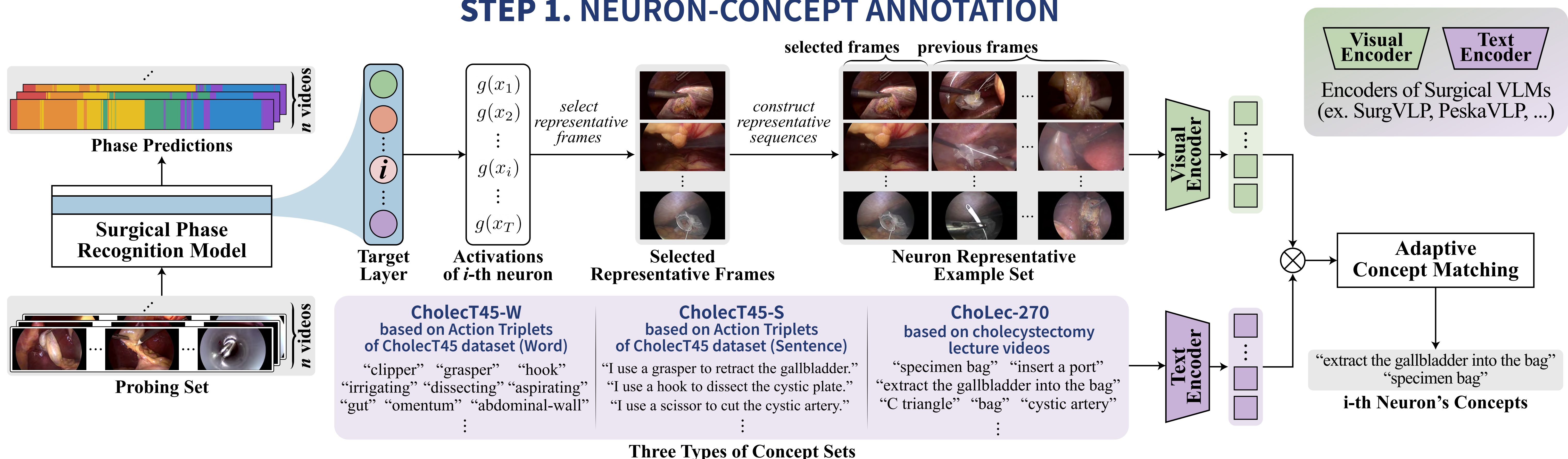
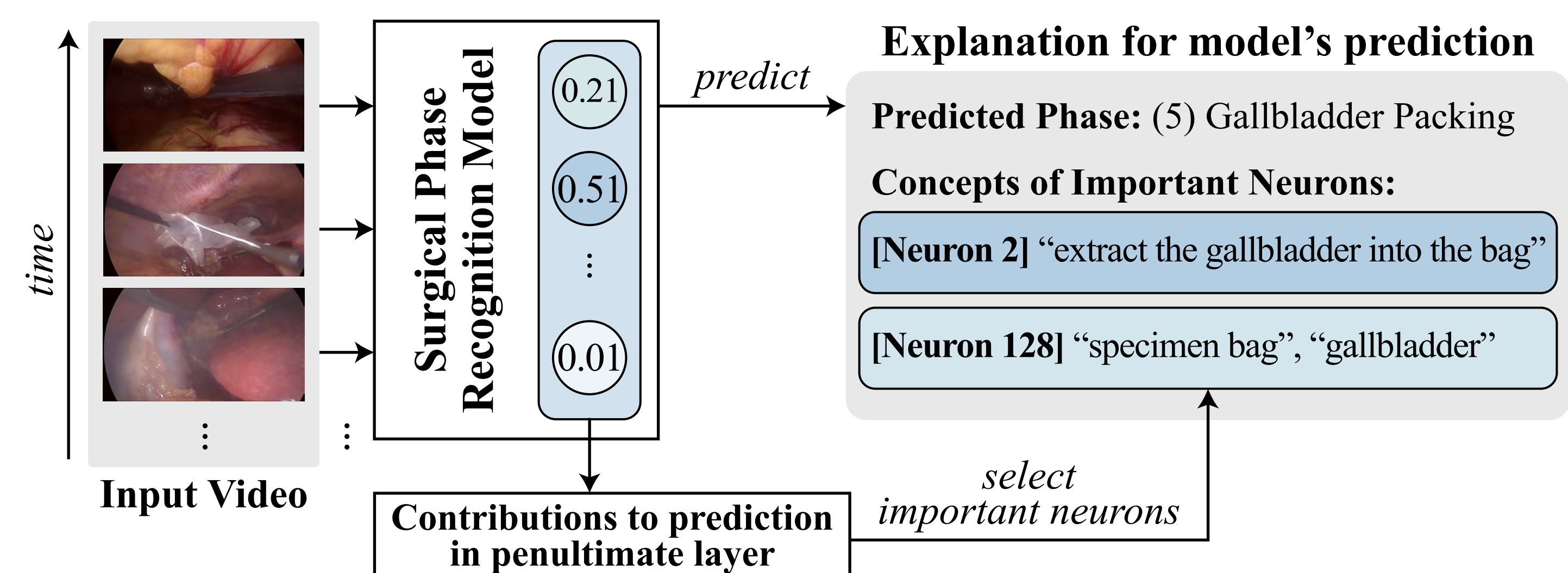


