

Medical Image Analysis
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Lecture 22
Endoscopy – Where are we with AI?

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Endoscopy - Where are we with AI?

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Hello guys, I am Vinayak Rengan, I am a general laparoscopic surgeon. And I also run a startup called Curium life where we solve everyday problems in surgery using machine learning, artificial intelligence and deep learning. So, what I essentially do is I operate on the abdomen. I operate on the thyroid, breast. But a majority of my work deals with laparoscopy. So, many people call me a laparoscopic surgeon in some countries, I am called as an endoscopic surgeon. So, we are going to tell you to kind of look into all these terms, what is endoscopy? What is laparoscopy? And kind of going to understand where this field stands with regards to image processing, machine learning, deep learning and everything.

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What is endoscopy?

A long tube to view any hollow organ is called endoscopy

1. Diagnostic
2. Therapeutic

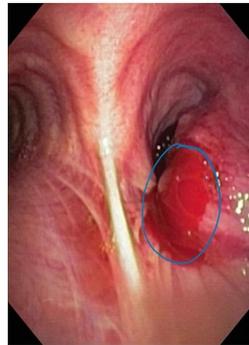


So, endoscopy is a very misunderstood term. You know, there has been a lot of hype, a lot of misconceptions regarding endoscopy. People imagine a scary looking surgeon with sharp instruments poking holes into wherever sharp stuff are not supposed to go, but it is not as scary. It is one of the most commonly done procedures all over the world. And the definition of endoscopy is basically using long tube to view any hollow organ, that hollow organ can be your esophagus, stomach, your small intestine, large intestine, it can be your bronchus or is the bifurcation of the windpipe, it can be even visualising inside the abdomen, what do we call as a peritoneal cavity.

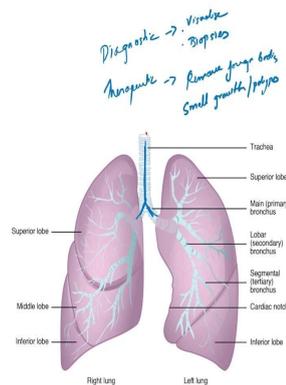
So, there are a lot of terms involved in this a brief understanding of these terms will help you understand the entire industry and give you an overall outlook.

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Bronchoscopy



European respiratory society

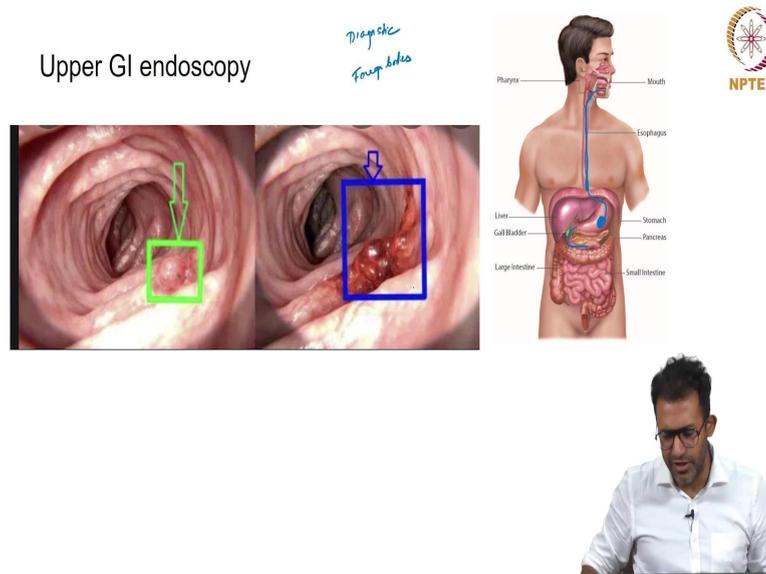


So, what we see here is a bronchoscopy. Bronchoscopy essentially involves passing a tube through your passing a tube through your windpipe, so this bifurcates into what we call as the bronchus. And, you are able to visualize the inside of your windpipe. So, this is a very important modality in an in diagnosing and even ruling out problems such as lung cancer, early lung cancer and also kind of removing foreign bodies. So, again like any forms of endoscopy, it can be the diagnostic or therapeutic.

