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# Comparaison de fonctions de coût pour la détection automatique de fil guide sur des images fluoroscopiques de Cholangiopancréatographie Rétrograde Endoscopique

Garance Martin, Aymeric Becq, Isabelle Bloch, Marine Camus, Andrea Pinna, Jérôme Szewczyk

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# Comparison of Loss Functions for Guidewire Automatic Detection on a Limited Dataset of Fluoroscopic Images for Endoscopic Retrograde CholangioPancreatography

Garance MARTIN [garance.martin@lip6.fr], Aymeric BECQ, Isabelle BLOCH, Marine CAMUS, Andrea PINNA, Jérôme SZEWCZYK

## MEDICAL CONTEXT

### Endoscopic Retrograde CholangioPancreatography (ERCP)

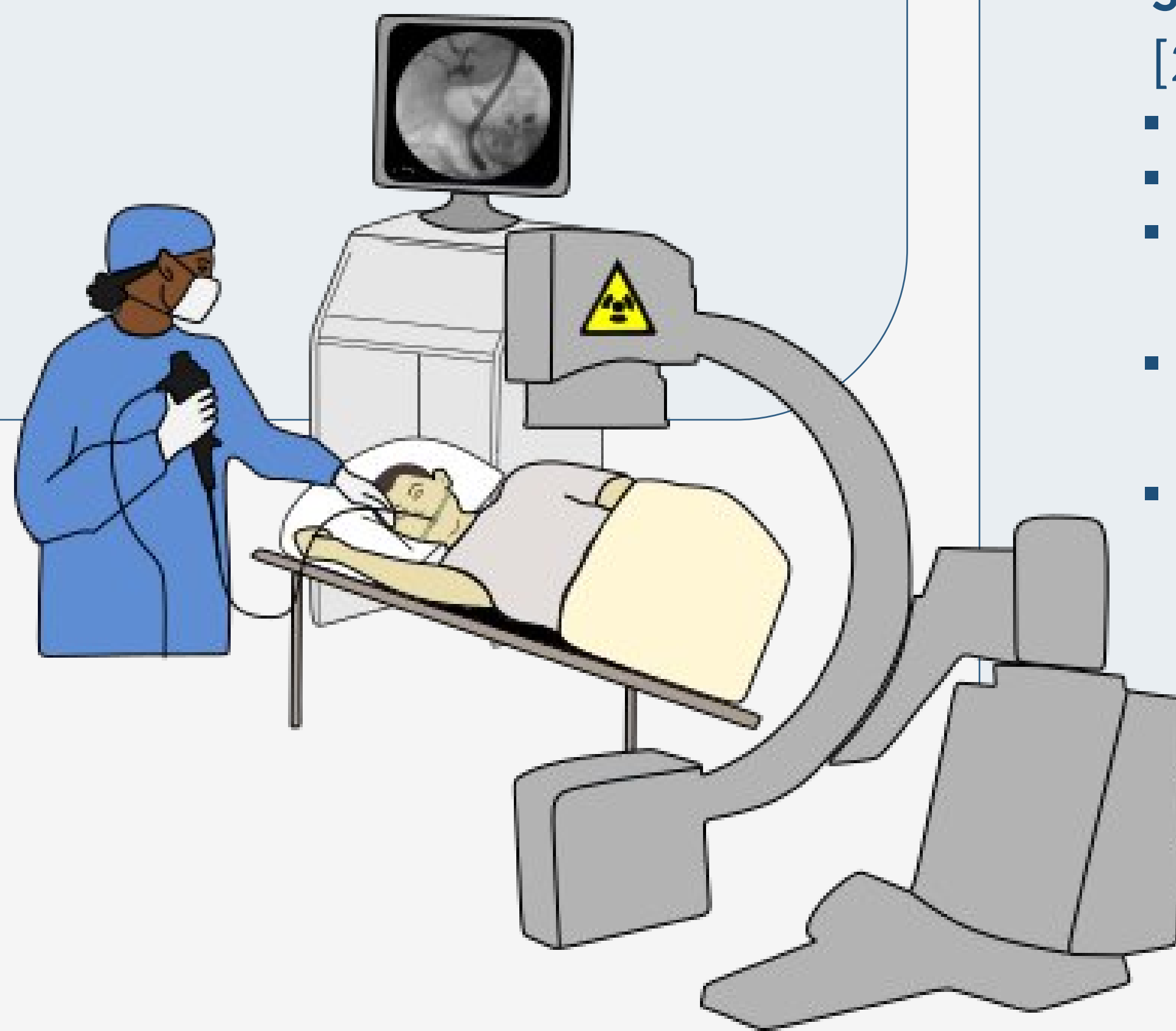
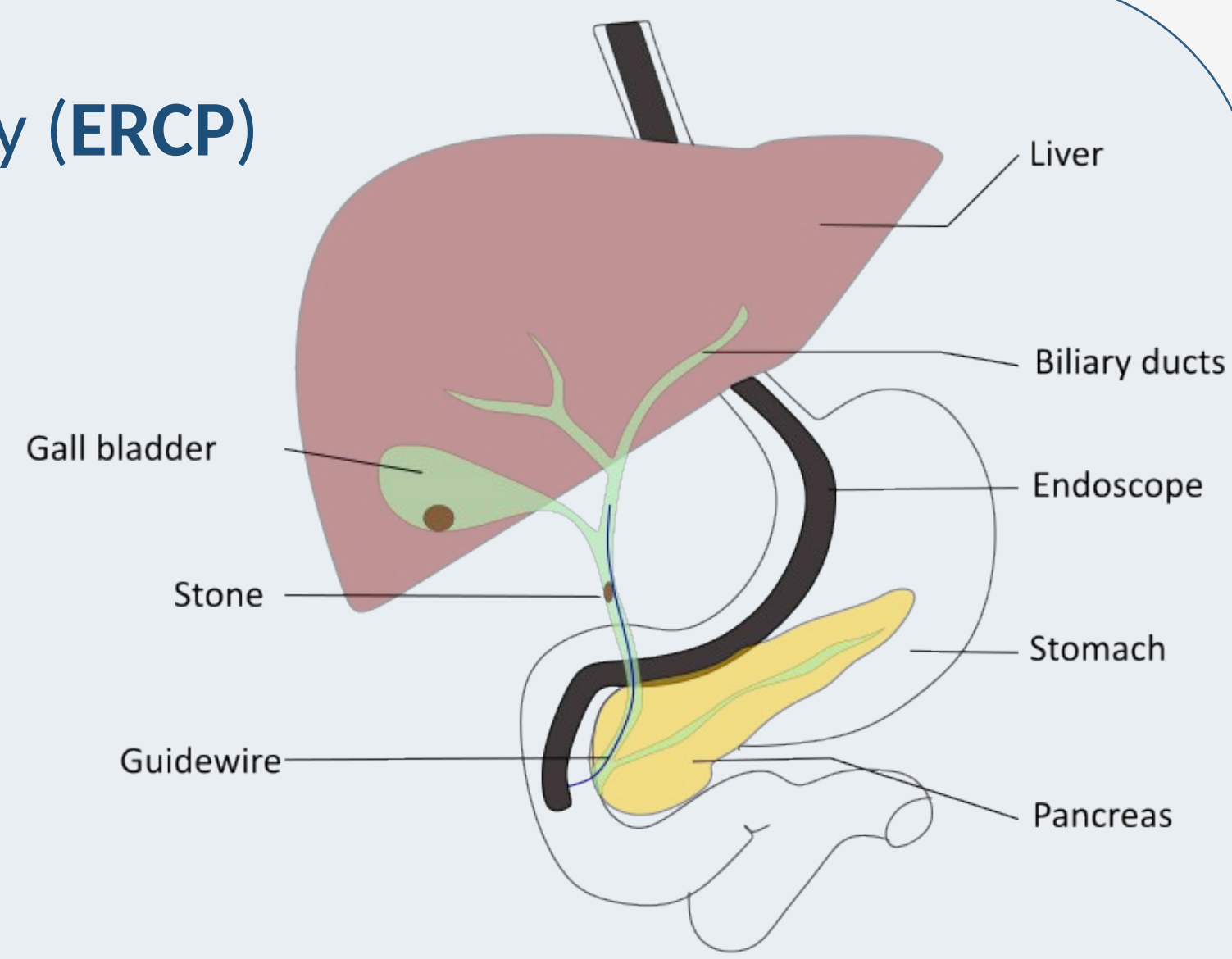
- Draining of the bile ducts
- Minimally invasive procedure

### Problems

- High inter-patient anatomical variability
- Loss of 3D information with 2D X-ray
- Contrast agent increases the risk of cholangitis

### State of the art

- None in ERCP
- Similar field: Endovascular (different images)
- U-Net paired with another method



## METHODS

### 2 Datasets :

- Saint-Antoine (SA)
- Henri Mondor (HM)

Dataset	Image Size	Total nb of images	Train	Validation	Test
SA	1024 x 1024	47	31	6	10
HM	1536 x 1536	73	50	13	10

