Detection of Coronary Artery Diseases with Machine Learning using 2D ECHO

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Introduction to Coronary Artery Diseases

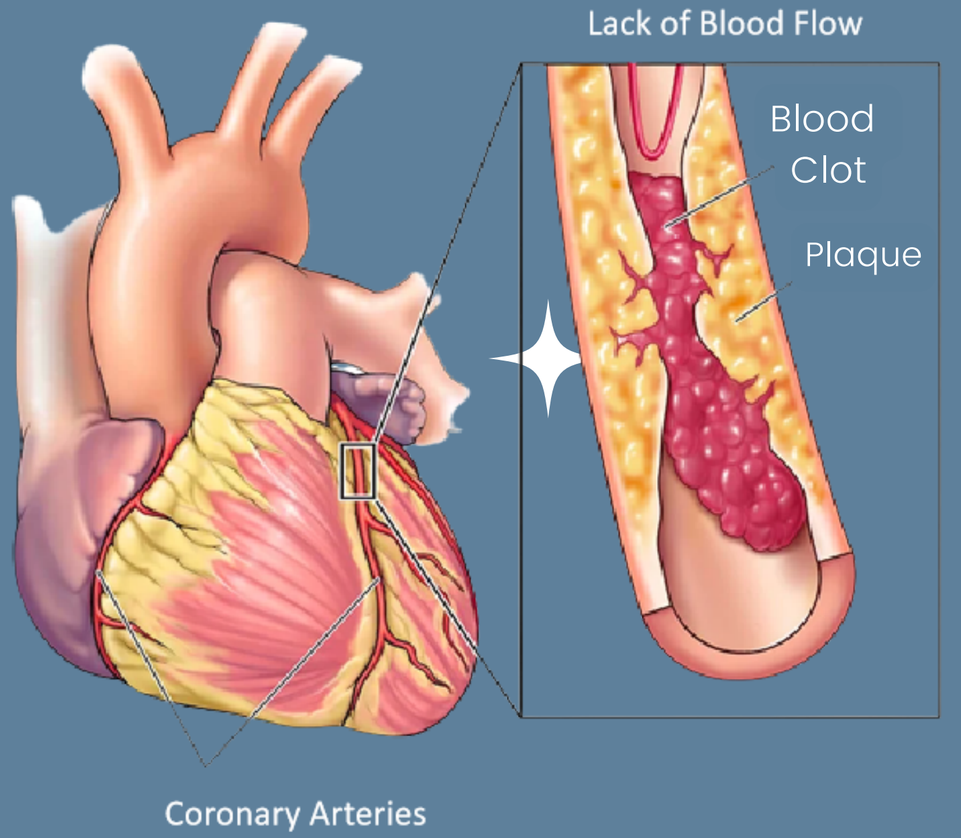
1. Definition and Prevalence

Coronary Artery Disease (CAD) is a cardiovascular condition characterized by the narrowing or blockage of the coronary arteries, which supply oxygen and nutrients to the heart muscle. This reduced blood flow can lead to chest pain (angina) or heart attacks.

