REVIEW ON HUMAN IMMUNO DEFICIENCY VIRUS AND ITS DETECTION

DR.S.DHANALAKSHMI
Associate Professor,
Department of SS,
Sri Krishna Arts and Science College,
Coimbatore.
dhanalakshmis@skasc.ac.in

S. DEEPSHIKHA
1BCA-B,
Department of CA,
Sri Krishna Arts and Science College,
Coimbatore.
sreyas24bca156@skasc.ac.in

S. SREYA
1BCA-B,
Department of CA,
Sri Krishna Arts and Science College,
Coimbatore.
sreyas24bca156@skasc.ac.in

S. K .SHRIMIKA
1BCA-B,
Department of CA,
Sri Krishna Arts and Science College,
Coimbatore.
sreyas24bca156@skasc.ac.in

***Abstract*---HIV (Human Immunodeficiency Virus) is a global health issue discovered in 1983, and while its impact on various health conditions has been understood, its connection to cardiovascular disease (CVD) has only recently been recognized. People living with HIV (PLWH) are at an elevated risk of heart attacks, even in the absence of traditional risk factors. Some antiretroviral therapies, particularly protease inhibitors, can adversely affect heart health. HIV is typically diagnosed through blood tests, though CT and MRI scans can assist in identifying related complications. Advanced algorithms like Support Vector Machines (SVMs) and Convolutional Neural Networks (CNNs) are employed in image processing to detect HIV-related abnormalities. CNNs, achieving detection rates of 90-95%, are particularly effective in analyzing CT data for HIV/AIDS conditions. MRI scans, processed with software such as FSL and AFNI, are useful for studying structural and functional brain changes related to HIV. Blood tests including antigen/antibody and RNA tests, exhibit nearly 100% accuracy in detecting HIV at various stages. Over time, the incidence of HIV/AIDS has significantly declined, with a peak in 1997, followed by a steady reduction by 2019. The study emphasizes the importance of combining diagnostic imaging with advanced algorithms and reliable blood tests to accurately detect and monitor HIV-related health issues.**

Keywords-HIV(HumanImmunodeficiencyVirus),Blood test, CT Scan, MRI Scan, SVM, CNN, Level Set Method, FSL, AFNI, HIV/AIDS detection.

I. INTRODUCTION

HIV (Human Immunodeficiency Virus) is a global health issue caused by a virus. HIV was discovered in 1983, it's been linked to many health issues, but its connection to heart disease, or cardiovascular disease (CVD), wasn't fully recognized for a long time. Only in recent years did it become clear that people living with HIV (PLWH) are at a higher risk of heart attacks, even if they don't have the usual risk factors like high blood pressure or high cholesterol. This increased risk is partly because some HIV medications, especially protease inhibitors, can have harmful effects on the heart and blood vessels HIV can be diagnosed using a blood test. Some test may not detect the virus during the first 2 to 4 weeks of HIV infections. An antigen/antibody test can be performed using a blood samples from a finger stick, and the blood can be examined under a microscope additionally, CT scans and MRI scans can help identify the presence of HIV in the body.[1]

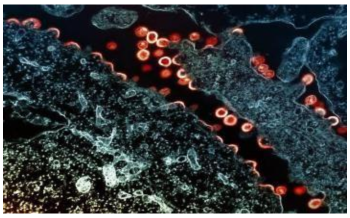

Fig 1. HIV Bacteria

HIV AIDS CAN BE DETECTED BY USING TOOLS:

- Blood Test (Microscope)
- CT Scan
- MRI Scan.

II. CT SCAN :

Computed tomography is commonly referred to as a CT scan. CT Scan detect HIV in patients with pulmonary symptoms. A CT scan can show detailed images of any part of the body, including the bones, muscles, organs and blood vessels. There are some algorithms, these algorithms help analyze CT scan data to detect and monitor HIV- related conditions, but it's important to note that CT scans are not directly used to diagnose HIV itself, as HIV testing is typically done through blood tests.[2]

ALGORITHM :

Some specific algorithms used in CT image processing for HIV includes :

1. Support Vector Machines (SVM).
2. Convolutional Neural Networks (CNN).
3. Active Contour Models.
4. Level Set Methods.

