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INTRODUCTION

- The use of AI in surgery has been gaining traction amongst the varying applications of AI as the Image Recognition Function of AI can be maximized through the use of Laparoscopy and Robotic technology.
- The wide adoption of Laparoscopic and Robotic techniques worldwide has resulted to a large amount of video and image-related intra-operative recorded data availability.
- Index general surgery procedure, like laparoscopic cholecystectomy, has received majority of the initial attention in the application of AI given its known “Critical View of Safety”.
- Moving forward, the next step would be to develop AI assistance for more technical and highly anatomically-specific procedures like surgery for groin hernia. Hence, the focus on the application of AI in groin Hernia surgery in this review.

Within each domain, the initial performance of the AI is set to -100. Human performance is used as a baseline, set to zero. When the AI's performance crosses the zero line, it scored more points than humans.

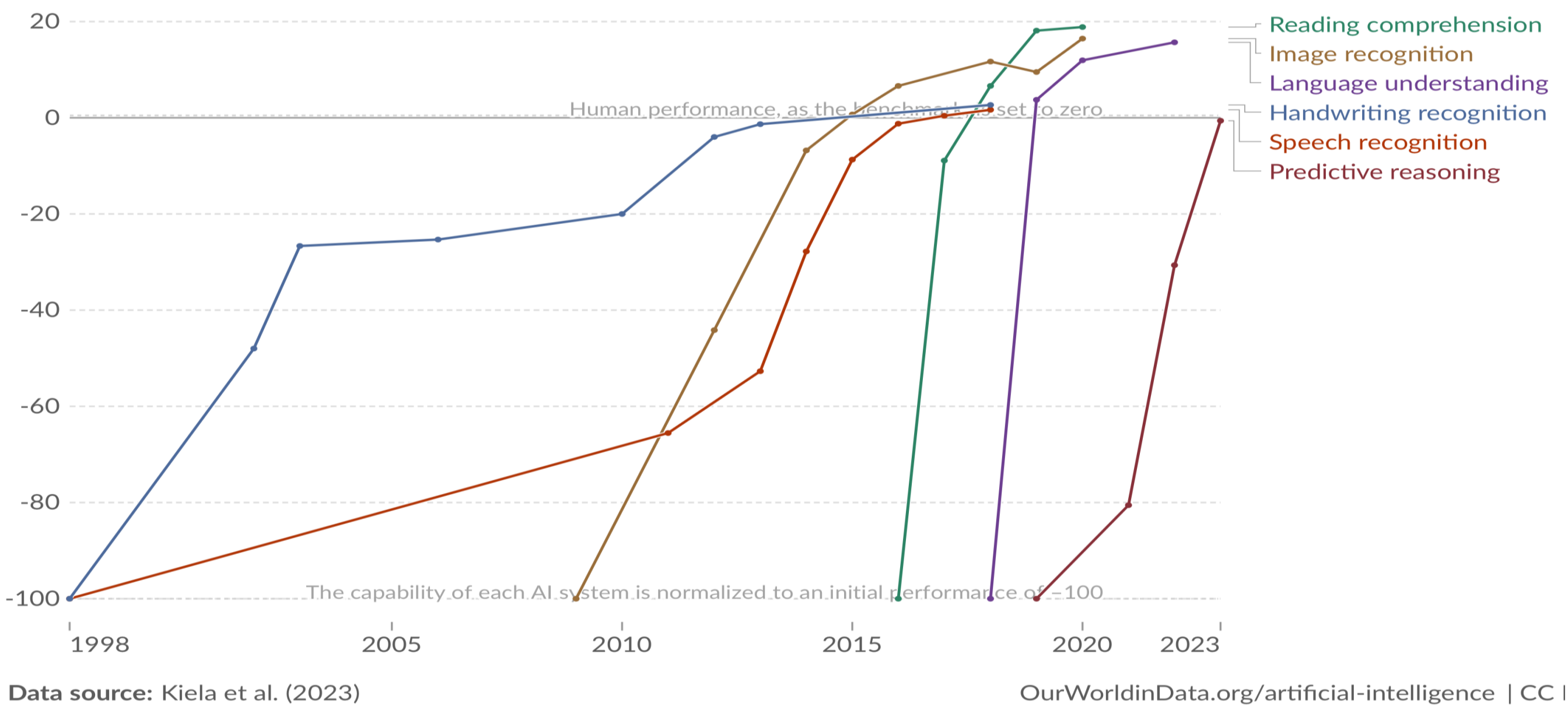


Figure 1. Test Scores of AI systems on various capabilities relative to human performance in a study done by Kiela et al 2023

AIM

This review aims to evaluate the current state of AI in inguinal hernia surgery, its practical applications, examine future prospects and offer recommendations for improving practical application of AI in inguinal hernia surgery.

METHODS

- The study used the Preferred Reporting Items for Systematic and Meta-analyses for Scoping Review (PRISMA-ScR) to guide the structuring of the manuscript and fulfill all the requirements of each subheading. The sources used to gather data are PubMed and Google Scholar search engine.
- Studies that focused on AI in inguinal hernia surgery done on humans, published in English between Jan 2019-Nov 2024 were included

RESULTS

- The study included 11 studies after screening. Out of the 11 included articles, One article had preoperative applications, six (55%) had intra-operative applications, and four (36%) had postoperative applications.

