial neural networks, and computer vision.<sup>3</sup> The recent increase in the applications of AI in healthcare holds the potential to enhance the healthcare information system and provide fresh perspectives for patient diagnosis, treatment and

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prognosis.<sup>4</sup> This is particularly important in vascular surgery, given its substantial potential for leveraging these technologies.<sup>3</sup> This review will focus on the significance of AI in vascular surgery, with a specific emphasis on its relevance in Pakistan. It will also address the obstacles faced and the necessity for AI in vascular surgery within our context, while also comparing the utilisation of AI in vascular surgery in Pakistan to global standards.

### Review

AI, in particular machine learning, is highly suitable for vascular surgery. Vascular surgery is heavily reliant on medical imaging, enabling the implementation of robust machine learning software.<sup>5,6</sup> Well defined clinical criteria for most vascular conditions, such as abdominal aortic aneurysm (AAA)(defined as a size of  $\geq 3$  cm) and peripheral artery disease(PAD) (defined as an ankle brachial index  $< 0.9$ ) allow the machine learning algorithms to independently make diagnoses with minimal human intervention.<sup>7-9</sup> Machine learning exhibits the capability to predict post-operative outcomes by drawing on previous experiences, a feature of particular significance in vascular surgery.<sup>10</sup> Given that a substantial proportion of these procedures are conducted on elderly individuals with multiple comorbidities, the ability to make accurate predictions holds paramount importance in ensuring optimal patient care.<sup>11,12</sup>

There has been an upward trend on research focussed on the applications of AI in vascular surgery around the world, consistently yielding favourable results.<sup>12</sup> The majority of these studies focussed predominantly on common vascular conditions, such as AAA, PAD, and Carotid Artery Stenosis (CAS).<sup>13-15</sup> The application of AI in AAA primarily centred on preoperative planning, as well as the prediction of postoperative outcomes, evolution, and rupture risk.<sup>13</sup> In the context of PAD, extensive research has explored the application of Natural Language Processing and Machine Learning models to enhance the screening, diagnosis, and categorization of PAD cases. Additionally, Machine Learning techniques have been leveraged to construct prognostic models for

more accurate patient assessments, and to devise real-time prediction models that provide critical support for clinical decision-making.<sup>14</sup> AI, using imaging techniques have shown a significant potential in the identification and evaluation of vulnerability-related features for CAS.<sup>15</sup> Given the expanding scope of AI applications in vascular surgery, its integration is poised to enhance patient care and lead to improved clinical outcomes.

Given the multifaceted applications of AI in vascular surgery, Pakistan stands to gain substantial advantages by adopting AI technologies. There exists a significant untapped potential for advancements in this field, particularly within our context, where research and developments have been relatively limited thus far. Pakistan falls within the lowest 25th percentile among the 195 countries assessed for healthcare and disease burden.<sup>16</sup> According to a study conducted in 2021, Pakistan only had 12 qualified vascular surgeons, most of whom were located in cities.<sup>17</sup> Consequently, a substantial portion of the population lacks access to vascular surgeons. Moreover, this situation exacerbates the workload burden on the already limited number of vascular surgeons. AI can improve efficiency and healthcare accessibility by enabling rapid analysis of medical images, including ultrasound and CTA, facilitating remote consultations in rural areas. Krackov et al's work is a good example of how AI can be used to improve healthcare coverage via telehealth. The research involved the utilization of AI for the non-invasive grading of vascular access aneurysms, thereby reducing high-morbidity events such as rupture in patients with End-Stage Renal Disease (ESRD).<sup>18</sup> AI can help reduce workload on vascular surgeons as it decreases the requirement of human resources by automating the diagnosis and treatment planning process.<sup>19</sup>

Diseases managed by vascular surgeons, like PAD and AAA, impose a significant healthcare burden.<sup>20</sup> In countries with limited resources like Pakistan, the use of AI will prove cost-effective for managing these issues by reducing the need for human resources.<sup>19</sup> AI can reduce human errors through precise programming, ensuring accuracy by leveraging predetermined algorithms based on previous information. Additionally, the continuous availability of AI contrasts with human limitations in working efficiently for 6 to 8 hours per shift, contributing to enhanced decision-making precision and task standardization in our setup.<sup>19</sup>

More importantly, as per the systematic review conducted by Li et al, machine learning predictive models exhibited superior performance compared to both clinicians and traditional predictive models.<sup>12</sup> This

highlights the significance of using AI for the improvement of diagnostic accuracy, preoperative planning, and overall outcomes in vascular surgery.