- Baseline: nnU-Net [1]
- Study of different loss functions with U-Net [2]
  - Dice
  - Dice + Cross Entropy
  - Tversky [3]
    - Weight differently false positives and false negatives
  - Dice + Focal [4]
    - Adapted for class imbalance
  - Dice + Vessel [5]
    - Adapted for segmentation of thin and elongated structures

### Training

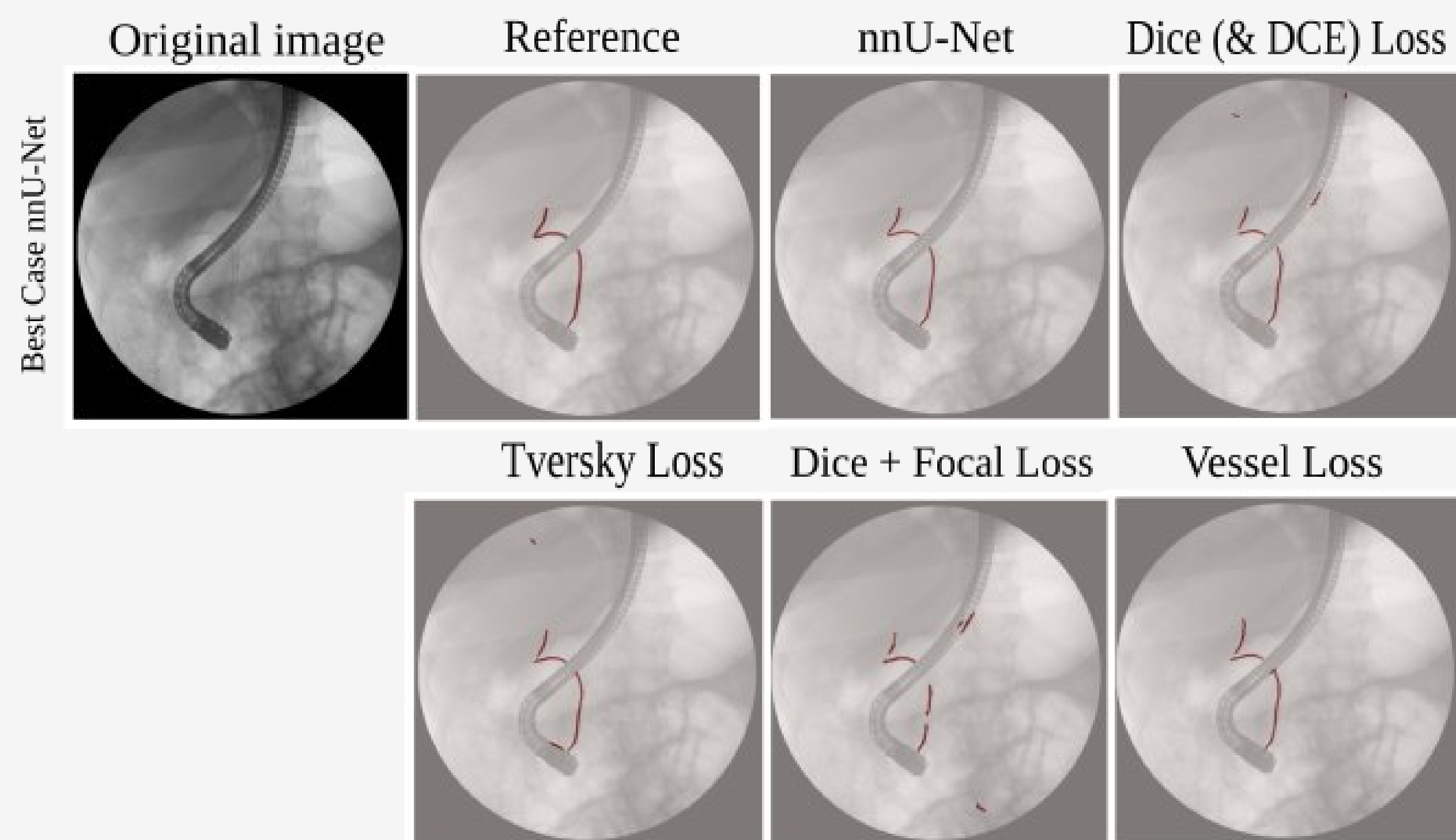
- 3-fold cross-validation
- SA dataset, 500 epochs
- HM dataset pretrained on SA

## OBJECTIVES

To segment the guidewire on 2D X-ray fluoroscopy with a limited dataset with varied loss functions

