ARTIFICIAL INTELLIGENCE BASED AUTOMATIC IMAGE RECOGNITION OF ANATOMICAL STRUCTURES AND OPERATIVE FIELDS IN LAPAROSCOPIC HEPATECTOMY.

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Aims

In recent years, there have been a number of reports on the application of computer vision, AI technology using deep learning, to laparoscopic surgery[1-5]. However, there are only a few reports of computer vision in liver surgery. To generate a deep learning model of computer vision , large annotated dataset is needed.

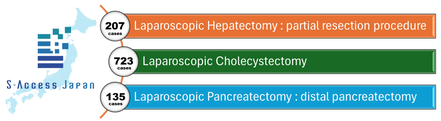
The aim of the study is to construct the large dataset in liver surgery.

Moreover, we aimed to develop novel deep learning models of computer vision by using this dataset, and to examine the feasibility of the models.

Methods

The dataset was constructed as a part of ''S-access Japan'', the project supported by the Japan Agency for Medical Research and Development (Grant Number 20he2102001h0002).

The dataset contains 207 cases of laparoscopic hepatectomy (LH) collected from 22 high volume center of laparoscopic surgery in Japan.



By using this dataset, we developed deep learning model of computer vision in laparoscopic hepatectomy.

We developed the model of automated surgical workflow identification with 40 operative videos.

40 LH videos

We developed the model of automated recognition of the liver transection plane with 20 operative videos.

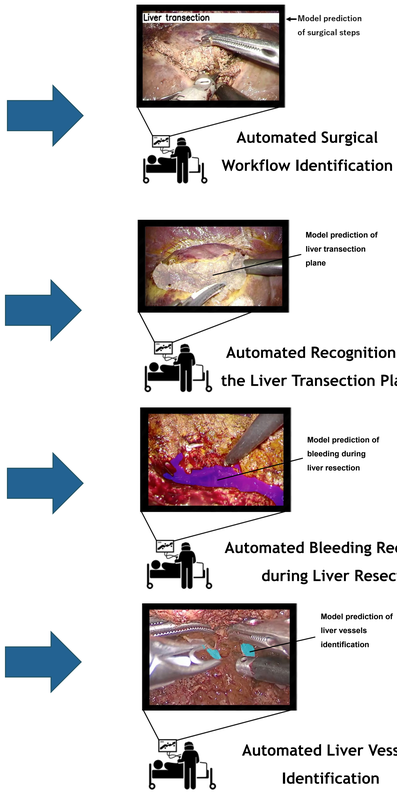
20 LH videos

We developed the model of automated bleeding recognition during liver resection with 44 operative videos.

44 LH videos

We developed the model of automated liver vessels identification with 48 operative videos.

48 LH videos



Results

	model 1			model 2		
Step	Precision	Recall	F1 score	Precision	Recall	F1 score
1: Port insertion	0.819	0.745	0.780	not applicable		
2: Lysis of adhesion	0.905	0.959	0.931	0.905	0.959	0.931
3: Identification of the target lesion using laparoscopic ultrasound and marking the resection line	0.961	0.919	0.939	0.961	0.919	0.939
4: Encircling of the hepatoduodenal ligaments and hepatic inflow-occlusion	0.899	0.934	0.916	0.899	0.934	0.916
5: Mobilization of the liver	0.947	0.937	0.942	0.947	0.937	0.942
6: Liver transection	0.960	0.974	0.967	0.960	0.974	0.967
7: Specimen extraction and closing of the surgical incision	0.828	0.726	0.774	not applicable		
8: Other actions	0.564	0.596	0.579	not applicable		
IP: Invalid Procedure	not applicable			0.899	0.866	0.882
Overall accuracy	0.891			0.937		

Positive Predicted Value	0.89
Sensitivity	0.86
DC Score*	0.88

DC score = 0.76

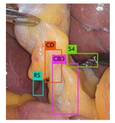
*DC Score: *(2 * Area of Overlap)/(total pixels combined)* =

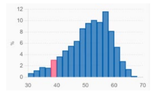
	DC*	
	Hepatic vein	Glissonean pedicle
1st validation	0.636	0.559
2nd validation	0.627	0.443
3rd validation	0.623	0.459
4th validation	0.646	0.520
5th validation	0.625	0.430
Average	0.631	0.482

Discussions

We constructed the large dataset and developed several deep learning models of computer vision in liver surgery. This dataset and models can be applied to generate further novel applications which contribute to the construction of computer-assisted-surgery systems as below.

- Automated surgical assisting system
- Automated surgical skill assessment
- Automated surgical robot and automated laparoscopic camera







Conclusions

We constructed the large dataset in liver surgery. This dataset can be applied to generate further novel deep learning models of computer vision.

References

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