In [51]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from scipy.stats import kurtosis
```

In [52]:

```
df = pd.read_excel("Customer Churn Dataset.xlsx")
pd.set_option("display.max_columns", None)
df.head()
```

Out[52]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetService	OnlineSecurity	OnlineB
0	7590-VHVEG	Female	0	Yes	No	1	No	No phone service	DSL	No	
1	5575-GNVDE	Male	0	No	No	34	Yes	No	DSL	Yes	
2	3668-QPYBK	Male	0	No	No	2	Yes	No	DSL	Yes	
3	7795-CFOCW	Male	0	No	No	45	No	No phone service	DSL	Yes	
4	9237-HQITU	Female	0	No	No	2	Yes	No	Fiber optic	No	

In [53]:

```
df.shape
```

Out[53]:

```
(7043, 23)
```

In [54]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7043 entries, 0 to 7042
Data columns (total 23 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   customerID        7043 non-null   object 
 1   gender            7043 non-null   object 
 2   SeniorCitizen     7043 non-null   int64  
 3   Partner           7043 non-null   object 
 4   Dependents        7043 non-null   object 
 5   tenure            7043 non-null   int64  
 6   PhoneService      7043 non-null   object 
 7   MultipleLines     7043 non-null   object 
 8   InternetService   7043 non-null   object 
 9   OnlineSecurity    7043 non-null   object 
 10  OnlineBackup      7043 non-null   object 
 11  DeviceProtection  7043 non-null   object 
 12  TechSupport       7043 non-null   object 
 13  StreamingTV       7043 non-null   object 
 14  StreamingMovies   7043 non-null   object 
 15  Contract          7043 non-null   object 
 16  PaperlessBilling  7043 non-null   object 
 17  PaymentMethod     7043 non-null   object 
 18  MonthlyCharges    7043 non-null   float64
 19  TotalCharges      7043 non-null   object 
 20  numAdminTickets   7043 non-null   int64  
 21  numTechTickets    7043 non-null   int64  
 22  Churn             7043 non-null   object 
dtypes: float64(1), int64(4), object(18)
memory usage: 1.2+ MB
```

In [55]:

```python
# Remove any leading or trailing spaces from all column names in the DataFrame
df.columns = df.columns.str.strip()
```

In [56]:

```python
df.columns
```

```
Out[56]:  Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
                 'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
                 'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
                 'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
                 'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'numAdminTickets',
                 'numTechTickets', 'Churn'],
                dtype='object')
```

```
In [57]:  # Replacing blank values with 0 because tenure is 0 and no total charges are recorded.
          df["TotalCharges"] = df["TotalCharges"].replace(" ", "0")
          df["TotalCharges"] = df["TotalCharges"].astype("float")
```

```
In [58]:  df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7043 entries, 0 to 7042
Data columns (total 23 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   customerID        7043 non-null   object 
 1   gender            7043 non-null   object 
 2   SeniorCitizen     7043 non-null   int64  
 3   Partner           7043 non-null   object 
 4   Dependents        7043 non-null   object 
 5   tenure            7043 non-null   int64  
 6   PhoneService      7043 non-null   object 
 7   MultipleLines     7043 non-null   object 
 8   InternetService   7043 non-null   object 
 9   OnlineSecurity    7043 non-null   object 
 10  OnlineBackup      7043 non-null   object 
 11  DeviceProtection  7043 non-null   object 
 12  TechSupport       7043 non-null   object 
 13  StreamingTV       7043 non-null   object 
 14  StreamingMovies   7043 non-null   object 
 15  Contract          7043 non-null   object 
 16  PaperlessBilling  7043 non-null   object 
 17  PaymentMethod     7043 non-null   object 
 18  MonthlyCharges    7043 non-null   float64
 19  TotalCharges      7043 non-null   float64
 20  numAdminTickets   7043 non-null   int64  
 21  numTechTickets    7043 non-null   int64  
 22  Churn             7043 non-null   object 
dtypes: float64(2), int64(4), object(17)
memory usage: 1.2+ MB
```

In [59]:

```
# checking null values
df.isnull().sum()
```

Out[59]:
```
customerID          0
gender              0
SeniorCitizen       0
Partner             0
Dependents          0
tenure              0
PhoneService        0
MultipleLines       0
InternetService     0
OnlineSecurity      0
OnlineBackup        0
DeviceProtection    0
TechSupport         0
StreamingTV         0
StreamingMovies     0
Contract            0
PaperlessBilling    0
PaymentMethod       0
MonthlyCharges      0
TotalCharges        0
numAdminTickets     0
numTechTickets      0
Churn               0
dtype: int64
```

In [60]:
```python
df.duplicated().sum()
```

Out[60]:
```
0
```

In [61]:
```python
# Check for duplicate customerID values –
# since customerID should be unique for every customer.
df["customerID"].duplicated().sum()
```

Out[61]:
```
0
```

In [62]:
```python
df.describe()
```

Out[62]:

	SeniorCitizen	tenure	MonthlyCharges	TotalCharges	numAdminTickets	numTechTickets
count	7043.000000	7043.000000	7043.000000	7043.000000	7043.000000	7043.000000
mean	0.162147	32.371149	64.761692	2279.734304	0.515689	0.419566
std	0.368612	24.559481	30.090047	2266.794470	1.275299	1.250117
min	0.000000	0.000000	18.250000	0.000000	0.000000	0.000000
25%	0.000000	9.000000	35.500000	398.550000	0.000000	0.000000
50%	0.000000	29.000000	70.350000	1394.550000	0.000000	0.000000
75%	0.000000	55.000000	89.850000	3786.600000	0.000000	0.000000
max	1.000000	72.000000	118.750000	8684.800000	5.000000	9.000000

In [63]:

```
print("kurtosis of tenure:",kurtosis(df["tenure"]))
print("kurtosis of MonthlyCharges:",kurtosis(df["MonthlyCharges"]))
print("kurtosis of TotalCharges:",kurtosis(df["TotalCharges"]))
```

```
kurtosis of tenure: -1.3872386910324277
kurtosis of MonthlyCharges: -1.2572191009381857
kurtosis of TotalCharges: -0.22926935367162837
```

tenure

- Since mean > median, the distribution is right-skewed (positive skewness).
- Kurtosis is less than 0, indicating a platykurtic distribution — flatter peak and wider spread.
- 📌 Insight: Some customers have very long tenure, pulling the mean upward. Many customers drop off early, indicating retention challenges.
-

2. Monthly Charges

- Since mean < median, this variable is left-skewed (negative skewness).

- Kurtosis is also negative, suggesting a platykurtic shape — less peaked, more spread.
- 📌 Insight: A few customers have low monthly charges, pulling the mean down. Most users pay moderate to high charges.

3. Total Charges

- With mean > median, this is another right-skewed distribution.
- Negative kurtosis points to a platykurtic shape — flatter than normal.
- 📌 Insight: High-value customers (long tenure with high charges) stretch the average upwards. These customers are vital to the business.

Overall Summary:

The dataset shows asymmetrical distributions across all major numeric features.

All three variables are platykurtic, showing less peaked, more spread out distributions.

These patterns help identify:

At-risk customers with short tenure or low charges.

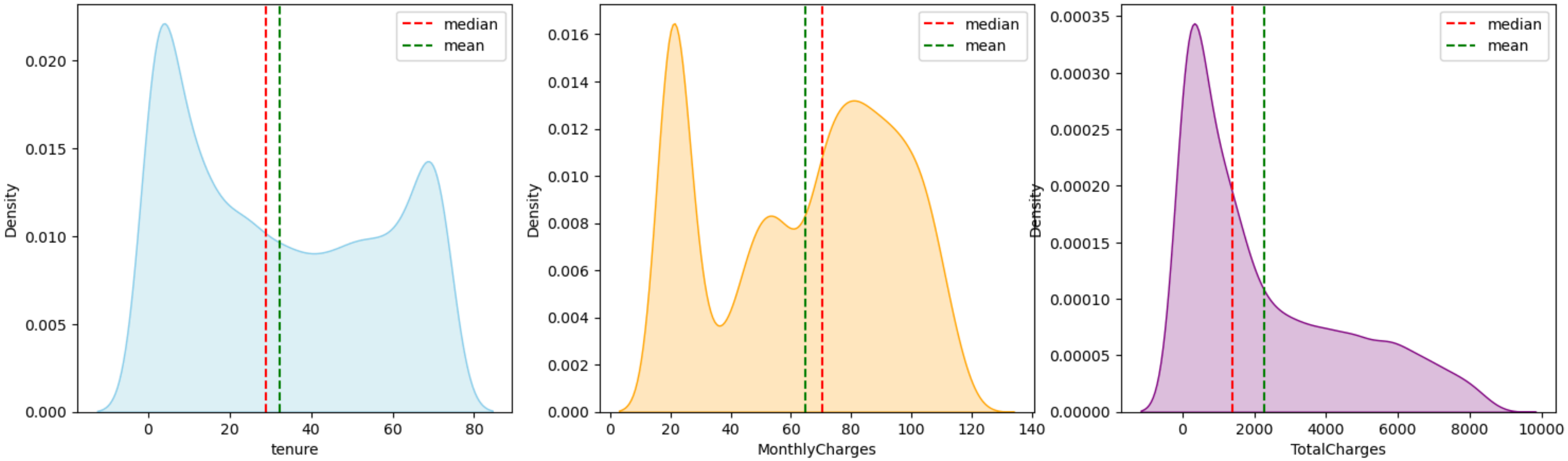
High-value customers with long tenure and high total charges.

tenure

In [64]:

```
# tenure
fig, axes = plt.subplots(1,3, figsize = (18,5))

sns.kdeplot(x = "tenure",data=df, fill = True,color = "skyblue", ax = axes[0] )

axes[0].axvline(np.median(df["tenure"]), color = "r", linestyle="--", label = "median" )
axes[0].axvline(np.mean(df["tenure"]),   color = "g",  linestyle = "--", label = "mean",)
axes[0].legend(loc='upper right')

# monthlycharges
```

```
sns.kdeplot(x = "MonthlyCharges", fill = True,color = "orange", data=df, ax = axes[1])

axes[1].axvline(np.median(df["MonthlyCharges"]), color = "r", linestyle="--", label = "median" )
axes[1].axvline(np.mean(df["MonthlyCharges"]), color = "g",linestyle="--", label = "mean")
axes[1].legend(loc='upper right')

# total charges
sns.kdeplot(x = "TotalCharges", fill = True,color = "purple", data=df, ax = axes[2])

axes[2].axvline(np.median(df["TotalCharges"]), color = "r",linestyle="--", label = "median")
axes[2].axvline(np.mean(df["TotalCharges"]),   color = "g",linestyle="--", label = "mean")
axes[2].legend(loc='upper right')

plt.show()
```