HIV/AIDS-RELATED ABNORMALITIES IN CT SCANS, EXPRESSED AS PERCENTAGES:

Convolutional Neural Networks (CNNs) are one of the most effective methods in the field of image recognition and computer vision, achieving very high accuracy, typically between 90-95%. They are widely used because of their ability to automatically detect important features in images, making them highly reliable. On the other hand, Support Vector Machines (SVMs) are also used for classification tasks, but their performance is generally lower, with accuracy rates ranging from 70-80%. SVMs are still useful, especially in simpler tasks, but they are less powerful when compared to CNNs for complex image- related tasks. Active Contour Models, which are used for outlining objects in images, perform with even lower accuracy, generally around 50-60%. These models rely on energy minimization techniques to detect object boundaries, but they are not as reliable as CNNs or SVMs. Finally, the Level Set Method, another approach used for tracking shapes and objects in images, shows similar accuracy to Active Contour Models, usually between 55- 65%. While useful in certain applications, its accuracy also lags behind more advanced methods like CNNs..Convolutional Neural Network (CNN) 90-95% are significantly more effective than the other methods in detecting HIV/AIDS in CT scans. [3]

CNN :

A CNN (Convolutional Neural Network) is a type of artificial intelligence model commonly used to classify images. It works by automatically learning important features from the images without needing to be explicitly told what to look for Convolutional layers help the network learn small patterns in the image, like edges or textures Pooling layers reduce the size of the image step by step, keeping the important information while making the network more efficient. Fully-connected layers combine everything the network has learned and use that to make a final decision about what’s in the image, like whether it’s a cat or a dog. Unlike traditional machine learning (ML) methods, which often require you to manually select the features to analyze, a CNN learns these features by itself. The pooling layers also help by reducing the complexity of the image data as it moves through the network. [4]

Fig 2. CNN Scan IMAGE

III. SUPPORT VECTOR MACHINES (SVMS):

Support Vector Machines (SVMs) are a method used in machine learning to find patterns in data by first transforming it into a higher-dimensional space, where it becomes easier to detect linear relationships. Essentially, SVMs work by finding a line (or hyperplane) that separates different categories of data. The simplest form of an SVM works with data that can be perfectly separated by a straight line. This line divides the data so that everything on one side belongs to one category, like +1, and everything on the other side belongs to a different category, such as -1. SVMs aim to make this separation as wide as possible, creating a "margin" between the dividing line and the closest data points. When data is more complex and can't be separated by a simple line, SVMs use mathematical tools called kernels to transform the data into a higher dimension, making it easier to find a separation. These kernels allow SVMs to deal with complex, non- linear data. For classification problems with more than two categories, SVMs break down the task into smaller two- class problems and use a voting system to determine which category a new data point belongs to.[5]

Fig 3. Support Vector Machines Scan Image

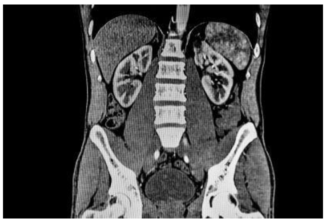

Fig 4. CT Sanning

IV. MRI SCAN :

In HIV research, MRI (Magnetic Resonance Imaging) is used to find places in the body where HIV hides, called viral reservoirs. These reservoirs are important because even when someone is on antiretroviral therapy (ART), HIV can still remain in these spots. If treatment is stopped, the virus can become active again from these hidden areas. Traditional MRI scans help create clear images of tissues inside the body, and when paired with PET (Positron Emission Tomography), they can show where HIV is still actively reproducing. A recent development involves combining MR-PET with a special antibody that is tagged with a radioactive marker (Zirconium-89). This antibody sticks to cells infected with HIV, helping scientists see where the virus is hiding, such as in the lymph nodes, bone marrow, and gut. This method allows researchers to detect these hidden HIV spots without needing to do invasive procedures like biopsies, and it could help in the search for ways to eliminate HIV from the body altogether. [6]