When I say diagnostic, it means like you are trying to diagnose or find out what the problem is when I say therapeutic. I mean, I am trying to treat what the problem is. So, bronchoscopy can also be diagnostic or therapeutic. So, when I diagnose, I can just visualize what is there, is there a problem, I can take biopsies, these biopsies will be sent to the pathologist and they will tell me whether it is cancer or whether it is something to be scared or not scared, it can be therapeutic, when I say therapeutic, I can remove foreign bodies. I can remove small growths or polyps.

So, what you see here is an image of a lesion at the bifurcation near the bifurcation. So, here you can see that the trachea, the windpipe is bifurcating into the right bronchi and the left bronchi. So, here you see a lesion, it could be a suspicious lesion, it could be cancer, so or it could be something which we do not know and what we are trying to do is we might take a biopsy from there and send it to the pathologist to understand what that is.

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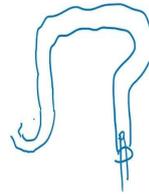
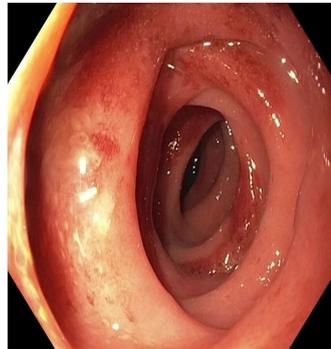
Upper GI endoscopy, upper GI endoscopy is what we traditionally understand our call is endoscopy. When I say endoscopy, what I usually mean is just upper GI endoscopy, that involves putting a tube into your food pipe and it goes into the stomach where I can visualize the stomach and sometimes even early part of the small intestine. Again, it can be diagnostic or therapeutic. When I say diagnostic, you can see if there is a cancer and when I see therapeutic again I can remove foreign bodies, if there in fact, it is kind of advanced so much that if there is a small tear or a perforation was what we call, you can even close those rents through endoscopy.

So, endoscopy has a field is advanced extremely well and now we are, even able to go into the biliary tract which is like the bile duct and the pancreas to remove stones. So, that is all very technical stuff inside endoscopy and that is not something what you going to do. Here what you see is an image is computer vision tool as kind of segmented lesions in an endoscopy.

So, endoscopy because of the huge volumes it has immense applications in the area of machine learning and supervised and unsupervised learning as well. So, here what you can see is a summary as box lesion in both these lesion. And, you can use machine learning and tools to kind of understand what the stuff are.

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Lower GI Endoscopy / Colonoscopy

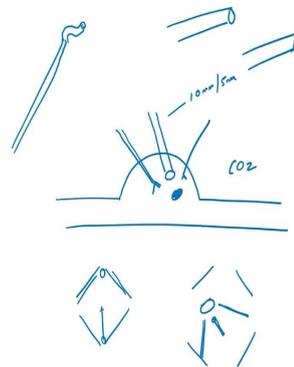


Lower GI endoscopy is traditionally called as colonoscopy it involves passing a tube through your anus and visualising the large intestine. The large intestine leads into the sink, the anus and it involves passing a tube through here and it goes till where the small intestine starts. So, it is a very technically demanding procedure much more demanding than the traditional upper GI endoscopy.

Again, it can be diagnostic or therapeutic, a diagnostic and colonoscopies are performed on a day to day basis. Thousands of them are performed every day in India, and all over the world. It is a very common procedure. In most parts of the world. It is a daycare procedure. It can be therapeutic, you can remove small polyps, and you can do certain small procedures over there through colonoscopy as well.

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Laparoscopy



Laparoscopy, laparoscopy is essentially putting a tube inside the abdomen. That is me on the screen. So, what I am trying to do is I am trying to remove the gallbladder. Gallbladder is the organ just under the liver. And right now since early 90s, laparoscopy has been considered the gold standard for gallbladder surgeries. In many other fields of surgery, laparoscopy is slowly emerging as a gold standard these days, we perform a whole gamut of procedures through laparoscopy. As you can see here, in this particular diagram, this is the abdomen and you inflate the abdomen with gas which is usually carbon dioxide.

And put in a camera, there is usually a 10mm or a 5mm camera. And then you are working ports 2, 3, 4 depending on how you use them. And these can involve graspers, needle holders, you can suture, you can cut stuff, you can remove stuff. There are a whole host of videos available on YouTube or any other platform so you can kind of kind of watch them to understand what really happens in laparoscopy.

There is a lot of physics and optics involved in laparoscopy. We have different types of cameras there are 0 degree cameras. Then we have 30 degree cameras, which kind of allow for greater degree of movement, there are 45 degree cameras, each of them has their own different applications.