SeniorCitizen

In [65]:
```
df["SeniorCitizen"].unique()
```

Out[65]:
```
array([0, 1], dtype=int64)
```

In [66]:

```
def convert(value):
    if value == 1:
        return "Yes"
    else:
        return "No"

df["SeniorCitizen"] = df["SeniorCitizen"].apply(convert)
```

In [67]:

```
df["SeniorCitizen"].unique()
```

Out[67]:

```
array(['No', 'Yes'], dtype=object)
```

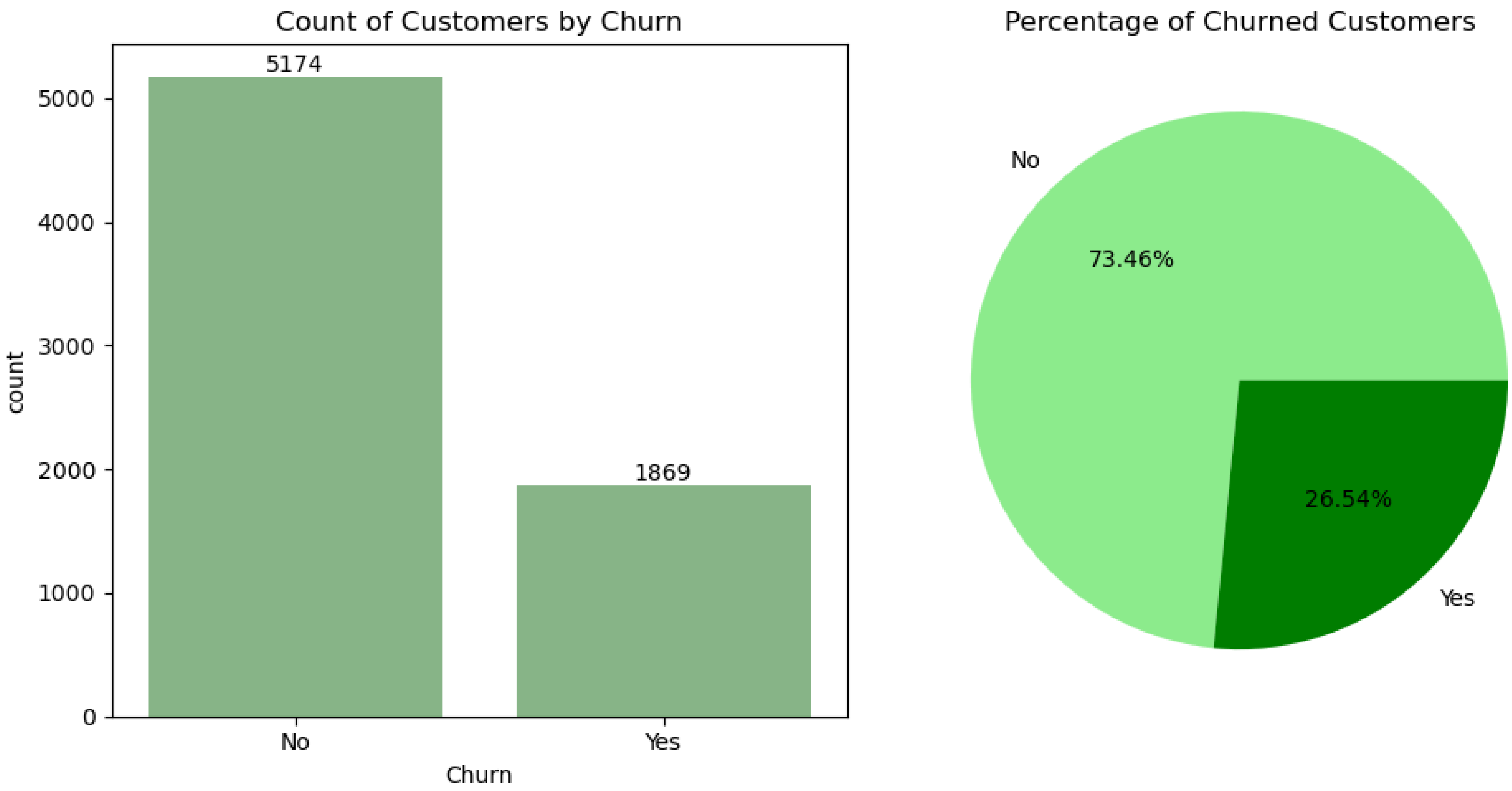
In [ ]:

```
# converted 0 and 1 values of senior citizen to yes and no to make it easier to understand
```

Churm

In [68]:

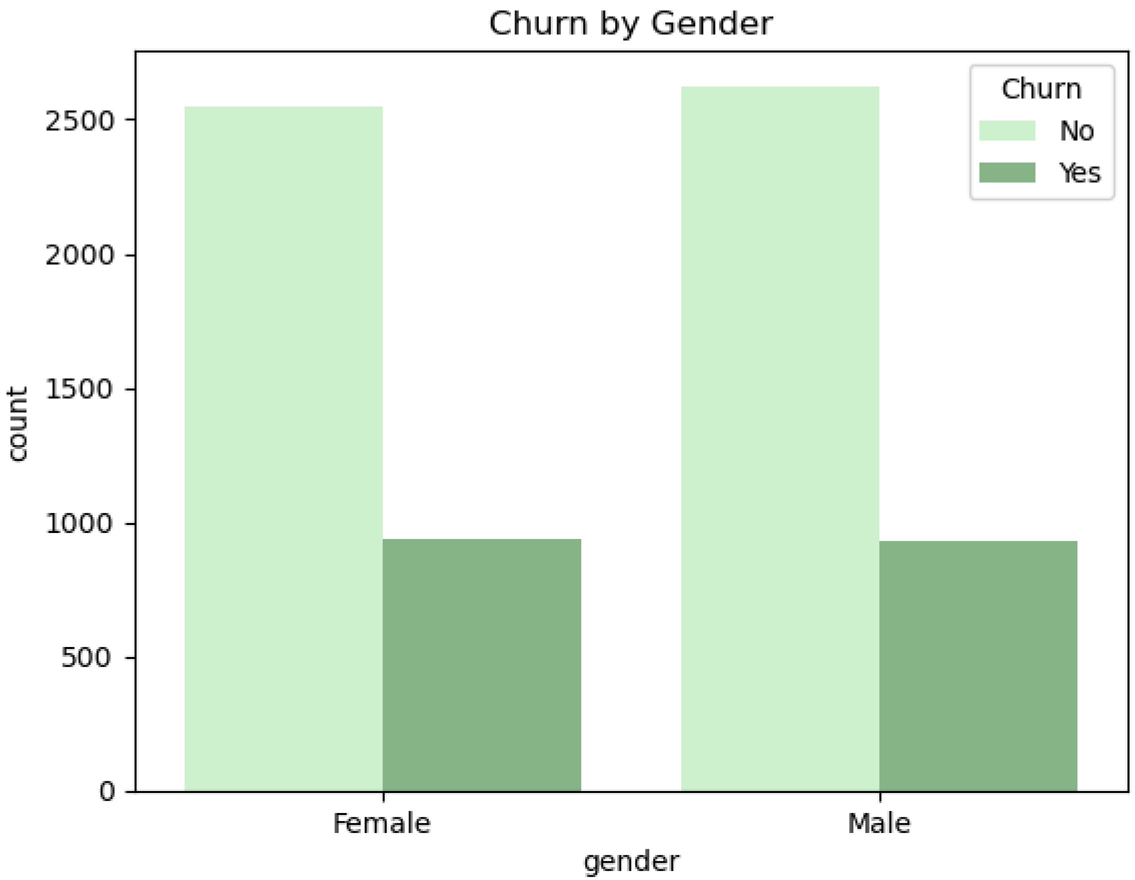
```
# Prepare grouped data
ag = df.groupby("Churn").agg({"Churn": "count"})

# Set up subplot
fig, axes = plt.subplots(1, 2, figsize=(10, 5))

# Countplot (Bar)
ax1 = sns.countplot(x="Churn", data=df, color="green", alpha=0.5, ax=axes[0])
ax1.set_title("Count of Customers by Churn")
ax1.bar_label(ax1.containers[0])

# Pie chart (manual plot on axes[1])
axes[1].pie(ag["Churn"],labels=ag.index, autopct="%1.2f%%",  colors=["lightgreen", "green"])
axes[1].set_title("Percentage of Churned Customers", fontsize=12)

# Show combined plot
plt.tight_layout()
plt.show()
```



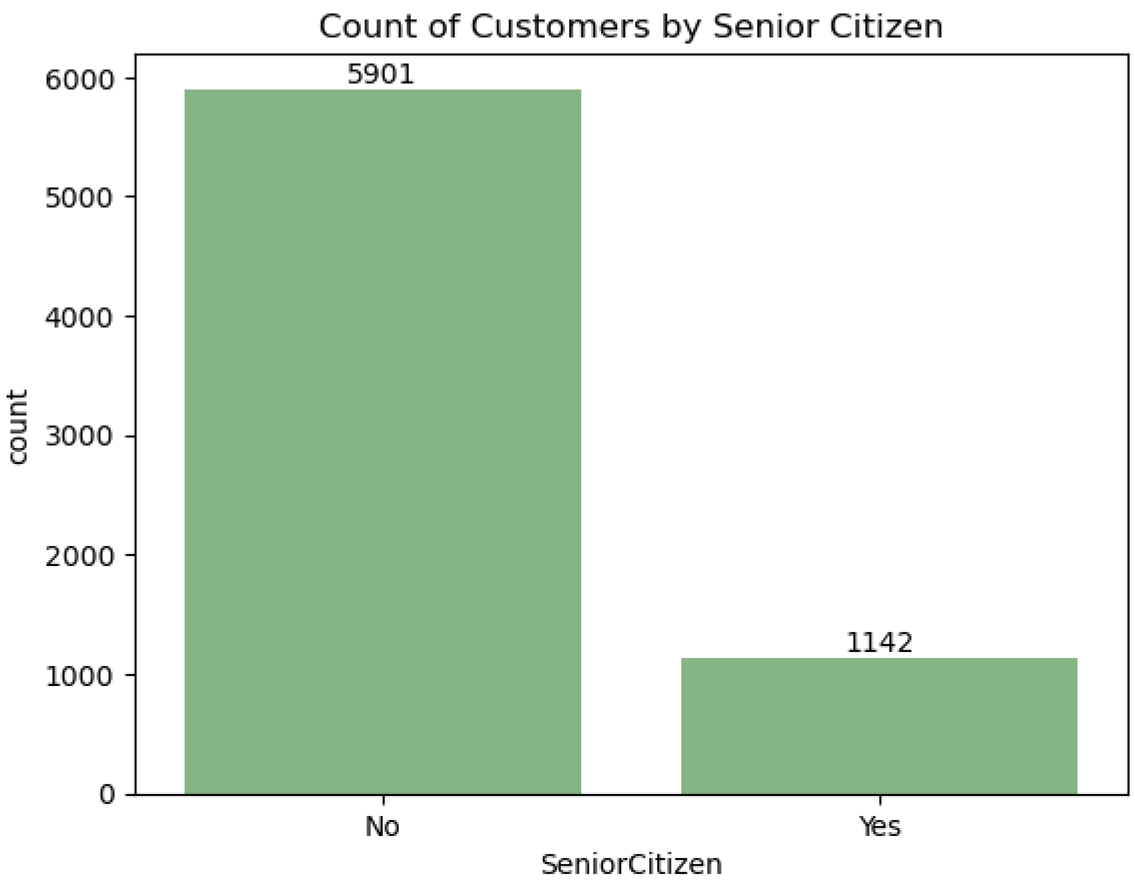
From the pie chart, we observe that 26.54% of customers have churned. Let's now explore the potential reasons behind this churn.