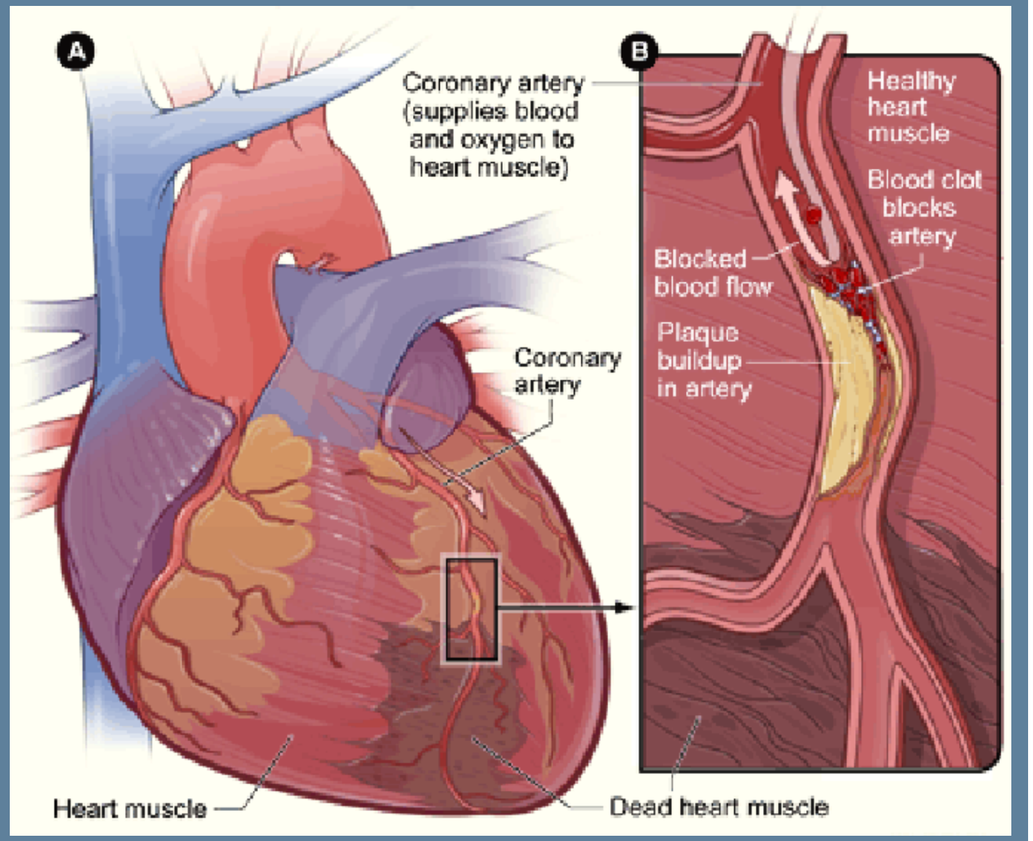
It is the leading cause of death worldwide.

2. Importance of Early Detection

Early detection is crucial for timely intervention, which leads to better treatment outcomes, improved quality of life, and reduced healthcare costs. It can prevent disease progression, saving lives and promoting overall well-being.



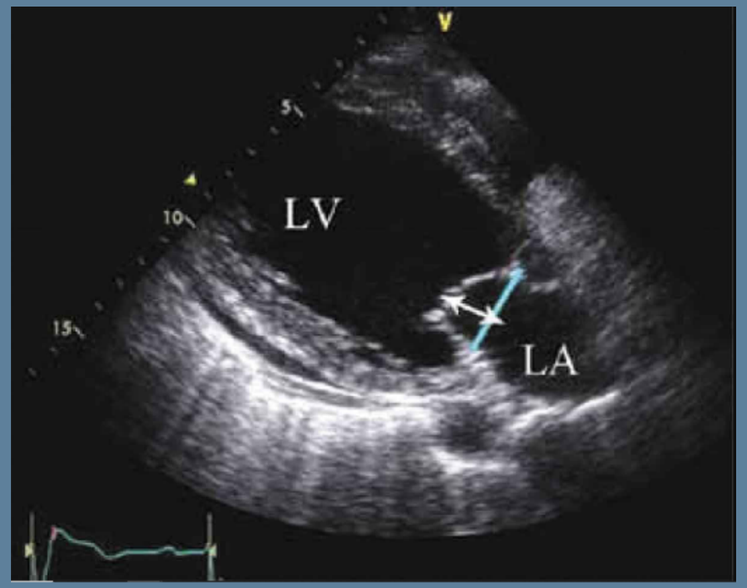
Literature Review: Detecting Coronary Artery Diseases