There are energy devices which you can push through your laparoscopy there can be electrocautery. And it is a whole different field of physics, surgical electrocautery and surgical energy devices. And these days, we are using laparoscopic ultrasound as well, putting an ultrasound device through your laparoscope and trying to visualize certain cancers

which cannot be visualized through CT or MRI or traditional ultrasound. So, the potential for laparoscopy is immense. And right now, we are doing everything through laparoscopy. A lot of stuff through laparoscopy requires a huge amount of skill and dedication on the part of the learner who to improve his skills in laparoscopy.

And some of the basic principles of laparoscopy is that there is obviously so this is the abdomen. So, I am just going to take the example of a gallbladder. So, here is your gallbladder. So, while approaching an organ, what you essentially follow is the principle of triangulation. So, if this is the gallbladder and you need to approach it, your camera should be angled in this manner in the center and your working instrument should be like this. So, this is essentially called as the baseball diamond configuration, where you kind of approach the target organ, like a baseball diamond, the instruments are here and the camera port is through here. So, I would not I am not going to delve too much into the principles of laparoscopy.

But the major need for the challenge of laparoscopy is that you are not touching the organ with your hands. So, you lose that tactile sensation and for 200 years, 300 years, we have been taught that surgery is a very tactile art you feel the organ you touch the organ and that is something we which we kind of lose with laparoscopy, but what advantage it gives us that it provides a degree of magnification which is not possible with conventional open surgery. So, there are certain advantages, there are certain disadvantages and robotic surgery is a type of laparoscopy in fact, what we call as laparoscopy is straight stick laparoscopy.

So, your instruments are like this. And robotic surgery is not artificial intelligence surgery, there is no robot operating independently and trying to solve problems that is still not allowed anywhere in any part of the world. And I am sure you would also not want a non-human trying to take decisions inside your abdomen as of now I mean, at least I will not. Even though I understand a little bit of AI and surgery as well, I still am not confident enough to trust a machine. So, robotic surgery is essentially a kind of laparoscopy where the principles are same as laparoscopic except that the instrument at the end has a risk like motion.

So, what we call it the degrees of freedom. So, the traditional Robot the most commonly used robot is what we call it the Da Vinci robot produced by intuitive surgical and it has seven degrees of freedom which allows you to kind of manipulate organs it gives you a semi tactile feel and with recent advances in machine learning and artificial influence, the amount of haptic feedback those instruments are giving is also kind of improving.

So, technology is moving in the way to take minimal access surgery. I personally feel that minimal access surgery itself is a misnomer because it is actually maximal access the entry is small, but the access you get is quite maximum. So, it is taking laparoscopic surgery towards, new frontiers, we are able to come as close to open surgery as possible along with the advantages of open surgery such as tactile sensation. So, a lot of effort is devoted into understanding the structure of organs are we touching the right organ are we cutting the right organ.

So, that is an area of research in which my team is also closely involved with IIT Madras in trying to implement scoring systems in laparoscopy and in endoscopy where we try to assess surgical performance, we try to assess whether the surgeon has correctly executed a set of steps which lead into safer surgery. So, the ultimate beneficiary in all these experiments is the patient because laparoscopy has changed the way surgeries being performed all over the world, we do have patients going back home or going back to work, my own father was operated using laparoscopy and he was back to work in about 2 to 3 days and that would be something unimaginable 20 years ago, where we were using conventional surgery.

And if you had the conventional surgery, it is you will be out of work for at least 20 days, 15, 20 days. So, the perceptions of laparoscopy and endoscopy are changing throughout the world, especially in the field of intervention. There was a time when laparoscopy was considered a surgery for the rich, advanced devices and the same. And the thing with the fact is that laparoscopy has the potential and the need not just in the well-off population, it serves the poorest of the poor, because the rich man can afford to stay out of work for 15 days. A poor man, a daily laborer cannot afford to stay out of work for even if the state even if the government is providing surgeries free of cost, which is the case in India, we have a public health care system, which is pretty good.

We are performing all the surgeries in the public healthcare system, I was trained in a public health care system, and all the surgeries are being performed. The biggest beneficiary is the poor people because they are able to return back to work faster. And I think that is pushing this field further.

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Why do I need to know about this?



