A NON-INVASIVE APPROACH FOR DIAGNOSING ENDOMETRIOSIS USING DEEP LEARNING

BRAUDE College of Engineering, Karmiel

Students: Daniel Berkowitz, Tal Turjeman
Supervisor: Miri Weiss Cohen

What is Endometriosis?

Endometriosis is an inflammatory, chronic gynecologic disorder that affects approximately 10% of reproductive-age women worldwide.
It is characterized by the growth of endometrial like tissue outside the uterus, primarily in the pelvic cavity.

Disease subtypes

1. Superficial Peritoneal Endometriosis: On pelvic organ surfaces.
2. Endometriomas: Fluid-filled cysts on the ovaries, linked to infertility and ovarian cancer risk.
3. Deep Infiltrating Endometriosis (DIE): Invades organs, causes severe pain and requires surgery.

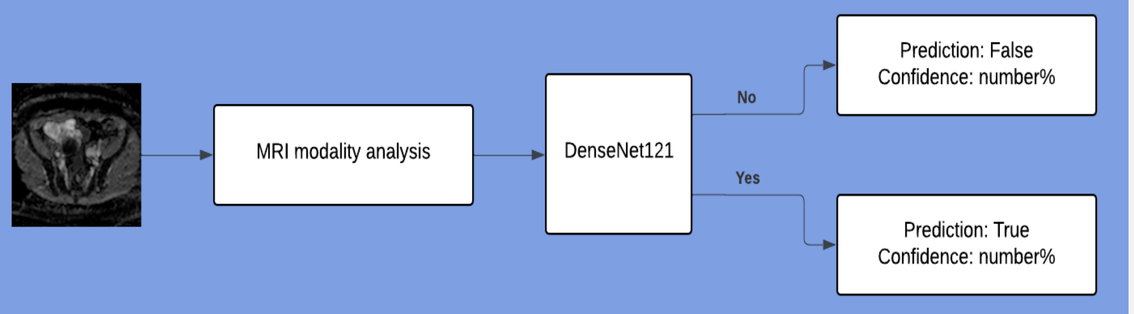
Main Symptoms & Impact

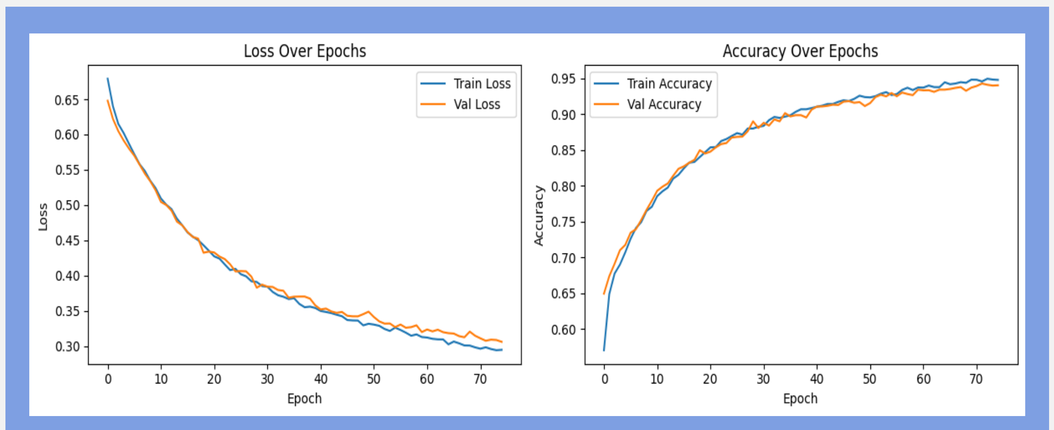
Common symptoms include chronic pelvic pain, dysmenorrhea, dyspareunia, infertility, and digestive or urinary issues. In addition, it has been associated with mental health issues such as anxiety and depression.

Diagnostic challenges

Endometriosis is commonly underdiagnosed, with delays of 8 – 12 years due to nonspecific symptoms.
While MRI can assist in identifying signs of the disease, a definitive diagnosis still requires invasive procedures, with high costs and risks.

Pretrained DenseNet121, a convolutional neural network with densely connected layers, is used to analyze pelvic MRI scans. Its architecture enables efficient feature reuse and deep feature extraction by connecting each layer to all preceding layers. This structure allows the model to capture both low-level and high-level patterns within MRI images, identifying subtle signs of endometriosis and outputting a binary prediction indicating the presence or absence of the condition.





Using the combined T1 and T2 MRI modalities and Fine tuning the final dense block of DenseNet121 improved the ability of the model to capture endometriosis specific features, improving overall diagnostic performance.

The model achieved a classification accuracy of **0.9346** and a loss value of **0.3198**, Precision of **94.13%**, Recall of **92.03%** and F1 score, **93.07%**.