In [69]:

```
sns.countplot(x="gender", data=df, hue="Churn", palette=["lightgreen","green"], alpha = 0.5)

plt.title("Churn by Gender")
plt.show()
```



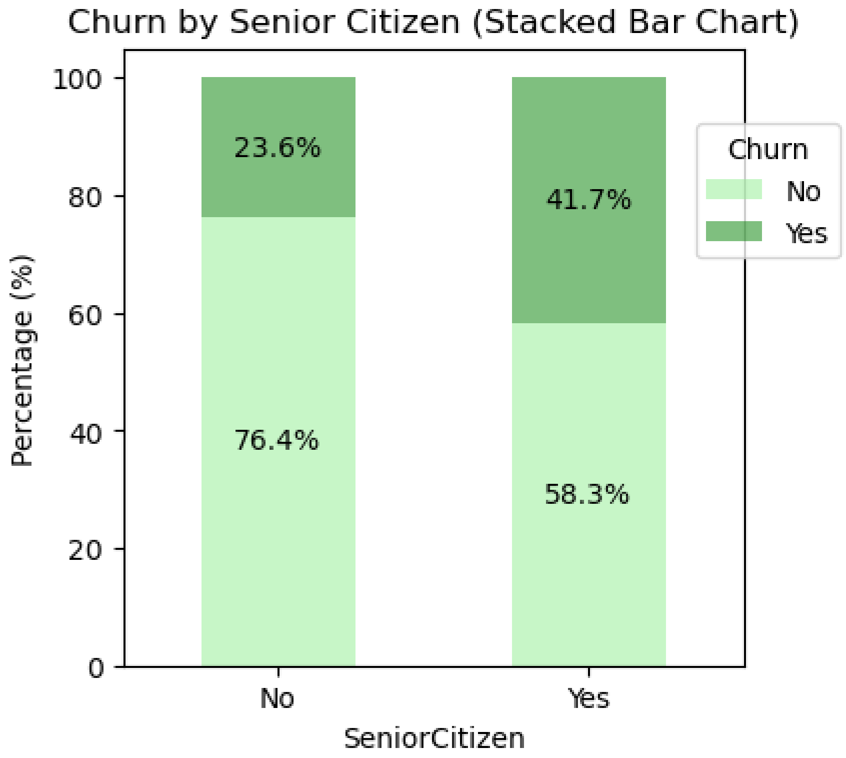
```
In [70]: ax = sns.countplot(x = "SeniorCitizen", data = df, color = "g", alpha = 0.5)
         plt.title("Count of Customers by Senior Citizen")

         ax.bar_label(ax.containers[0])
         plt.show()
```



In [71]:

```
total_counts = df.groupby('SeniorCitizen')['Churn'].value_counts(normalize=True).unstack() * 100

# Plot
fig, ax = plt.subplots(figsize=(4, 4))  # Adjust figsize for better visualization

# Plot the bars
total_counts.plot(kind='bar', stacked=True, ax=ax, color=['lightgreen', 'green'], alpha = 0.5)  # Customize colors if desired

# Add percentage labels on the bars
for p in ax.patches:
    width, height = p.get_width(), p.get_height()
    x, y = p.get_xy()
    ax.text(x + width / 2, y + height / 2, f'{height:.1f}%', ha='center', va='center')
```

```
plt.title('Churn by Senior Citizen (Stacked Bar Chart)')
plt.xlabel('SeniorCitizen')
plt.ylabel('Percentage (%)')
plt.xticks(rotation=0)
plt.legend(title='Churn', bbox_to_anchor = (0.9,0.9))  # Customize legend location

plt.show()
```

