

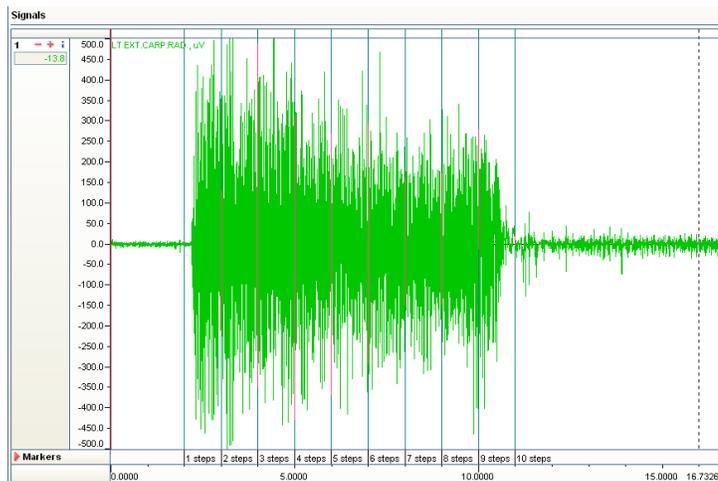
Frequency/Fatigue Report

When you use the FFT to calculate the Median/Mean Frequency, it only makes sense if it is an isometric muscle movement. If you use the Median/Mean Frequency for a dynamic movement, the Median Frequency values are all over the place and do not provide useful info.

In our Frequency/Fatigue report, we are expecting an isometric movement. Our recommendation is to set the periods by “steps”. You may wonder why we use “steps” if the FFT does not indicate the time an event occurred.

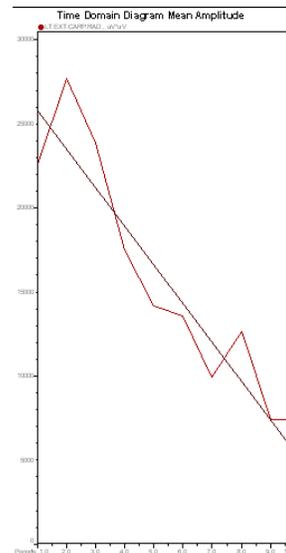
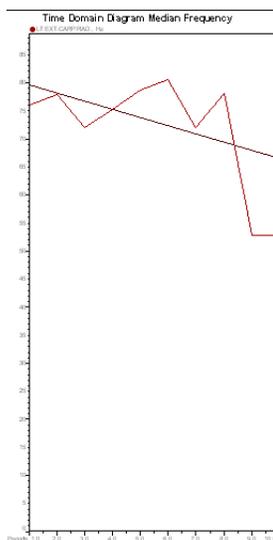
To determine if fatigue is occurring, we need to look at the Median Frequency at regular intervals in the signal because we want to see if there is a shift in the Power Spectrum curve.

If I use the Freq/Fatigue report on an Isometric contraction and set the periods by “steps” – every 1.000 seconds.



Each step/interval is 1 second

What the Freq/Fatigue Report does is apply the FFT Power Spectrum to each period, e.g. every 1.000 seconds. If the power spectrum shifts towards the left, then we should see a decrease in Median Values. Typically, the Mean Amplitude will increase when a muscle is fatigued.



Frequency/Fatigue Report

Notice that the Median Frequency does decrease, but the picture shows that the values go up and down. If we look at the Mean Amplitude, the values are decreasing. Usually when a muscle is fatiguing, we expect the Mean Amplitude to increase.

The statistics in MRXP Freq/Fatigue report Median Frequency are:

Statistics for Median Frequency

Channel	Slope, Hz/(Periods)	Intercept	Difference, %
LT EXT.CARP.RAD., Hz	-1.47	79.6	-10.3