SurgX, A Framework to Explain Surgical Phase Recognition Model

STEP 1. NEURON-CONCEPT ANNOTATION



STEP 2. MODEL'S PREDICTION EXPLANATION



Ablation Studies

- **Concept Alignment:** Cosine similarity between key neuron's concepts and the groundtruth class.
- **Prediction Interpretability:** Cosine similarity between key neuron's concepts and predicted class.

Concept Sets

Concept Set	Concept Alignment			Prediction Interpretability			Unique Concept
	Word	Sentence	Avg	Word	Sentence	Avg	
CholecT45-W	0.4078	0.3681	0.3880	0.5978	0.5099	0.5539	7
CholecT45-S	0.3000	0.4538	0.3769	0.4679	0.5564	0.5122	11
ChoLec-270	0.4153	0.4796	0.4475	0.6532	0.5452	0.5992	34

Neuron Representative Frame Selection

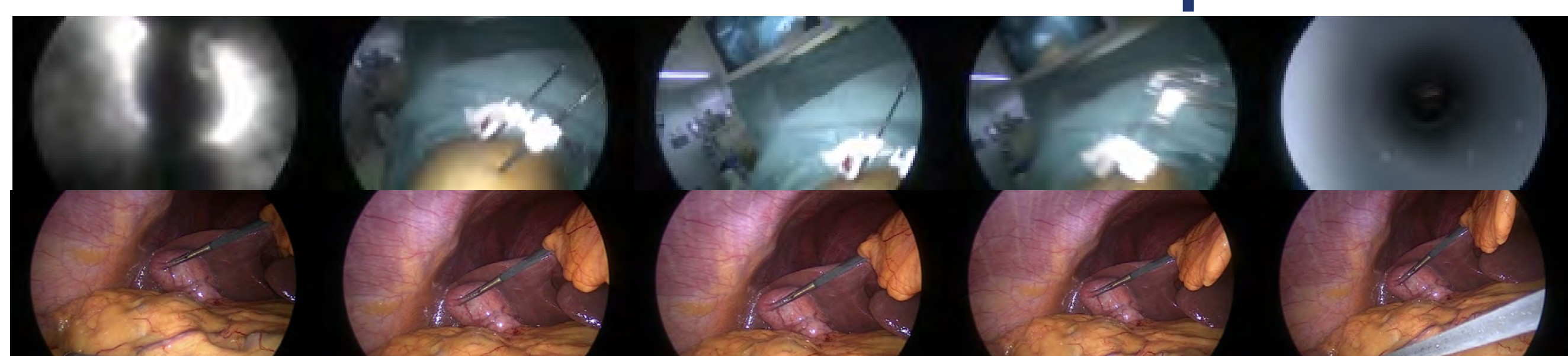
Method	Concept Alignment			Prediction Interpretability		
	Word	Sentence	Avg	Word	Sentence	Avg
Global Threshold	0.3222	0.4621	0.3922	0.5586	0.4819	0.5203
Global TopK	0.3099	0.4622	0.3861	0.5369	0.4531	0.4950
Video-wise Threshold	0.4153	0.4796	0.4475	0.6532	0.5452	0.5992
Video-wise TopK	0.4146	0.4824	0.4485	0.6454	0.5403	0.5929