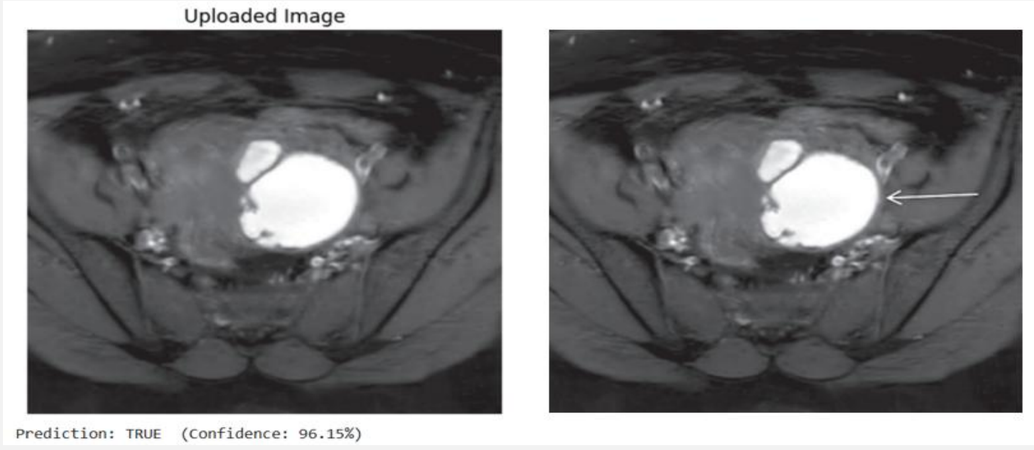
Conclusion

This study demonstrated the potential of using deep learning techniques for non-invasive diagnosis of endometriosis with MRI scans. By applying transfer learning with a DenseNet121 model, we were able to classify MRI cases with promising results.

The experiments highlighted that the model was capable of learning meaningful patterns from the data. Overall, this work supports the idea that deep learning can assist in the detection of endometriosis, potentially reducing the need for invasive diagnostic procedures.

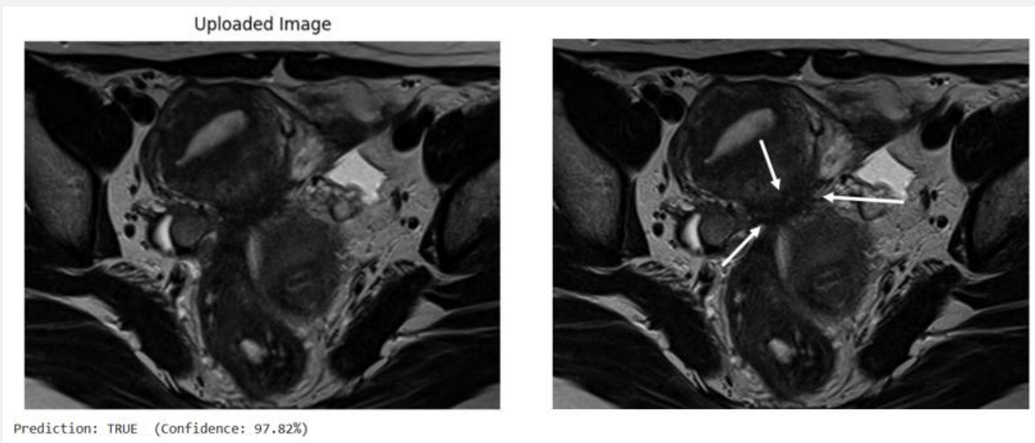
Endometrioma on axial T1FS

Model prediction: True 96.15%



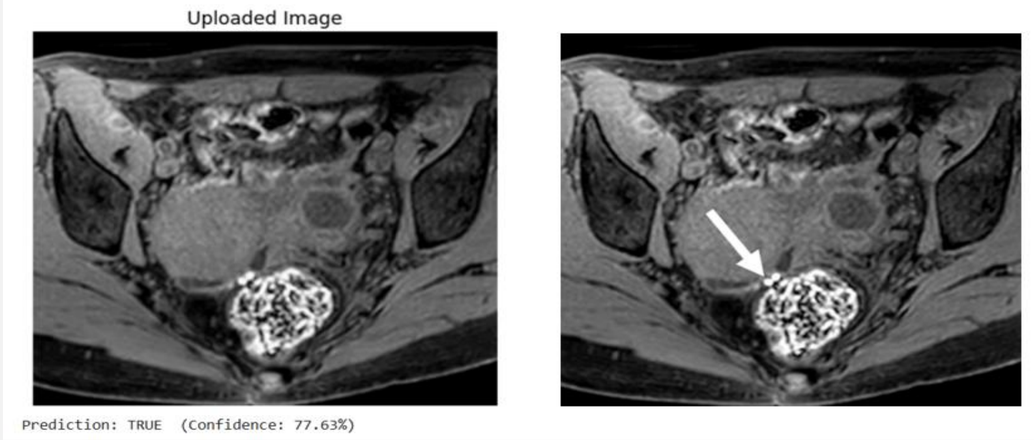
Pelvic endometriosis in a 42-year-old female with abdominal pain

Model prediction: True 97.82%



deep pelvic endometriosis on axial T1FS

Model prediction: True 77.63%



Axial T1FS with no endometriosis

Model prediction: False 84.59% False 79.62%