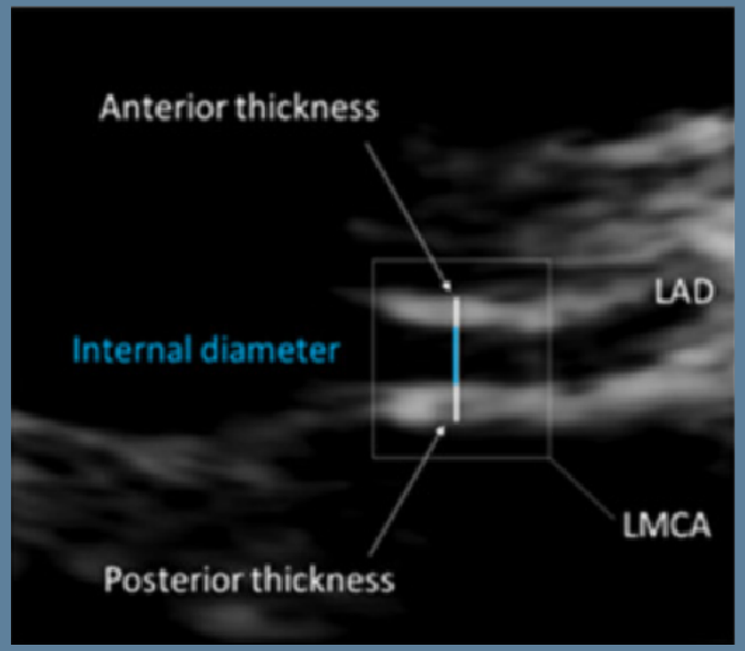


source-https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3587668/

- Coronary artery disease (CAD) is a condition that affects your coronary arteries, which supply blood to your heart. With CAD, plaque buildup narrows or blocks one or more of the coronary arteries.
- The main complication of coronary artery disease is a heart attack. The heart muscle starts to die because it's not receiving enough blood.
- Symptoms- chest pain or discomfort, shortness of breath, feeling dizzy or lightened, heart racing, feeling tired, nausea, stomach discomfort or vomiting.
- 2-D (two-dimensional) echocardiography is used to see the actual motion of the heart structures. A 2-D echo view appears cone-shaped on the monitor, and the real-time motion of the heart's structures can be observed. This imaging procedure is not invasive and carries no risks.

2D ECHO in Coronary Artery





source-https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7827741/

1. **Explanation of 2D Echocardiography**

2D Echo is a non-invasive medical imaging technique that uses high-frequency sound waves (ultrasound) to create detailed two-dimensional images of the heart's structure and function. It provides real-time visual information about the heart's chambers, valves, and blood flow.

2. **Role Assessment**

- **Severity Assessment: 2D Echo helps gauge the extent of arterial blockages by assessing blood flow changes and heart muscle function.**

- **Location Identification: By visualizing real-time images of the heart, 2D Echo can pinpoint the specific location of arterial blockages, aiding in targeted treatment for coronary artery disease.**

Angiography

source-https://en.wikipedia.org/wiki/Angiography

Why CAD ?

- ~6.1 lakh deaths annually due to leading effects of CAD.
- Early detection can prevent heart failure, heart attack, cardiomyopathy, sudden cardiac death, complications in other organs such as kidney dysfunction or damage to liver.

Why 2D ECHO ?

- The gold standard method i.e angiography is an invasive method of detection.
- Cost per angiography is 25-40k.

Objectives of the study

1. Collect a dataset of 2D echocardiographic information, comprising essential data for heart assessment.

2. To design and develop a machine learning-based model capable of automated analysis of 2D echocardiograms for CAD detection.

3. To compare the performance of the machine learning model with traditional manual interpretation by clinicians.

WORK FLOW OF OUR PROJECT

1. Data Collection
2. PreProcessing
3. Machine learning model development and optimization
4. Clinical Validation and Ethical Considerations
5. Result and discussion

ECHOCARDIOGRAPHY & COLOR DOPPLER REPORT

UHID: 23242			**Date of Study:** 25.11.2023		
Name of Patient: -Mr.			**Age / Sex**: Y/M		
Address: Ringus					
Referred By- Cardiology		**Referring Diagnosis:** CAD/ACS/IWMI			
ECG: NSR					
PR (per min) :	**BP :** mm of Hg	**Chest X-Ray**: -			
ECHO Window: **GOOD**	**Weight: Kg.**	**Height: cm**	**DM** No	**HTN** No	**Smoking** No

Summary of ECHO findings

- LVRWMA +, LAD territory hypokinesia
- Apex & Anterior lateral Wall hypokinesia
- LVEF 40%
- Grade I Diastolic Dysfunction
- Mild AR, All Others Valves Normal
- RA/RV Normal
- Pericardium: Normal
- No Intracardiac mass /thrombus /Vegetation

Final Impression	**CAD/RWMA as above/Mild AR/Moderate LV Dysfunction**
Recommendations	

Dr.Ramlal Ola
MD, DM Cardiology (AIIMS)
Chief Interventional Cardiologist

P.T.O

2D- Echo Report obtained from hospital

Work Done So Far

- Contacted various hospitals and cardiologists for the echocardiogram reports.
- Successfully managed to get a database of 304 patients and individual 42 echo reports.
- Evaluated the data and shortlisted below parameters to train the machine learning model.
    - Typical Chest pain
    - Higher BMI(overweight - 25- 29.9 and obese- >30)
    - Diabetes, Hypertension, Smoker
    - Ejection Fraction- Mild(50-55%)
      Moderate(35-50%)
      Severe(<35%)
    - Dilation in either left atrium or left ventricle.
    - Abnormal LV function
    - Hypokinesis in posterior wall
    - VSD or ASD present(left to right shunt)
    - Mitral Regurgitation or Mitral Valve Prolapse(Systolic)