Neuron Representative Sequence Selection

Method	Concept Alignment			Prediction Interpretability		
	Word	Sentence	Avg	Word	Sentence	Avg
Single-Frame	0.3576	0.4569	0.4073	0.6426	0.5513	0.5970
Contiguous-Sequence	0.3641	0.4711	0.4176	0.6458	0.5487	0.5973
Dilated-Sequence (3)	0.3534	0.4920	0.4227	0.6545	0.5499	0.6022
Dilated-Sequence (5)	0.4153	0.4796	0.4475	0.6532	0.5452	0.5992
Dilated-Sequence (10)	0.3684	0.4004	0.3844	0.6856	0.5548	0.6202

Qualitative Result with Explanation Examples

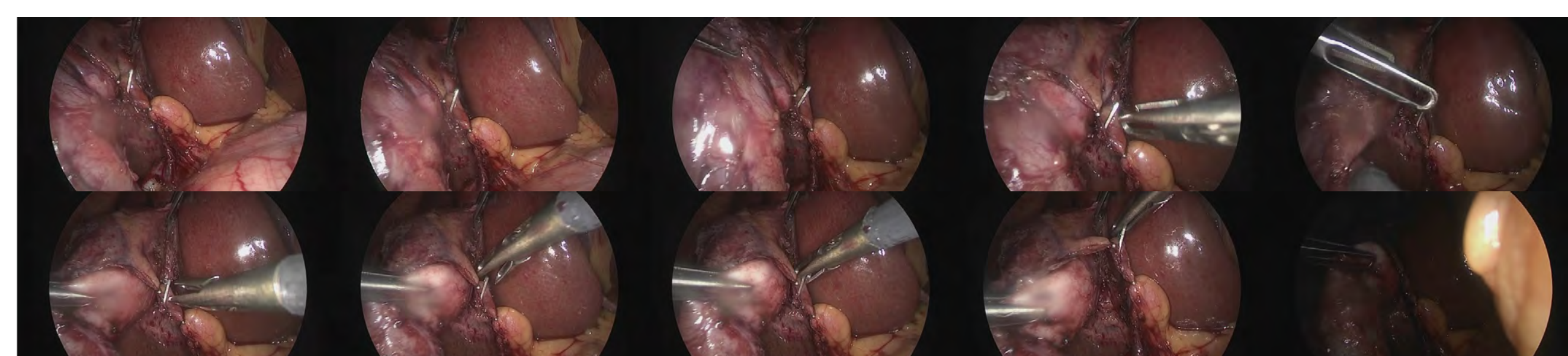
Explanations for Correct Predictions



• GT: (1) Preparation • Pred: (1) Preparation

Key Neuron: #91

“grasping the gallbladder,” “empty the gallbladder,” “insert a port”