According to Fischer et al the integration of AI in vascular surgery has commenced, for routine diagnoses, interventions and approaches to patient outcomes.<sup>3</sup> However, the use of AI in healthcare, particularly in the field of vascular surgery is in its early stages in Pakistan. National Centre of Artificial Intelligence (NCAI) in Pakistan, is a prominent centre for innovation, research, and education in the field of AI. NCAI has formulated 221 AI products, across diverse sectors including smart cities, precision agriculture, healthcare, media monitoring, manufacturing industry, judiciary, and various others.<sup>21</sup> However, Vascular Arterial Surgical Planning System (VASP), is the only AI based model developed by NCAI for disease prediction and clinical decision making in vascular procedures.<sup>22</sup> Furthermore, the approval status of VASP by the Drug Regulatory Authority of Pakistan (DRAP) remains undisclosed. Conversely, the US has developed 521 AI/machine learning-enabled medical devices relevant to vascular surgery, approved by The Food and Drug Administration (FDA).<sup>23</sup> This gap in the integration of AI in vascular surgery in Pakistan, in contrast to global literature, highlights the substantial prospects for growth and advancement.

While the potential for AI in vascular surgery in Pakistan appears promising, it is not without its associated challenges. The employment of AI models necessitates substantial volumes of high-quality data for accurate decision-making.<sup>24</sup> In the context of Pakistan, the absence of a database for vascular surgery poses a challenge in training these models. Additionally, the prevalent practice of manual data entry results in compromised data quality and the potential loss of crucial information. Consequently, a collaborative initiative among the vascular surgery community is imperative to establish a national registry consisting of a large database to train the AI models.<sup>25</sup>

Another obstacle involves the scarcity of proficient AI experts in Pakistan. According to a study conducted by Hoodbhoy et al.<sup>26</sup> on the role of AI in low-resource settings, the main hurdles to the implementation of AI was lack of trained AI professionals.<sup>26</sup> Nonetheless, there exists an optimistic perspective regarding AI, and there is a willingness to embrace its integration. As per the findings of Ahmed et al.<sup>27</sup> a significant portion of doctors and medical students demonstrated a lack of familiarity with AI but expressed support for its inclusion in the curriculum. A study conducted in Canada showed poor knowledge of AI by vascular surgeons.<sup>28</sup> These findings

may also be applicable to Pakistan, where a shortage of adequately trained vascular surgeons exists. In the future, there is a need to incorporate AI into the educational programmes enabling the students and healthcare providers to comprehend AI tools, their applications, and to adjust their practices<sup>29</sup>

A significant challenge regarding AI involves the possibility of bias in the algorithms employed for model training. Such biases can result in incorrect disease classification and potential harm to patients. Given that models are typically trained on large datasets that predominantly represent a biased population, mainly white Europeans, their applicability to low- and middle-income countries like Pakistan may be questionable.<sup>30</sup> Hence, it is crucial to allocate resources to the development of AI models tailored to our population, ensuring the training of unbiased algorithms. However, the initial investment required for the integration of AI systems, coupled with ongoing maintenance costs, may pose financial challenges, especially in our context.

## Conclusion

In conclusion, while challenges persist, the prospects for growth and advancement in AI applications for vascular surgery in Pakistan are vast. Continued research, collaboration, and investment in AI technologies are essential to overcome barriers and ultimately improve vascular healthcare outcomes for the population.

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