CT/MRI have been the foundation of AI in medical imaging

Last few years - more endoscopic data and laparoscopic data

Very less advances in the area of endoscopic imaging and ML/DL



So, why do I need to know about all this? Most of you guys are engineers who are trying to get into medical imaging, medical image processing and understanding medical data. So, for the past 10 to 15 years as AI has grown CT and MRI has been the foundation of artificial intelligence, we have had tangible images, we have been able to extract ground truth easily in CT's and MRI's because you are able to label the data, the data is more reliable, the data is less operator dependent, unlike endoscopy laparoscopy because there is a lot of operative dependence, the way I handle the camera is going to be very different from the way my other surgeon handles it.

The way I place the instruments is going to be very different. I have might have my own personal preferences. But that is not the case in CT or MRI, where the machine takes a scan and the only the interpretation is left to the radiologist and that is where AI has played a major role. But over the last few years endoscopy and laparoscopy as kind of the amount of cases has exponentially increased. As more surgeons are having access to laparoscopic and endoscopy the previous generation of surgeons about 10 years older than me, they never trained in laparoscopy.

But when I was training at Madras Medical College, laparoscopy had become pretty standard. And when my juniors are being trained right now, they have more access to laparoscopy, because the costs are decreasing as well. And but there have been very few advances in the area of endoscopic imaging and machine learning and deep learning because these are new fields. So, if you look at most of the papers, most of these papers are from 2017-18. And

since, the COVID 2020 to 22 we have seen an explosion of research in this particular field, but it is still a very nascent field and there are a lot of work to be done.

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Review > Gut. 2020 Nov;69(11):2035-2045. doi: 10.1136/gutjnl-2019-320466.
Epub 2020 May 11.

Machine learning in GI endoscopy: practical guidance in how to interpret a novel field

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PMID: 32393540 PMCID: PMC7569393 DOI: 10.1136/gutjnl-2019-320466
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> VideoGIE. 2020 Nov 9;5(12):598-613. doi: 10.1016/j.vgie.2020.08.013. eCollection 2020 Dec.

Artificial intelligence in gastrointestinal endoscopy

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PMID: 33319126 PMCID: PMC7732722 DOI: 10.1016/j.vgie.2020.08.013
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doi: 10.3748/wjg.v24.i45.5057.

Methodology to develop machine learn algorithms to improve performance in gastrointestinal endoscopy

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Affiliations + expand
PMID: 30668383 PMCID: PMC6288655 DOI: 10.3748/wjg.v24.i45.5057
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So, here you can see a lot of papers. So, most of these papers are in 2020 or so. So, a lot of papers are coming up. These are all clinical journals. These are not technical journals, which talk about machine learning in GI endoscopy GI is gastrointestinal endoscopy and how endoscope is using machine learning and deep learning to understand these concepts. One of the major challenges which has been in adoption is that clinicians are have not kind of warmed up to the idea of using artificial intelligence for diagnosis. There is still a lot of resistance among the clinicians to using artificial intelligence techniques.

There is a lot of there is a huge perception that how can a machine understand a diagnosis or a cancer or a particular polyp better than a human and evidence has been conclusively mounting that machine learning techniques how are kind of improving and are proving to be better than clinicians in understanding endoscopy and thus making endoscopic diagnosis.

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Computer vision in Endoscopy



1. Computer-assisted detection (CADe) for lesion detection
2. Computer-assisted diagnosis (CADx) for optical biopsy and lesion characterization.
3. Others - guidance systems for scope negotiation

Review > Chin Med J (Engl). 2020 Feb 5;133(3):326-334.
doi: 10.1097/CM9.0000000000000623.

Artificial intelligence in gastrointestinal endoscopy: general overview

Ahmad El Hajjar¹, Jean-François Rey



So, computer vision and endoscopy, it can be computer aided detection, which is for lesion detection, which we call as CADe or computer aided diagnosis which is can be called as CADx for optical biopsy and lesion characterization. There are other roles of computer vision endoscopy, such as guidance systems, like for example, if you are finding difficult to negotiate the scope through narrow spaces, AI can kind of help in understanding that.

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Esophageal cancer screening



High grade dysplasia - major risk factor for cancer

A biopsy protocol consisting of 4 quadrant jumbo biopsies (every 1 cm) with biopsies of mucosal abnormalities (the Seattle protocol)

Comparative Study > Clin Gastroenterol Hepatol. 2009 Jun;7(6):653-8; quiz 606.
doi: 10.1016/j.cgh.2008.11.024. Epub 2008 Dec 13.

