In [1]:
```
import pandas as pd
import os
from sklearn.model_selection import train_test_split
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense, Dr
from tensorflow.keras.regularizers import l2
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.metrics import AUC, TruePositives, TrueNegatives, Fals
```

In [2]:
```
from tensorflow.keras.preprocessing.image import ImageDataGenerator

# directory
base_dir = r"BrEaST-Lesions_USG-images_and_masks"

# Training and testing
train_dir = os.path.join(base_dir, 'train')
test_dir = os.path.join(base_dir, 'test')

# rescaling
train_datagen = ImageDataGenerator(rescale=1/255, horizontal_flip=True)
test_datagen = ImageDataGenerator(rescale=1/255)

# Create a stream for training
train_dataset = train_datagen.flow_from_directory(
    directory=train_dir,
    target_size=(256, 256),
    batch_size=8,
    class_mode='binary'
)

# Create a stream for testing
test_dataset = test_datagen.flow_from_directory(
    directory=test_dir,
    target_size=(256, 256),
    batch_size=8,
    class_mode='binary'
)
```

```
Found 201 images belonging to 2 classes.
Found 51 images belonging to 2 classes.
```

In [3]:
```
test_dataset
```

Out[3]:
```
<keras.preprocessing.image.DirectoryIterator at 0x21cb7a734f0>
```

In [3]:
```
# Initialize the model
model = Sequential()

# Add regularization to the convolutional layers and include dropout layers
model.add(Conv2D(32, (5,5), activation='relu', padding='same', input_shape=(
model.add(MaxPooling2D(3, 3))

model.add(Conv2D(64, (3,3), activation='relu', padding='same', kernel_regula
model.add(MaxPooling2D(3, 3))
model.add(Dropout(0.25))

model.add(Conv2D(128, (3,3), activation='relu', padding='same', kernel_regul
model.add(MaxPooling2D(3, 3))
model.add(Dropout(0.25))


model.add(Flatten())

model.add(Dense(128, activation='relu', kernel_regularizer=l2(0.001)))
model.add(Dropout(0.5))  # Add dropout after the dense layer

# Output layer
model.add(Dense(1, activation='sigmoid'))

# Compile the model
model.compile(optimizer='adam', loss='binary_crossentropy',
              metrics=['accuracy', AUC(), TruePositives(), TrueNegatives(),

# Model summary
model.summary()

# Add EarlyStopping when the validation loss starts increasing
early_stopping = EarlyStopping(monitor='val_loss', patience=5, restore_best_

# Train the model
history = model.fit(
    train_dataset,
    steps_per_epoch=train_dataset.samples // train_dataset.batch_size,
    epochs=40,
    validation_data=test_dataset,
    validation_steps=test_dataset.samples // test_dataset.batch_size,
    callbacks=[early_stopping])
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 256, 256, 32)      2432

 max_pooling2d (MaxPooling2D  (None, 85, 85, 32)       0
 )

 conv2d_1 (Conv2D)           (None, 85, 85, 64)        18496

 max_pooling2d_1 (MaxPooling  (None, 28, 28, 64)       0
 2D)

 dropout (Dropout)           (None, 28, 28, 64)        0

 conv2d_2 (Conv2D)           (None, 28, 28, 128)       73856

 max_pooling2d_2 (MaxPooling  (None, 9, 9, 128)        0
```

In [4]:
```
# Print final accuracy and loss
final_train_accuracy = history.history['accuracy'][-1]
final_train_loss = history.history['loss'][-1]
final_val_accuracy = history.history['val_accuracy'][-1]
final_val_loss = history.history['val_loss'][-1]

print(f"Final Training Accuracy: {final_train_accuracy}")
print(f"Final Training Loss: {final_train_loss}")
print(f"Final Validation Accuracy: {final_val_accuracy}")
print(f"Final Validation Loss: {final_val_loss}")
```

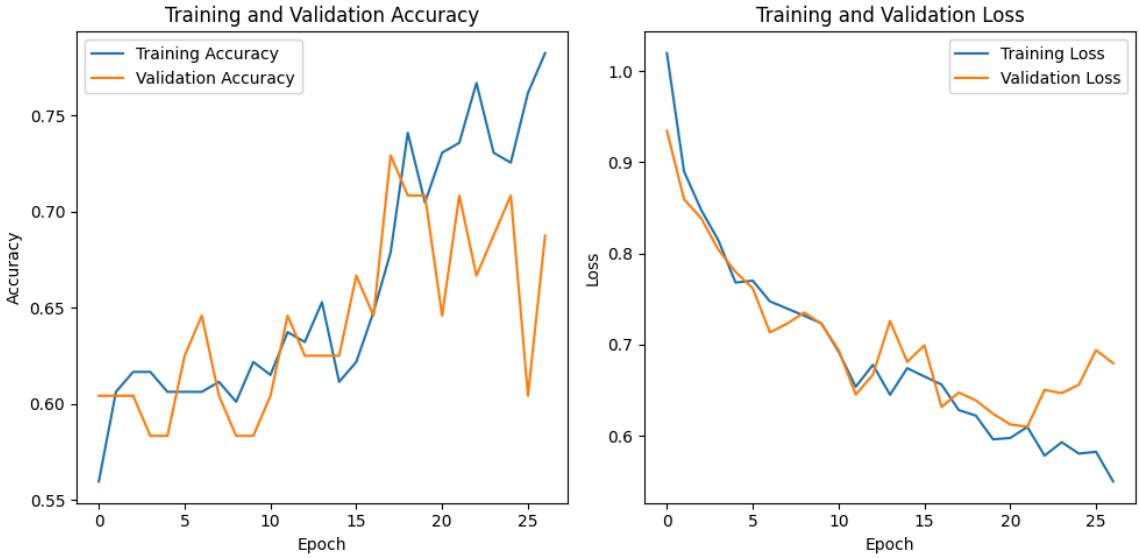
```
Final Training Accuracy: 0.7823834419250488
Final Training Loss: 0.5500085353851318
Final Validation Accuracy: 0.6875
Final Validation Loss: 0.6796305775642395
```

In [5]:
```
import matplotlib.pyplot as plt

# Plot for accuracy
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Training and Validation Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()

# Plot for loss
plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()

plt.tight_layout()
plt.show()
```



In [6]:
```
model.save('C:/Users/alan/Medical Image Project/CNN model.h5')
```

In [ ]:
```

```