## RESULTS

### Saint-Antoine Dataset

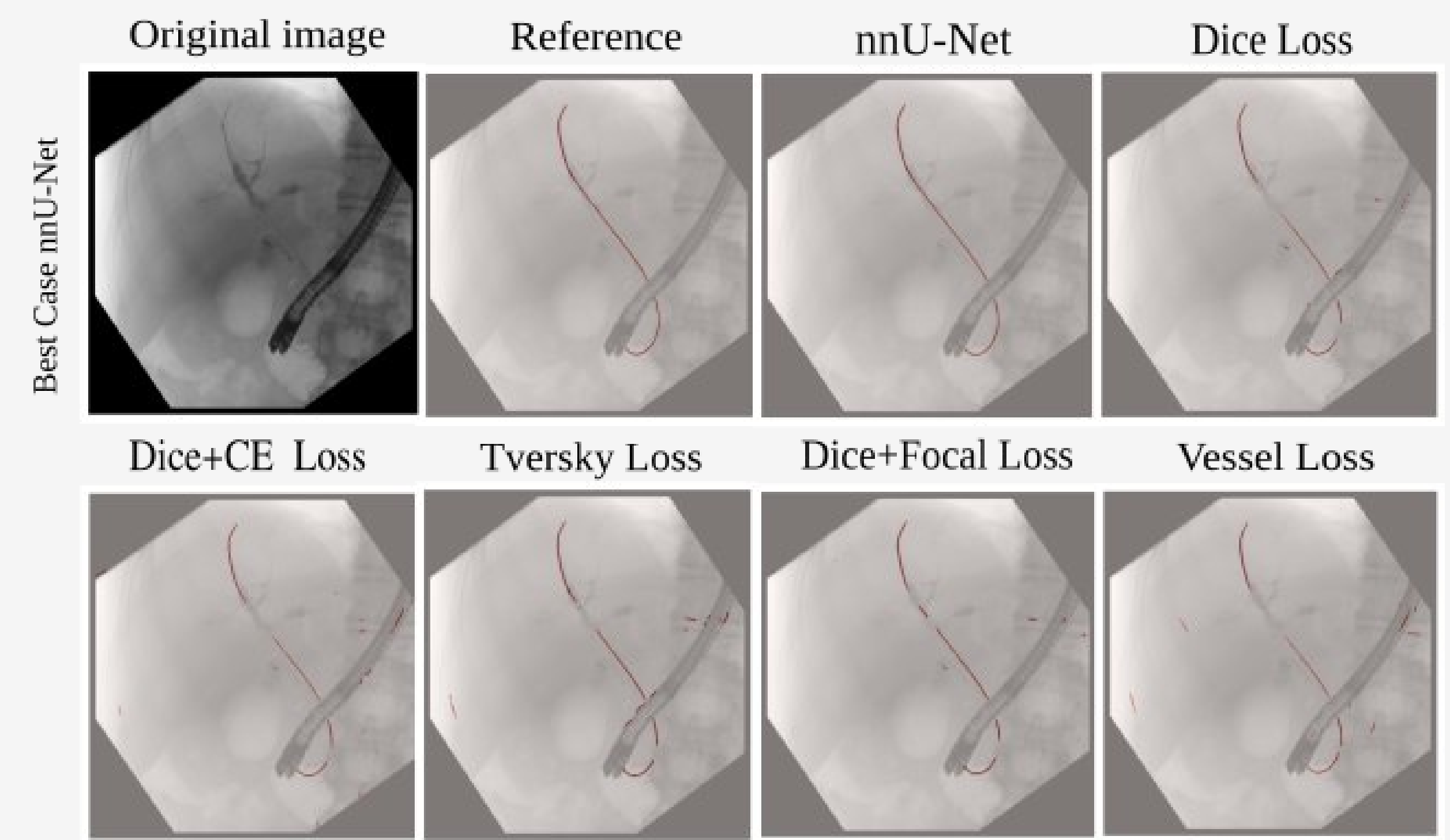


METHOD	DICE	CIDice	TVERSKY	MCC	HD	Diff CC
nnU-Net [1]	0.78 ± 0.04	0.94 ± 0.05	0.74 ± 0.05	0.89 ± 0.02	25 ± 28	1
Dice/Dice + CE	0.59 ± 0.06	0.69 ± 0.09	0.57 ± 0.04	0.80 ± 0.03	336 ± 107	6
Tversky	0.65 ± 0.03	0.76 ± 0.03	0.61 ± 0.03	0.83 ± 0.01	233 ± 45	3
Dice + Focal	0.66 ± 0.03	0.74 ± 0.01	0.64 ± 0.02	0.83 ± 0.01	271 ± 48	4
Dice + Vessel	0.61 ± 0.04	0.72 ± 0.05	0.57 ± 0.03	0.81 ± 0.02	242 ± 71	4