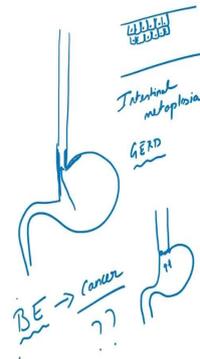
The Seattle protocol does not more reliably predict the detection of cancer at the time of esophagectomy than a less intensive surveillance protocol

Revital Kariv¹, Thomas P Plessec, John R Goldblum, Editorial > Clin Gastroenterol Hepatol. 2009 Jun;7(6):610-2. doi: 10.1016/j.cgh.2009.02.012.
Epub 2009 Feb 24.

Declaration of bankruptcy for four-quadrant biopsies in Barrett's esophagus?

Oliver Pech





So, we are going to discuss a clinical problem. So, we are going to discuss a problem called Barrett's esophagus or intestinal metaplasia, also called as high grade dysplasia, it is basically what you have to kind of understand here is that this is the esophagus and it kind of leads into the stomach. So, the insides of these tubes are lined by cells which are called as epithelium, these can be these can be multi layered depending on which part of the intestine or organ we are talking about.

So, in patients who have a huge amount of acidity or gastroesophageal reflux disease GERD gastroesophageal reflux disease, what kind of happens is that the acid which is being produced in the stomach and early part of the small intestine, kind of reflexes back into the esophagus.

There is usually a mechanism which prevents that there are valves there is a sphincter, which kind of, there is a muscle basically, which kind of contracts when the esophagus when it is in resting state which prevents this reflex from happening. So, but when these muscles are these sphincter gets sort of relaxed due to multiple reasons, whether it can be due to in excess production of acid it can be due to a whole host of factors, including genetic factors, this acid can reflect back and kind of damage the epithelium over here. So, what happens is that the epithelium of the lower esophagus starts resembling the epithelium of the stomach.

So, this is called as intestinal metaplasia. So, this can predisposed to cancer. So, this intestinal metaplasia is called as Barrett's esophagus, in short, called as BE, this BE can progress into cancer. The type of cancer, variety of cancer is way beyond the scope of this particular discussion. So, how do you know whether it is Barrett's esophagus or whether it is cancer?

You look at this particular image, how do I know which part of the intestine could be cancer? So the cancer could be over here, it could be it grows this small thing. It could be over here. It could be over here. It could be over here. It could be over here.

Honestly, looking at this particular image, I am not able to find out where this particular Barrett's esophagus could have cancer. And to understand that they have devised something called as a Seattle protocol. Seattle protocol consists of four quadrant jumbo biopsies, every one centimeter with biopsies of mucosal abnormalities. So, for example, if kind of see this Barrett's esophagus area, this entire demarcated area, where the color change. So, this kind, if you look at it under the microscope, it kind of resembles how the stomach could be inside. And this is the lower esophagus, the muscles contracting which prevents reflux, but there is this muscle complex has kind of gotten loose.

And, it is allowing the acid to come into the esophagus. I think everybody would have kind of felt that you have a heart that heartburn after you had a whole plate of biryani at 1:00 am, along with some beer or coke. I think that is what if it happens on a regular basis, and you kind of tune your diet to that particular modality. It is bound to happen. And that is not very healthy, by the way. So, what the Seattle protocol kind of does is that it goes every one centimeter distance and takes biopsies in every four quadrants, here, here, here, and then another one centimeter here, here, here. So, this is the Seattle protocol.

And that has been followed for multiple years because we never have a way of determining where the cancer could be. But you look at these studies, this is as early as 2008 and 2009. Seattle protocol does not reliably predict the detection of cancer at the time of esophagectomy than a less intensive surveillance protocol. Right then there is a 2009 paper which is even more kind of striking on the face, declaration of bankruptcy for four-quadrant biopsies in Barrett's esophagus. So, is it really obsolete? Not yet because we kind of not have started using machine learning and deep learning in a big extent big way.

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> Gastrointest Endosc. 2017 Nov;86(5):839-846. doi: 10.1016/j.gie.2017.03.011. Epub 2017 Mar 16.



Computer-aided detection of early Barrett's neoplasia using volumetric laser endomicroscopy

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Volumetric laser endomicroscopy (VLE) is an advanced imaging system that provides a near-microscopic resolution scan of the esophageal wall layers up to 3 mm deep.