Application	Author	Year Published	Country	Primary Theme
Preoperative				
	Nechay, T. V. et al (21)	2024	Russia	Evaluating the quality of recommendations provided by AI bot regarding inguinal hernia repair
Intraoperative				
	Takeuchi, Masashi et al (24)	2023	France	Developing an AI system that automatically recognizes the TAPP key CVMPO landmarks in hernia repair videos
	Choksi, Sarah et al (28)	2023	USA	Implementing real-time phase recognition workflow and demonstrating its performance on Hernia Repairs (RIHR) to obtain phase predictions during the procedure
	Zygomalas, Apollon et al (26)	2024	Greece	Evaluating the feasibility and usefulness of AI in the recognition of anatomical landmarks and tools in laparoscopic TAPP videos
	Mita, Kazuhito et al (27)	2024	Japan	Validating the accuracy of of an AI system in recognizing dissection layers, nerves, vas deferens, and microvessels during transabdominal preperitoneal inguinal hernia repair (TAPP)
	Cui, Zhao, and Chen (25)	2021	China	Identification of the vas deferens using a CNN model
	Ortenzi et al (29)	2023	Italy	validate the accuracy of the first reported AI-based computer vision algorithm that automatically recognizes surgical steps
Postoperative				
	Gao, Zagadailov, Merchant (30)	2021	USA	development and validation of an artificial neural network (ANN) model for the prediction of surgical outcomes
	O,Brien et al (31)	2021	USA	Developing a machine learning regression model that detects the occurrence of long-term hernia-associated SSTI.
	Wu et al (32)	2023	China	Developing a machine learning (ML)-based model to predict in-hospital VTE in Chinese patients after hernia surgery
	Yan et al (33)	2024	China	Develop and validate, and evaluate ML algorithms for predicting SSI and surgical site occurrences SSO after elective open inguinal hernia surgery

- One of the most significant contributions of artificial intelligence in hernia surgeries lies in its ability to enhance visualization and provide decision support : to identify critical anatomical landmarks, blood vessels, nerves, and other structures that need to be preserved

RESULTS

- AI is being studied to predict postoperative complications in hernia surgery.

AUTHORS	DATATYPE	DATASET SIZE	TEST SIZE	MODEL	METRIC
Nechay, T. V. et al (21)	GPT database	570GB	5 queries	TNN (LLM)	Experts scored the responses lower than non-experts
Takeuchi, Masashi et al (24)	Videos annotated by Certified surgeons	130 Videos	Videos of 160n TAPP procedures	Deep Neural Network based Object Detector	88.3% Agreement on objective evaluation
Choksi, Sarah et al (28)	Robotic Inguinal Hernia Repair videos	211 videos of RIHR	10 inguinal hernia repairs	Computer Vision-DL	Real-time predictions 68.7% average accuracy
Zygomalas, Apollon et al (26)	Annotated Images from TAPP videos	1095 selected annotated images	2716 segmented areas of interest	YOLOv8-DL	Recall rate was above 50% when confidence was less than 70%
Mita, Kazuhito et al (27)	TAPP videos	150 cases of TAPP, Gastrectomy and colectomy	10 TAPP videos	EUREKA-DL	Images without EUREKA visualization, dissection layers recognized and displayed
Cui, Zhao, and Chen (25)	Videos of 35 inguinal Surgery	2,600 Images	1200 images and 6 videos	CNN	94% Accuracy and 92% precision
Ortenzi et al (29)	TEP videos	371 TEP videos	155 TEP Videos	Vision AI Algorithm	Average accuracy of 68.7%
Gao, Zagadailov, Merchant (30)	Data from ACSNSQI	2000 images	1,500 images	ANN	ANN and logistic regression evaluations were comparable
O,Brien et al (31)	Hernia surgeries with mesh from 2008-2015	96,435 Surgeries	40 patients with probability of SSTI	ML	C- statistics 0.929 in the training set and 1.901 in the testing set
Wu et al (32)	Patients who underwent elective hernia surgery 2019-2020	491 patients who underwent hernia surgery	Postoperative Follow-up of the 49q patients	ML	sensitivity=0.769, specificity=0.769, and accuracy=0.769
Yan et al (33)	Patients admitted with Hernia	2,536 patient cohort	320 cases	ML	Acceptable-performing models for pre-operative data had an AUROC≥0.60, including logistic regression, SVM_Linear, TabNet, and RF

- The results of the review clearly show that AI can be applied in the Pre-Operative, Intra-Operative, and Post-Operative Phases of Inguinal Hernia Surgery.

CONCLUSION

The outcome of this study shows that the application of AI in groin hernia surgery is still in its early stages and it is evident that a literature gap in AI application exists. Also, majority of current studies focus heavily on intra-operative application. The study implies that further research is needed and a change in the approach of future research into AI development in groin hernia surgery may yield more effective AI applications.