For nnU-Net: Training time = 33 hours & Inference time = 6.2s/ image

For any U-Net with specific loss function: Training time = 3 hours & Inference time = 0.69s/ image

### Henri Mondor Dataset



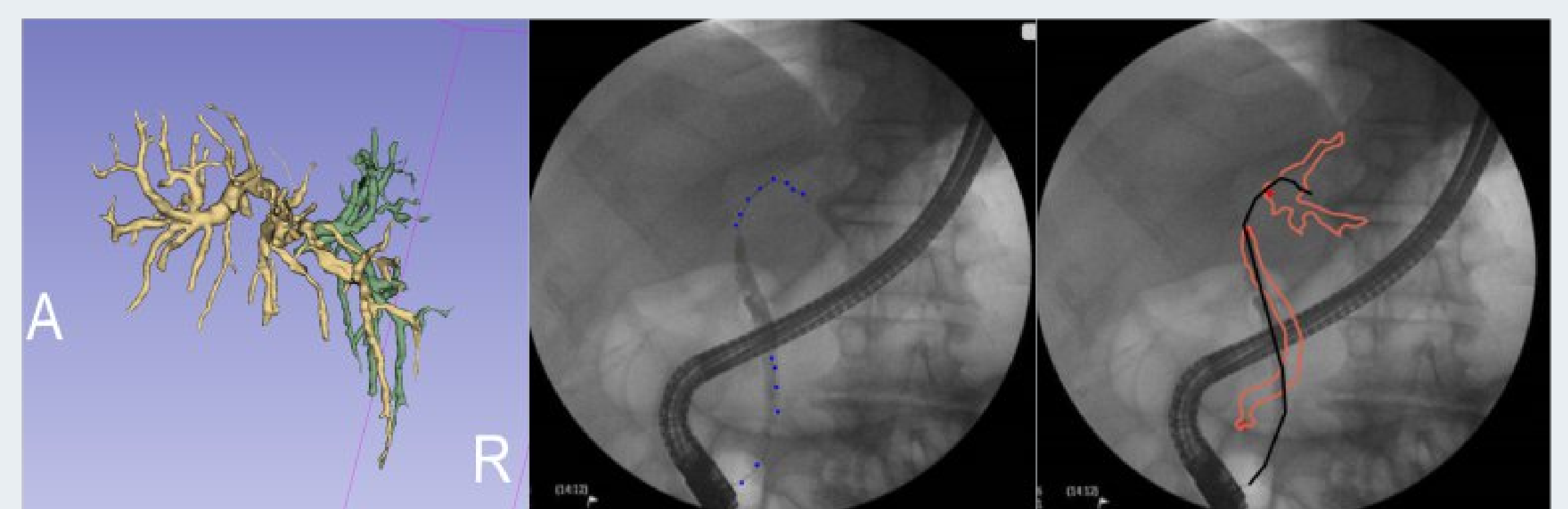
METHOD	DICE	CIDice	TVERSKY	MCC	HD	Diff CC
nnU-Net [1]	0.79 ± 0.05	0.90 ± 0.05	0.79 ± 0.05	0.89 ± 0.03	92 ± 215	2
Dice	0.64 ± 0.04	0.72 ± 0.06	0.60 ± 0.08	0.83 ± 0.02	408 ± 5	6
Dice + CE	0.65 ± 0.01	0.75 ± 0.04	0.63 ± 0.02	0.82 ± 0.01	625 ± 183	7
Tversky	0.58 ± 0.01	0.70 ± 0.05	0.58 ± 0.02	0.79 ± 0.02	619 ± 43	8
Dice + Focal	0.62 ± 0.03	0.70 ± 0.03	0.60 ± 0.04	0.81 ± 0.01	376 ± 40	6
Dice + Vessel	0.61 ± 0.01	0.69 ± 0.01	0.59 ± 0.01	0.81 ± 0.01	582 ± 72	8

For nnU-Net: Training time = 52 hours & Inference time = 9.4 s/ image

For any U-Net with specific loss function: Training time = 4.5 hours & Inference time = 0.98 s/ image

## CONCLUSION & CLINICAL APPLICATION

- Simple and well known method
- Comparison of multiple loss functions
- Reduce training and inference time by 10
- Result of segmentation usable for 2D/3D fusion to predict in which bile duct the guidewire is and improve navigation



### References

[1] Isensee, *Nature Methods*, 2020 [2] Ronneberger, *MICCAI*, 2015 [3] Salehi, *MICCAI*, 2017 [4] Lin, *ICCV*, 2017 [5] La Barbera, *Medical Image Analysis*, 2023