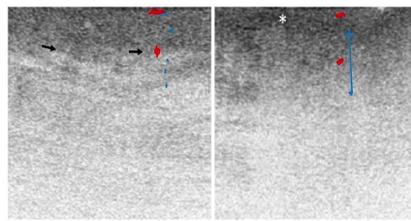
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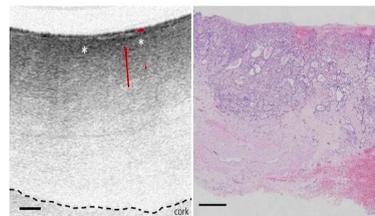
So, here is this paper, this is 2017 paper Computer aided detection of early Barrett's neoplasia using volumetric laser endomicroscopy, this was published in a top journal in our field Gastrointest endoscopy. So, what we hear us here is a type of endoscopy called as volumetric endomicroscopy, which is a kind of microscopy which is performed through the endoscope, where you get an advanced imaging, which provides near microscopic resolution of the abdominal wall layers, sorry, the individual wall layers.

So, esophagus is divided into multiple layers. So, what you see over here on the, what you would see on the endoscopy would be the mucosa there is something called as a submucosa there are multiple lymphatics lymph channels, there are muscle coats, muscle layers, which are kind of this thing. Understanding the anatomy is very essential, and if you look at this, it kind of under makes you understand what are the layers of the thing? So, here is the layer closest. So, you go these are layers which are deeper and here what you can see is the muscle layer. So, basically it provides an extremely high resolution of what you see in an endoscopy.

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Examples of normalized VLE images, containing NDBE (A) and neoplasia (EAC) (B) on corresponding histology. In (A) a layered pattern is visible (arrows). In (B) lack of layering is visible and a higher surface than subsurface signal (asterisk).



Example of a VLE image showing lack of layering and a surface VLE signal that is higher than subsurface signal (asterisks) (A), corresponding with EAC on histology (B). The dotted line represents separation between cork and EAC, early adenocarcinoma; VLE, volumetric endomicroscopy. Scale bars represent 500



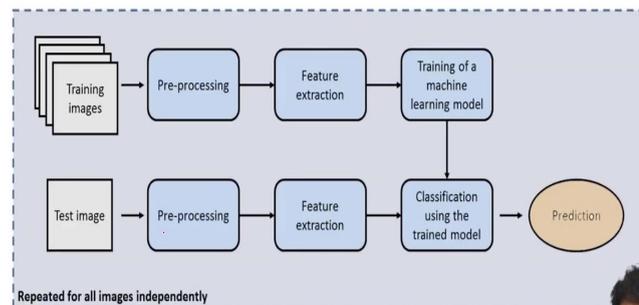
So, one of the changes in malignancy would be the loss of layering and higher surface than subsurface signal intensity. If you look at this particular image, this is the what do you NDBE is non dysplastic Barrett's esophagus, when I say non dysplastic Barrett's esophagus, it means that Barrett's esophagus, which is not kind of become cancer, and EAC is esophageal adenocarcinoma, which is the doctor speak for saying, esophageal cancer. And adenocarcinoma is a type of cancer, there are multiple types of cancers by the way, just saying adenocarcinoma does not kind of correlate all types of cancer.

And so, if you look at this particular image, you will see that the VLE images show that the esophagus is arranged in layers, there is a layer over here, there is a layer over here, there is a layer here, and there is a layer here, here, here, here. So, these are multiple layers, which you can see, if you look at this particular image, the layering is not very clearly visible, this layering is not very clearly visible. And if you look at the intensity on the surface, this is the surface, and this is the subsurface, the difference is there. But if you look over here, in this particular image, the difference in signal intensity is pretty significant. In image B it is much more darker, the signals are higher in on the surface, the difference is remarkably visible.

So, in this particular image, again, you can see the same, see the same thing, there is a lack of layering over here, and the signal intensity on the surface is higher over here. So, basically, using image processing techniques, what we kind of what they did in this particular study is they analyze those features and extracted data of these particular features, which is the

presence or absence of layering. And the difference in signal intensities between surface and subsurface, I will not be getting into the technical details, the papers are available.

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And then, they use that into and fit that information into a machine learning model. So, the training images were preprocessed to remove low quality images and then the features were extracted. So, they took these two features, which is the signal difference, the signal intensity difference and the presence or absence of layering and defendant into a model. There was classification again using all these models, they were able to predict the presence of cancers. And that accuracy is compared to the gold standard, which is a surgeon measuring the images or extracting those features, as well as the actual gold standard is the biopsy specimens, where you are able to confirm whether there is actual cancer or not.