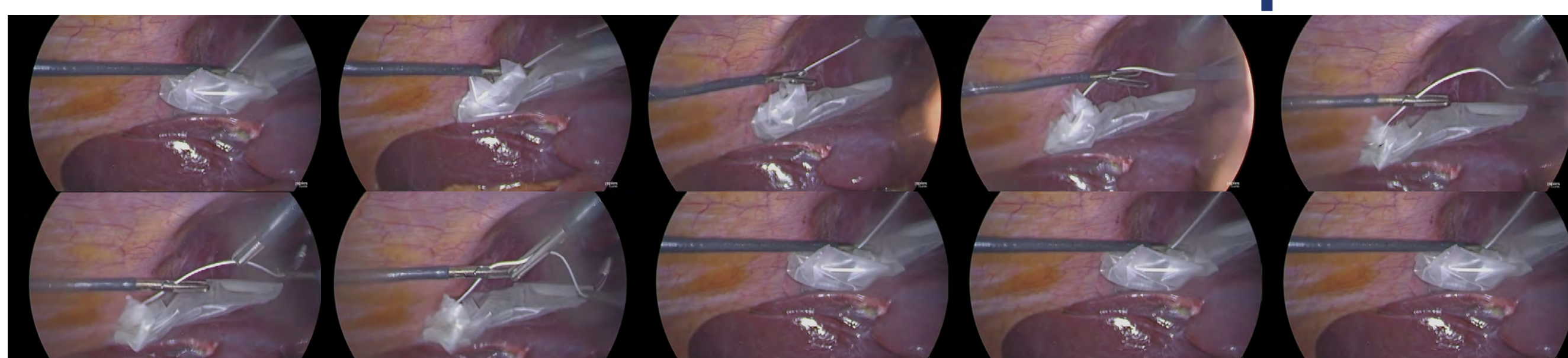


• GT: (3) Clipping and Cutting • Pred: (3) Clipping and Cutting

Key Neuron: #182

“hepatocystic triangle,” “cystic artery is isolated between clips”

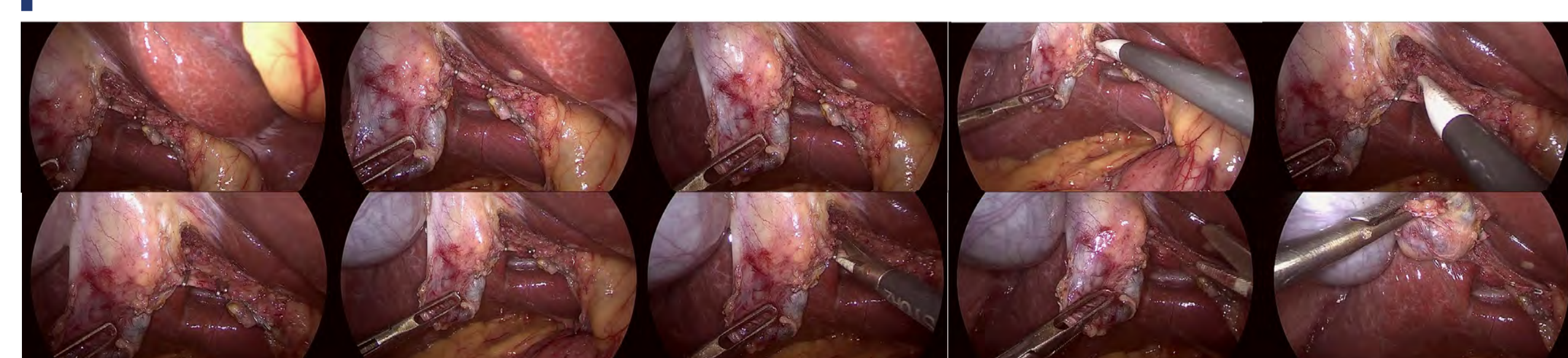
Explanations for Mispredictions



• GT: (6) Cleaning and Coagulation • Pred: (5) Gallbladder Packing

Key Neuron: #250

“extract the gallbladder into the bag”



• GT: (4) Gallbladder Dissection • Pred: (3) Clipping and Cutting

Key Neuron: #182

“hepatocystic triangle,” “cystic artery is isolated between clips”