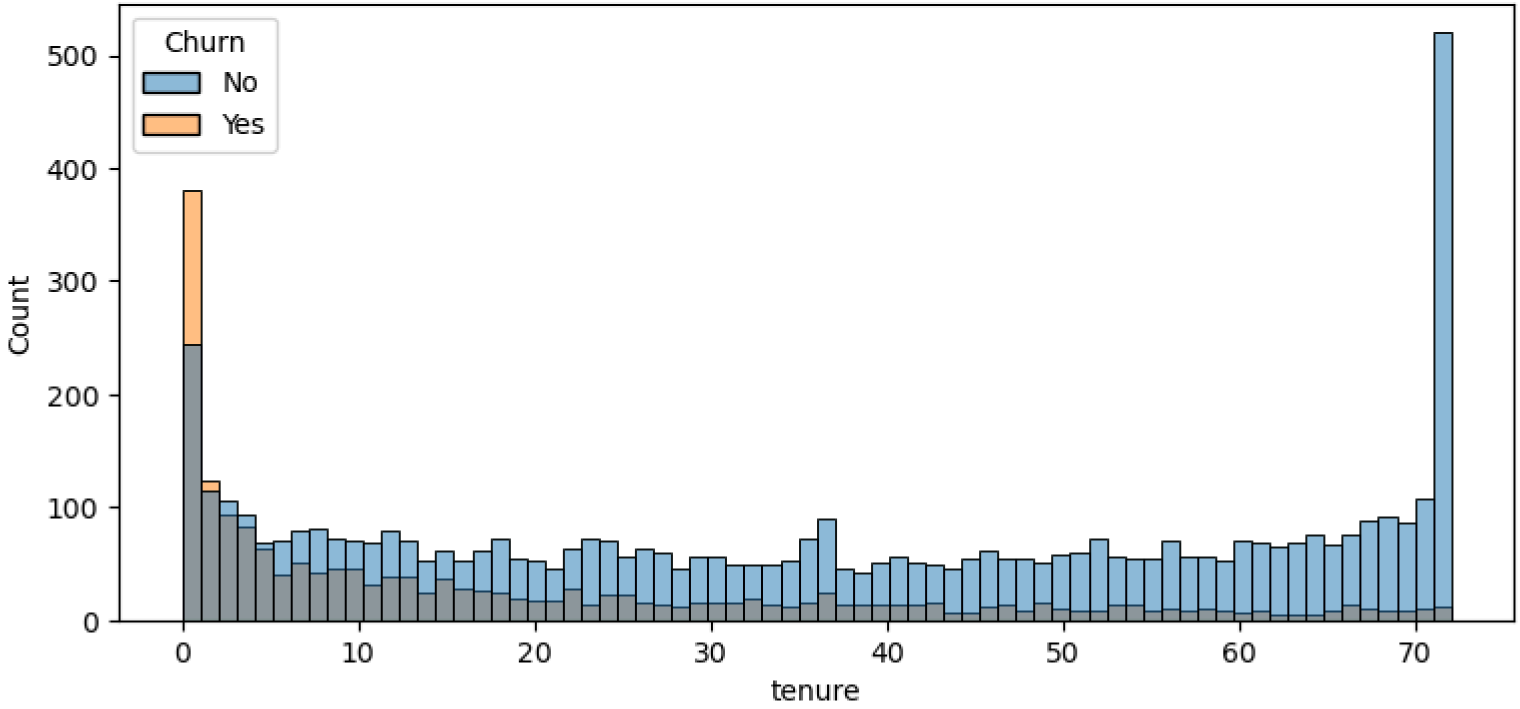


comparative a greater pecentage of people in senior citizen category have churned

In [72]:

```
plt.figure(figsize = (9,4))
sns.histplot(x = "tenure", data = df, bins = 70, hue = "Churn" )
```

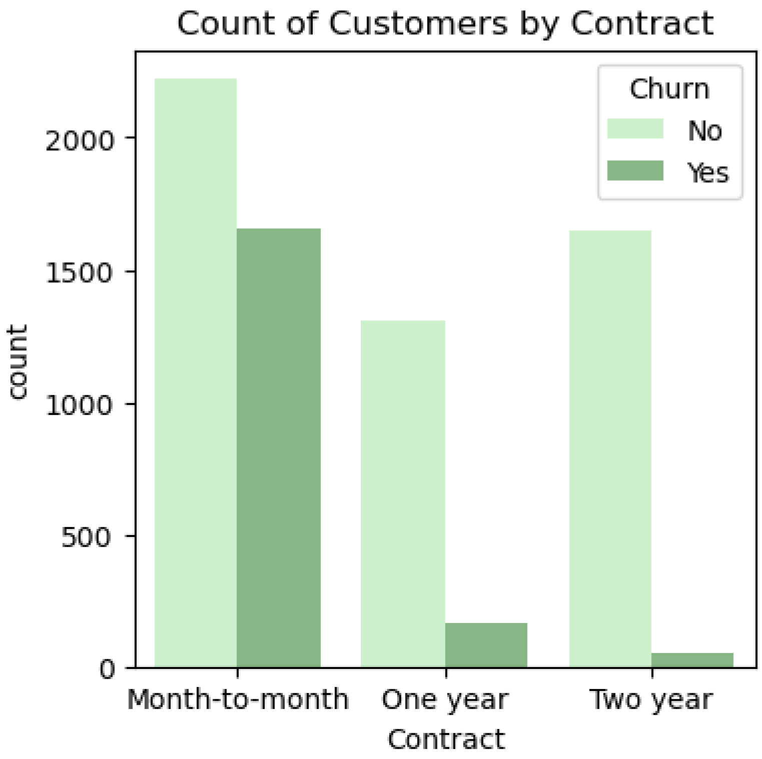
```
plt.show()
```



most of churned customers left within their first year.