	A	B	C	D	E	F	G	H	I	J	K	L
1	Age	Weight	Height	Sex	BMI	Diabetes Mellitus	Hypertension	Current Smoker	EX-Smoker	Obesity	Typical Chest Pain	Left Ventricular Hypertrophy
2	53	90	175	Male	29.3877551	0	1	1	0	Y	0	N
3	67	70	157	Fmale	28.398718	0	1	0	0	Y	1	N
4	54	54	164	Male	20.07733492	0	0	1	0	N	1	N
5	66	67	158	Fmale	26.83864765	0	1	0	0	Y	0	N
6	50	87	153	Fmale	37.16519287	0	1	0	0	Y	0	N
7	50	75	175	Male	24.48979592	0	0	1	0	N	1	N
8	55	80	165	Male	29.38475666	0	0	0	1	Y	1	N
9	72	80	175	Male	26.12244898	1	0	1	0	Y	1	N
10	58	84	163	Fmale	31.61579284	0	0	0	0	Y	0	N
11	60	71	170	Male	24.56747405	1	0	0	0	N	1	N
12	58	75	168	Male	26.57312925	0	1	0	1	Y	1	N
13	80	67	153	Fmale	28.62147037	0	1	0	0	Y	1	N
14	70	70	151	Fmale	30.70040788	1	1	0	0	Y	0	Y
15	67	63	154	Fmale	26.56434475	1	1	0	0	Y	0	N
16	66	63	155	Fmale	26.2226847	1	1	0	0	Y	0	N
17	59	81	167	Male	29.04370899	1	0	0	0	Y	1	N
18	41	68	169	Male	23.80869017	0	0	1	0	N	0	N
19	68	59	161	Fmale	22.76146754	0	0	0	0	N	0	N
20	60	89	163	Fmale	33.49768527	1	1	0	0	Y	1	N

Link to the prepared excel sheet- https://docs.google.com/spreadsheets/d/1LW134QHVRBYAaBgZ8nujH88rZ-Pmqi_WUPqaV9P_eJg/edit?usp=sharing

M	N	O	P	Q	R	S	T	U
Low Density Lipoprotein	High Density Lipoprotein	Ejection Fraction	Regional Wall Motion Abnormalities	Valvular Heart Disease	Left Anterior Descending	Left Circumflex	Right Coronary Artery	Result
155	30	50	0	N	Stenotic	Normal	Stenotic	CAD
121	36	40	4	N	Stenotic	Stenotic	Normal	CAD
70	45	40	2	mild	Stenotic	Normal	Normal	CAD
55	27	55	0	Severe	Normal	Normal	Normal	Normal
110	50	50	0	Severe	Normal	Normal	Normal	Normal
119	34	50	0	N	Stenotic	Stenotic	Stenotic	CAD
85	34	40	4	mild	Stenotic	Normal	Normal	CAD
90	55	45	4	mild	Stenotic	Stenotic	Stenotic	CAD
90	59	50	0	N	Normal	Normal	Normal	Normal
90	44	40	2	N	Normal	Stenotic	Stenotic	CAD
101	33	50	0	mild	Stenotic	Stenotic	Normal	CAD
112	44	50	3	mild	Stenotic	Stenotic	Stenotic	CAD
148	25	25	4	Moderate	Stenotic	Normal	Stenotic	CAD
118	32	55	2	mild	Stenotic	Normal	Stenotic	CAD
110	30	55	0	mild	Stenotic	Normal	Normal	CAD
110	45	30	0	Moderate	Stenotic	Stenotic	Stenotic	CAD
130	22	35	0	Severe	Normal	Normal	Normal	Normal
91	31	60	0	N	Normal	Normal	Normal	Normal
93	46	55	0	N	Stenotic	Normal	Stenotic	CAD
82	34	50	1	N	Normal	Stenotic	Normal	CAD
137	42	50	0	N	Normal	Stenotic	Normal	CAD
139	35	55	0	N	Stenotic	Stenotic	Normal	CAD
99	43	30	0	N	Stenotic	Stenotic	Normal	CAD
112	57	50	0	N	Stenotic	Normal	Stenotic	CAD

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Thank You!