ALGORITHM :

Some specific algorithms used in MRI image processing for HIV include:

1. FSL (FMRIB Software Library) for DTI and structural.

2. AFNI (Analysis of Functional Neuro lmages) for fMRI analysis.

3. SPSS or R for statistical analysis and machine learning.

These algorithms help analyze MRI scan data to detect and monitor HIV-related conditions.

HIV/AIDS-RELATED ABNORMALITIES IN MRI SCANS, EXPRESSED AS PERCENTAGES:

FSL is the most suitable tool for your MRI analysis in HIV/AIDS, with a relevance score of 60%. This makes it the best option, particularly for structural MRI and Diffusion Tensor Imaging (DTI) studies. FSL offers a comprehensive suite of tools for analyzing brain imaging data, which makes it highly effective for these purposes. AFNI, on the other hand, carries a relevance of 25%. While it is not the top choice, it remains highly useful, especially for functional MRI (fMRI) analysis, offering strong capabilities for processing and visualizing fMRI data. Lastly, SPSS or R, with a relevance score of 15%, can play a role in the statistical analysis of your findings but is not specifically tailored to MRI analysis like FSL or AFNI. Given this overall breakdown, FSL emerges as the most appropriate choice for handling the structural MRI and DTI components of your research in HIV/AIDS Thus, FSL would be the best choice for your MRI analysis in HIV/AIDS.

FSL (FMRIB SOFTWARE LIBRARY) FOR DIT AND STRUCTURAL :

The FSL (FMRIB Software Library) algorithm is typically used for brain imaging analysis in the context of MRI data. It's not generally associated with HIV/AIDS prediction.

However, for predicting HIV/AIDS progression or risk, machine learning algorithms and models can be used, such as: Logistic regression can be employed to assess the probability of HIV infection based on various features, providing a statistical framework to estimate the likelihood of the disease. Decision trees and random forests are useful for classifying and predicting outcomes based on patient data, allowing for clear and interpretable decisions regarding HIV-related conditions. Support vector machines (SVM) can effectively distinguish between different stages of HIV infection, providing a robust tool for pattern recognition in medical datasets. Finally, neural networks, with their ability to handle large and complex datasets, can be used for more intricate and nuanced predictions, offering deeper insights into the progression and outcomes of HIV infection. These models can be trained using various clinical and demographic data to predict the likelihood of HIV infection or progression to AIDS. [7]

AFNI (ANALYSIS OF FUNCTIONAL NEURO IMAGES) :

AFNI (Analysis of Functional Neuro Images) is another software suite primarily used for analyzing and visualizing functional MRI (fMRI) data. Like FSL, AFNI is mainly focused on brain imaging rather than HIV/AIDS prediction. For predicting HIV/AIDS progression or risk, AFNI isn't typically used. Instead, predictive modeling in this domain often relies on machine learning techniques applied to clinical, demographic, and health-related data. Techniques like logistic regression, decision trees, random forests, or neural networks would be more appropriate for this purpose. AFNI is not used for predicting HIV/AIDS; machine learning models analyzing relevant health data would be the more suitable approach [8].

PREPARATION

1. Remove metal objects: Remove any metal objects, such as jewelry, glasses, or clothing with metal fasteners.

2. Change into gown: Wear a hospital gown to prevent any metal objects from interfering with the MRI machine.

3. Complete questionnaire: Fill out a questionnaire to ensure you're safe for the MRI procedure.

4. Inform about medical history: Inform the MRI technologist about any medical conditions, such as pacemakers, artificial joints, or implants.