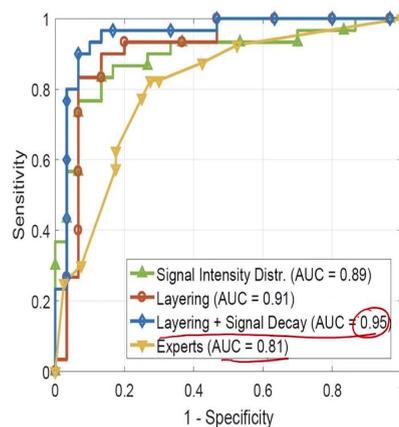
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Machine learning methods	Generic image analysis features				Clinically inspired features		
	1 (Gray-Level Co-occurrence Matrices)	2 (Local Binary Patterns)	3 (Histogram of Oriented Gradients)	4 (Wavelet transform ²¹)	Layering	Signal intensity distribution	Layering and signal decay statistics
1 (Support Vector Machine)	0.65	0.70	0.72	0.74	0.80	0.82	0.81
2 (Discriminant Analysis)	0.59	0.70	0.70	0.69	0.75	0.74	0.74
3 (AdaBoost)	0.68	0.64	0.61	0.70	0.84	0.90	0.91
4 (Random Forest)	0.66	0.64	0.72	0.63	0.75	0.83	0.81
5 (k-Nearest Neighbors)	0.63	0.68	0.64	0.64	0.80	0.77	0.61
6 (Naive Bayes)	0.53	X	X	0.67	0.73	X	0.73
7 (Linear Regression)	0.59	0.57	X	0.70	0.72	0.62	0.72
8 (Logistic Regression)	0.57	0.61	X	0.65	0.71	X	0.73



So, these were the machine learning models used. So, the most successful models are highlighted in grey. So, SVM support vector machine and AdaBoost kind of proved to be very effective. And when they use tested using just layering and signal intensity distribution. But when they found that, they were able to combine both layering and signal decay statistics, the AUC was pretty high and in AdaBoost and support vector machine.

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So, this is the area under the curve. So, experts demonstrated an area under the curve of 0.81. And when you are using both layering and signal decay, the area under the curve was 0.95, which proved that the experts were kind of significantly less effective than the machine learning models.

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Results

The sensitivity of the optimal feature "layering and signal decay statistics" was 90%, with a specificity of 93%.

The features "layering" and "signal intensity distribution" showed a sensitivity and specificity of 83% and 93%, and 83% and 87%, respectively.



So, the results when the sensitivity of optimal features is layering and signal decay statistics was 90% and the specificity was 93%. And when you are using layering and signal intensity distribution, it showed a specificity sensitivity and specificity of 83% and 93% and 83% and 87% respectively.

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Other Examples

Stomach

- (1) CADx for EGC diagnosis
- (2) CADx for cancer staging and estimation of invasion depth.
- (3) AI systems for automated lesion delineation.
- (4) AI systems for Helicobacter pylori (H. pylori) infection prediction.

Colon

- (1) CADE for polyp detection and identification.
- (2) CADx for polyp characterization and classification (also called optical biopsy or histology prediction).
- (3) CADx for mucosal inflammatory activity prediction in inflammatory bowel disease (IBD) patients.[]



So, there are a huge number of advantages. So, what you saw was just one of the examples of how you can use artificial intelligence and DAML. In understanding and helping early diagnosis, the benefits are pretty high. If you detect an esophageal adenocarcinoma earlier on, you are able to perform a surgery, you are able to avoid sometimes life threatening palliative chemotherapy, and you are able to remove only that lesion and kind of escape doing an

esophagectomy. An esophagectomy is a very difficult, very technically demanding and a very amorphous morbid procedure where you remove a significant part of the esophagectomy and sometimes the entire esophagus.

Create a new esophagus using a stomach or the colon, 6, 7, sometimes even 10 hours surgeries with very poor outcomes in certain cases. Of course, with advances in surgery, many of these surgeries are also being performed safely. But once the cancer kind of infiltrates into the layers, so as the staging of the cancers is kind of done in layers. So, if you can see, this is the lumen, this is what you is your food pipe and these are the layers and as the cancer, kind of infiltrates deeper into the layers, the prognosis becomes poorer and poorer because as it grows deeper, it kind of spreads into the lymphatics it spreads into other parts of the body as well. The cancers can tend to metastasize.