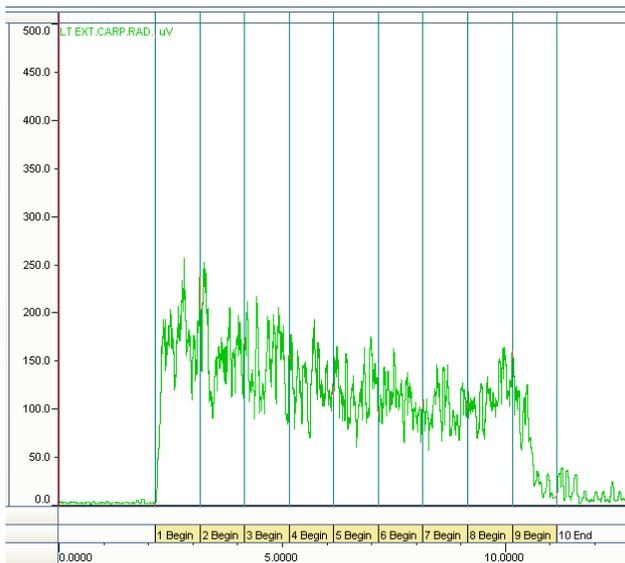
A difference of -10.3% and a slope of -1.47 doesn't appear to be significant, but let's look at the Mean Amplitude statistics.

If we look at the statistics for the Mean Amplitude, we have a difference of 118% and a slope of 0.37. The Mean Amplitude is decreasing and not increasing. Combined with the Median Frequency, is this muscle fatiguing? From the graphs it does not appear that the muscle is fatiguing; however, please review the literature for your application and selected muscle before coming to a conclusion.

Statistics for Mean Amplitude

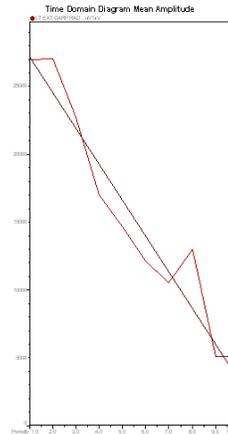
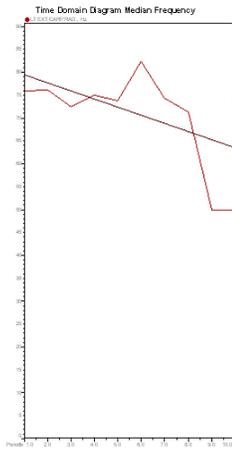
Channel	Slope, uV/(Periods)	Intercept	Difference, %
LT EXT.CARP.RAD., uV	0.37	-2.18	-118

According to the MyoResearch XP Freq/Fatigue Report description, signal processing should not be applied to the signal, but in the MyoResearch XP Demo project, the freq/fatigue sample is rectified and smoothed (RMS 50ms). So let's try that with this signal and see if anything changes.



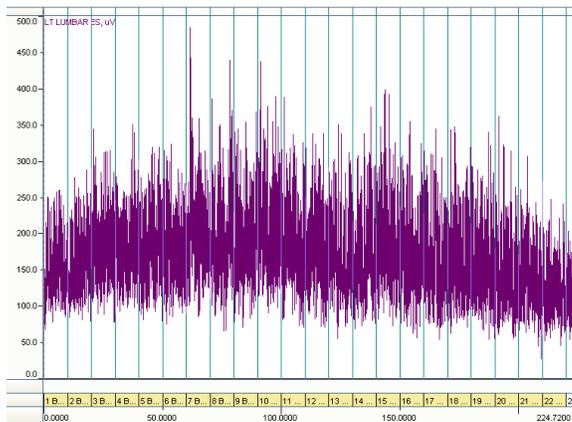
Each step/interval is 1 second
Signal Processed:
Rectified & Smoothed: RMS = 50 ms

Frequency/Fatigue Report



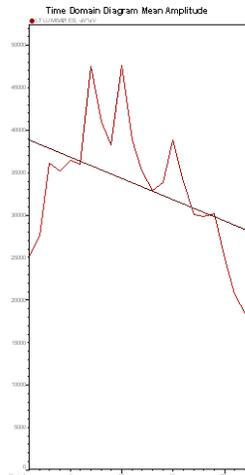
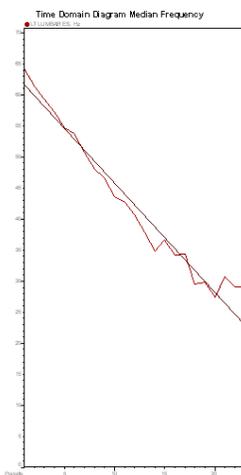
The Median and Mean Amplitude curves look very similar to the curves produced without applying Signal Processing. It appears that the muscle did not fatigue.

So now let's look at a signal that is measuring Lower Back fatigue.