MRI PROCEDURE

1. Lie down on table: Lie down on the MRI table, which will slide into the MRI machine.

2. Head or body coil: A coil will be placed around your head or body to receive the MRI signals.

3. Inject contrast agent (if necessary): A contrast agent may be injected into your vein to enhance image

quality.

4. MRI machine: The MRI machine will generate a strong magnetic field and radio waves to produce

images.

5. Hold still: Remain still and follow the technologist's instructions to ensure clear images.

6. Breathing instructions: You may be

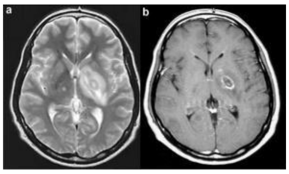

Fig 5. Mri Image Features

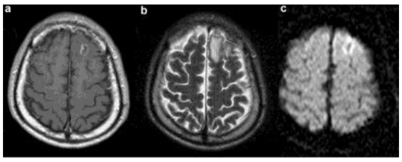

Fig 6. Mri Scan Image

V. MICROSCOPE

A microscope is a scientific instrument that uses lenses or other technologies to magnify and resolve small objects, samples, or microorganisms that are invisible to the naked eye, allowing for detailed observation and study of their structure, behavior, and properties.

ALGORITHM

Blood tests used to diagnose HIV (Human Immunodeficiency Virus) are highly accurate, with sensitivity and specificity percentages that indicate how well the test can detect true positive cases (sensitivity) and rule out false positives (specificity).

Below are the common blood tests used for HIV detection and their corresponding accuracy rates:

There are several types of HIV tests used to diagnose the virus. The Antigest Test directly detects HIV’s genetic material (RNA) in the blood with nearly perfect accuracy. It can identify HIV as early as 10–14 days after exposure, making it ideal for early detection following high-risk activities. Rapid Antibody Tests detect HIV antibodies in blood or oral fluids and provide quick results, which is useful for initial screening. The Antibody Combination Test looks for both HIV antibodies and other markers, with a high sensitivity of 99.7% and a specificity of 99.9%. It typically identifies HIV within 2–4 weeks after exposure. The HIV RNA Test is highly accurate, with a sensitivity of 99.3% and specificity of 99.8%, and can detect HIV about 3 months after exposure. Finally, the Western Blot or HIV-1/HIV-2 Differentiation Assay is used to confirm positive results from initial tests and is nearly 100% accurate in verifying HIV presence.[9]

SUMMARY OF TEST ACCURACY

Initial screening tests - (like the 4th generation antigen/antibody test) have a sensitivity of - 99.7% and a specificity of - 99.9%. Confirmatory tests - (such as the Western blot or NAT) ensure that if a positive

result is obtained, it is truly positive, with an overall accuracy of nearly 100%. These blood tests are reliable, and combining screening with confirmatory testing ensures that the diagnosis is extremely accurate.

TESTING USING MICROSCOPE

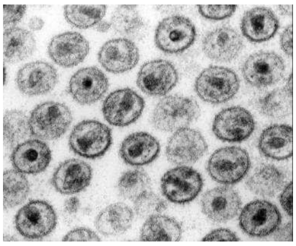

Fig 7. Testing Using Microscope

VI. PERCENTAGE OF PEOPLE AFFECTED

Over the past three decades, the age-standardized incidence of HIV/AIDS has undergone significant shifts. Between 1990 and 1997, there was a rapid increase in HIV/AIDS cases for both men and women, with men experiencing higher rates than women, leading to a widening gap between the genders. However, after 1997, the incidence rates began to decline sharply, continuing this downward trend until 2009.By 2019, the incidence had dropped to 5.4 cases per 100,000 men and 4.6 cases per 100,000 women, with the gap between male and female rates narrowing over time. The peak in age-standardized HIV/AIDS incidence was recorded in 1997, with 38.0 cases per 100,000 men and 27.6 cases per 100,000 women, marking the highest point of the epidemic before the significant decline in the following years.[10]