So, it is extremely essential that we kind of arrive at an early diagnosis. Much of the research in endoscopy has been done in Japan, which has a very effective screening program for early gastric cancer. So, the tradition in Japan is that on the 30th birthday, everybody gets an endoscopy done. For diagnosis so much of the research has been performed in Japan for especially gastric cancer, what he calls the EGC, early gastric cancer, and there is a computer's diagnosis for early gastric cancer diagnosis. If you have an early gastric cancer diagnosis, you can actually treat it by endoscopic mucosal resection, where you kind of go through endoscopy itself and can you remove the cancer and come out.

How nice that is, having a very deadly disease like gastric cancer. And, you go in the morning, I have gastric cancer. The surgeon kind of identifies the gastric cancer takes a biopsy confirms it, 3, 4 days later, you go in, same endoscopy go in the morning, come back in the evening, your cancer is cured. And that is so beautiful. Imagine if the patient comes back 3 or 4 months down the line, he has to undergo what we call as a gastrectomy where we remove a part of the stomach. We remove a part of the small intestine as well, because the cancer usually spreads along over there you have to remove a whole host of lymphatics in the abdomen. The surgery operating time for the D2 gastrectomy is usually at least 4 to 6 hours.

It can be done laparoscopically again, but the challenge is still are their survival rates are still hovering between 60 to 90 percent, depending on the center and imagine in centers where there is a 60 percent survival rate. It essentially means that you delay the diagnosis by 3 months, and 40 out of 100 people are going to succumb to the diagnosis. The gastric cancer would have kind of spread many times we go into the abdomen, we find that the cancer has

spread to the liver, it has spread to other parts of the intestine, it has spread inside the abdomen completely. And then we tell the patient and the attender it is a very difficult scenario.

Because you are not you may not make it your mother or father or your sometimes very sadly, you have to tell the parents that their son is going to die of cancer within the next few months. And, I think that is completely avoidable. Early diagnosis in this particular era is possible. And it becomes kind of inexcusable if we miss diagnosis. And that is where the role of engineer machine learning experts kind of comes into play. It can be used for cancer staging and estimation of invasion depth, many times you can you put an endoscope, you will see the cancer over there. But you do not know how inside it has gone. So, you have a cancer over here you do not know how much inside it has gone into the surface.

So, this helps us in staging the disease. So, if it does kind of reach over there, you can say that it has become a T for lesion or sometimes a stage 4 lesion and the patient may height have a poor survival. So, the entire survival of the patient depends on where the cancer is. If the cancer is over here, it is good. If the cancer is over here, it is it is slightly bad if it is over here even more bad. And if it goes over here, it becomes really bad. And it just a matter of few millimeters. And the role of early diagnosis kind of plays a role.

And even if we are not able to make an early diagnosis, understanding the depth of penetration helps us in having a meaningful discussion with the patients about their survival. And, that is where important in this particular era. In the lower GI area, we can use computer aided detection for polyp detection and identification. We can use it for the polyp characterization and classification. And, you can use it for predicting mucosal inflammatory activity in inflammatory bowel disease. Inflammatory bowel disease, you might have heard of it Crohn's disease and ulcerative colitis. These are all not cancers. These can lead to cancers in certain cases. But these are all very potentially painful condition that, affects a patient's life from 15, 20 years. They reduce the quality of life I know of many doctors who kind of suffer from these lesions, we can use them for mucosal inflammatory activity prediction.

And, that mucosal inflammatory activity understanding that helps us in understanding what medications to give. Some of the medications we give for Ulcerative Colitis and Crohn's disease also have a huge amount of side effects. So, they will give a lot of steroids to treat

them. So, understanding the exact level of inflammatory activity helps us in tapering and adjusting the dose so that we can free the patients with the side effects of these drugs.

(Refer Slide Time: 31:06)

The Future

Endoscopy as we know is changing rapidly

Considerable efficiency and reliability in GI endoscopy

AI is the future in endoscopy



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The future of endoscopy as we know is changing rapidly. There is growing acceptance of the efficiency and reliability of artificial intelligence in GI endoscopy and I sincerely believe that AI is the future in endoscopy and laparoscopy. In the next session, we will be discussing more about laparoscopy in detail and how we are able to use laparoscopy to make patient's lives safer and better. Thank you. Here are the references for the presentation. Thank you so much.