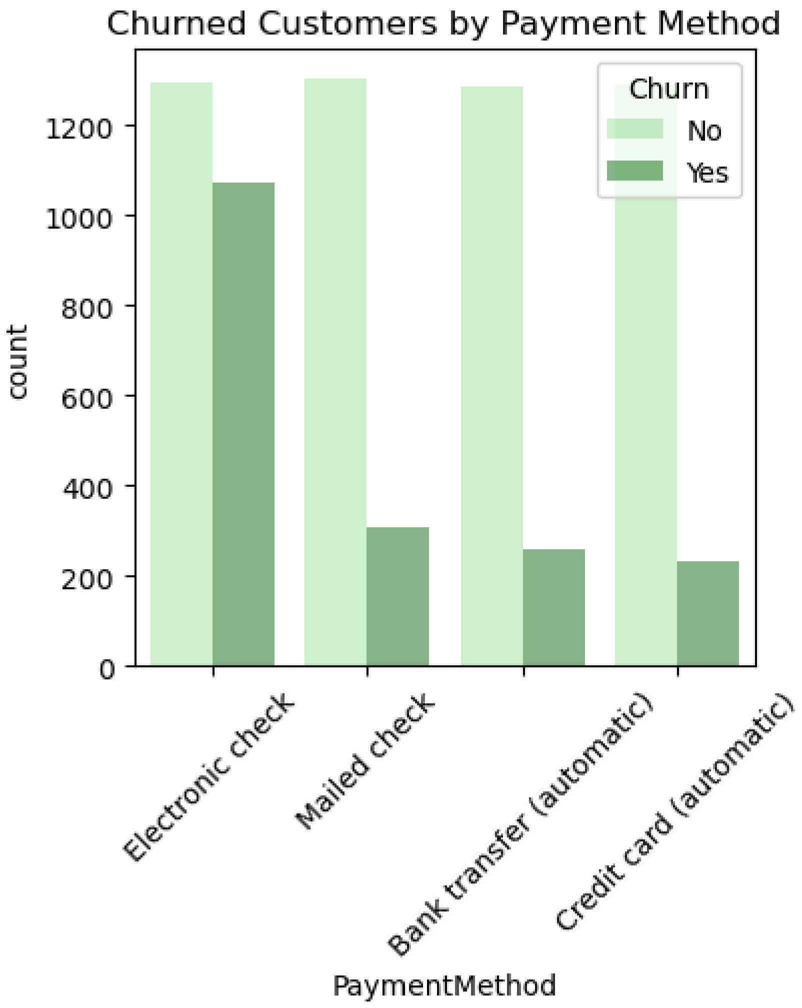
In [73]:

```
fig, ax = plt.subplots(figsize=(4, 4))  # Adjust figsize for better visualization

sns.countplot(x = "Contract", data = df, hue="Churn", palette=['lightgreen', 'green'], alpha = 0.5)
plt.title("Count of Customers by Contract")

plt.show()
```



In [74]:

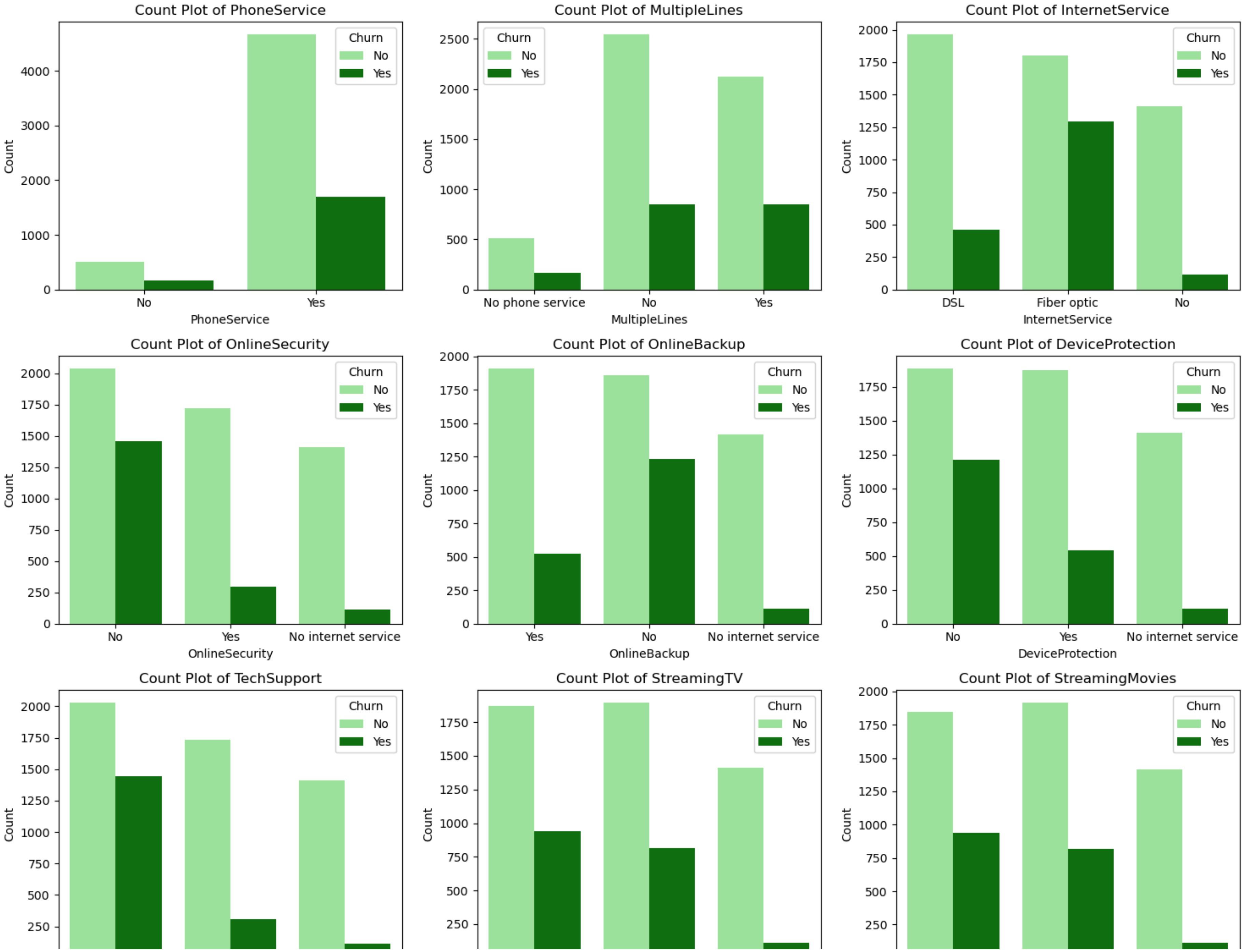
```
fig, ax = plt.subplots(figsize=(4, 4))  # Adjust figsize for better visualization
sns.countplot(x = "PaymentMethod", data = df, hue = "Churn",palette=['lightgreen', 'green'], alpha = 0.5)
plt.title("Churned Customers by Payment Method")

plt.xticks(rotation = 45)
plt.show()
```

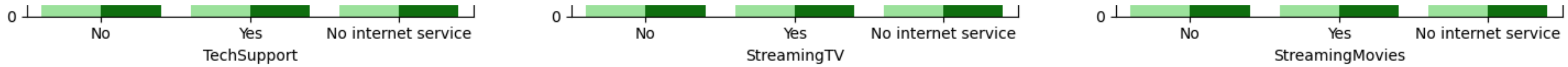


customer is likely to churn when he is using electronic check as a payment method and where on short-term contract(month-to-month).

```
In [75]: columns = ['PhoneService', 'MultipleLines', 'InternetService', 'OnlineSecurity',
                    'OnlineBackup', 'DeviceProtection', 'TechSupport', 'StreamingTV', 'StreamingMovies']
```

```python
n_cols = 3
n_rows = (len(columns) + n_cols - 1) // n_cols

fig, axes = plt.subplots(n_rows, n_cols, figsize=(15, n_rows * 4))
axes = axes.flatten()

# Set your desired colors for Churn = No / Yes
churn_palette = ["lightgreen", "green"]

for i, col in enumerate(columns):
    sns.countplot(x=col, data=df, ax=axes[i], hue=df["Churn"], palette=churn_palette)
    axes[i].set_title(f'Count Plot of {col}')
    axes[i].set_xlabel(col)
    axes[i].set_ylabel('Count')

# Remove empty plots
for j in range(i + 1, len(axes)):
    fig.delaxes(axes[j])

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


Count Plot of PhoneService
Churn
No
Yes
Count
0
1000
2000
3000
4000
No
Yes
PhoneService
Count Plot of MultipleLines
Churn
No
Yes
Count
0
500
1000
1500
2000
2500
No phone service
No
Yes
MultipleLines
Count Plot of InternetService
Churn
No
Yes
Count
0
250
500
750
1000
1250
1500
1750
2000
DSL
Fiber optic
No
InternetService
Count Plot of OnlineSecurity
Churn
No
Yes
Count
0
250
500
750
1000
1250
1500
1750
2000
No
Yes
No internet service
OnlineSecurity
Count Plot of OnlineBackup
Churn
No
Yes
Count
0
250
500
750
1000
1250
1500
1750
2000
Yes
No
No internet service
OnlineBackup
Count Plot of DeviceProtection
Churn
No
Yes
Count
0
250
500
750
1000
1250
1500
1750
No
Yes
No internet service
DeviceProtection
Count Plot of TechSupport
Churn
No
Yes
Count
250
500
750
1000
1250
1500
1750
2000
Count Plot of StreamingTV
Churn
No
Yes
Count
250
500
750
1000
1250
1500
1750
Count Plot of StreamingMovies
Churn
No
Yes
Count
250
500
750
1000
1250
1500
1750
2000



The majority of customers who do not churn tend to have services like PhoneService, InternetService (particularly DSL), and OnlineSecurity enabled. For services like OnlineBackup, TechSupport, and StreamingTV, churn rates are noticeably higher when these services are not used or are unavailable.