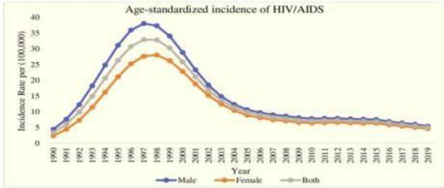

Fig 8 PERCENTAGE

HIV/AIDS is a major global health issue, affecting over 70 million people worldwide. Since the epidemic began, 35 million people have died from the disease, and currently, around 36.7 million are living with it. Despite extensive research—more than 260,000 papers on the topic—HIV/AIDS remains a focus of study across many scientific fields, including epidemiology, virology, and immunology, as well as in social sciences and humanities. Researchers from these diverse disciplines rely on a shared understanding of how HIV interacts with the immune system and host cells to explain the disease’s clinical effects.[11]

VII. CONCLUSION

Since HIV/AIDS was first identified in 1983, there have been significant strides in understanding and diagnosing the disease. Initially, the connection between HIV and heart disease wasn't fully recognized, but it's now known that people with HIV are at a higher risk for cardiovascular problems. Today, diagnosing HIV relies on very accurate blood tests, such as antigen/antibody tests, rapid tests, and confirmatory tests like Western Blot. These tests have different detection windows but work together to provide reliable results. While CT and MRI scans can't diagnose HIV directly, they are useful for spotting complications related to the virus. Convolutional Neural Networks (CNNs) are particularly effective at analyzing CT scans for HIV-related issues, and FSL is often used for MRI scans to detect structural changes. Machine learning tools like CNNs and SVMs help interpret these images, but they’re not used for the initial HIV diagnosis. Overall, even though HIV/AIDS rates have significantly dropped since the late 1990s, ongoing improvements in diagnostics and treatments continue to enhance our ability to manage and understand the disease.

REFERENCES

[1].JulianA.Luetkens.MD,LeonM.Bischoff,MD.”UnveilingSubclinical Cardiovascular Disease in HIV with Advanced Cardiovascular Imaging",2024.J

[2]. Paula R. Patel, Orlando De Jesus."CT Scan",2023. MinyechilAlehegn."Application of machine learning and deep learning for the prediction of HIV/AIDS". 1.7.2022.

[3]. Xisong Dong & Gang Xiong,"HIV/AIDS Model BasedonLocalActivity of CNN".1-10,2011.

[4]. Roohallah Alizadehsani, Mohammad HosseiZangooei,MohammadJavad Hosseini, Jafar Habibi, Abbas Khosravi,Mohamad Roshanzamir, Fahime

[5]. Khozeimeh, Nizal Sarrafzadegan, Saeid Nahavandi" Coronaryartery disease detection using computational intelligence methods" 109 (2016) 187–197..

[6]. M Alasdair Sinclair,"MRI imaging used to find areas of active HIV replication in the body", 2022

[7]. Mark jenkinson, Christian F.Beckmann,Timothy E.J.Behrens, Mark W.Woolrich, Stephen M.Smith."FSL"-9,2011.

[8]. Robert W. Cox."AFNI: What a long strange trip it's been",2012.

[9]. M Y. G. Kuznetsov, J. G. Victoria, W. E. Robinson, Jrand A. McPherson,"Atomic Force Microscopy Investigation of Human ImmunodeficiencyVirus (HIV) and HIV-Infected Lymphocytes", 14,2003.Neha Shri, Krittika Bhattacharyya, Deepak

[10]. Dhamnetiya, Mayank Singh, Ravi Prakash Jha, and Priyanka Patelcorresponding author. "Long-term trends of HIV/AIDS incidence in India: an application of joinpoint and age period–cohort analyses: a gendered perspective",2023.

[11]. M Neha Shri, Krittika Bhattacharyya, Deepak Dhamnetiya, Mayank Singh, Ravi Prakash Jha, and Priyanka Patelcorresponding author. "Long-term trends of HIV/AIDS incidence in India: an application of joinpoint and age period–cohort analyses: a gendered perspective",2023.