Since the signal is 200 seconds, I set the periods using a step/interval value of 10 seconds.

Using the Freq/Fatigue report, I get these results:



Frequency/Fatigue Report

The statistics in MRXP for the Median Frequency are:

Statistics for Median Frequency

Channel	Slope, Hz/(Periods)	Intercept	Difference, %
LT LUMBAR ES, Hz	-1.76	61.6	-52.8

The Median Frequency difference of 52.8% appears to be significant.

The statistics in MRXP for the Mean Amplitude are:

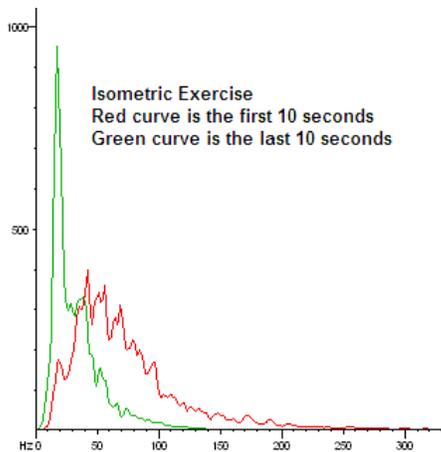
Statistics for Mean Amplitude

Channel	Slope, $\mu\text{V}/(\text{Periods})$	Intercept	Difference, %
LT LUMBAR ES, μV	-1.58	193	-16.5

The Mean Amplitude has a Difference percent of 16.5%.

You will want to review the literature in your field to determine if muscle fatigue is occurring.

If we do a Spectrum Analysis separately for the first and last 10 seconds and compare the two spectrums, this is what we get:



According to the literature, a shift in frequency towards the left indicates muscle fatigue.

You are probably thinking, okay, I understand your explanation, but how do I do it in MyoResearch XP?!

Frequency/Fatigue Report

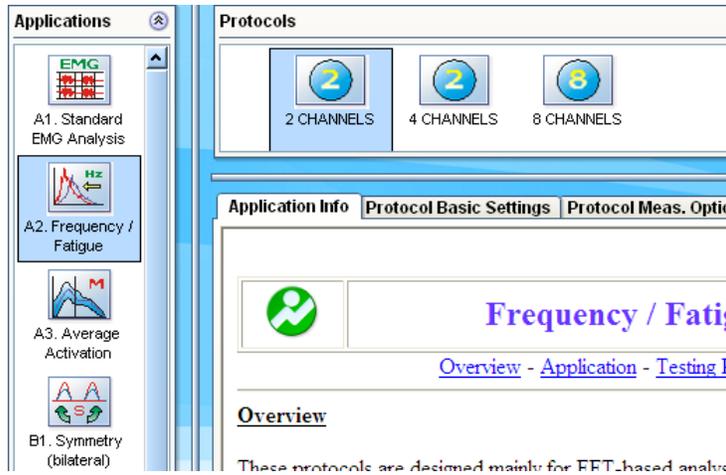
MyoResearch XP Frequency/Fatigue Report – Median Frequency

Taking a measurement in MRXP

If you are using Clinical Applications or Applications Protocol:

In the “Choice of Protocol” window, click on the Application “Freq/Fatigue”.

A set of Protocols will appear at the top of the screen. In the example below, the protocols are the number of channels you plan to use. (Don't worry if the number of channels you want to use are not available, you can always modify and rename a protocol.)



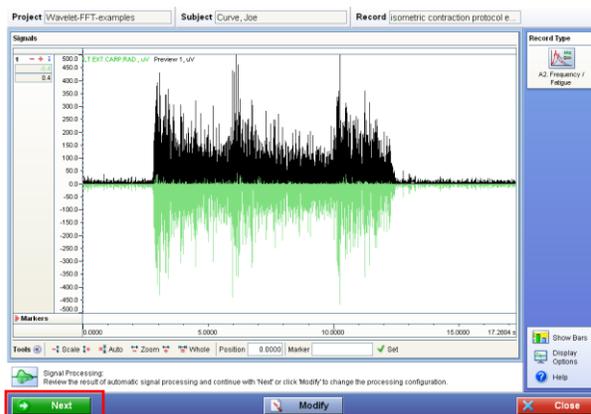
Click “Measure”



Enter the desired channel names, then click “Start”.

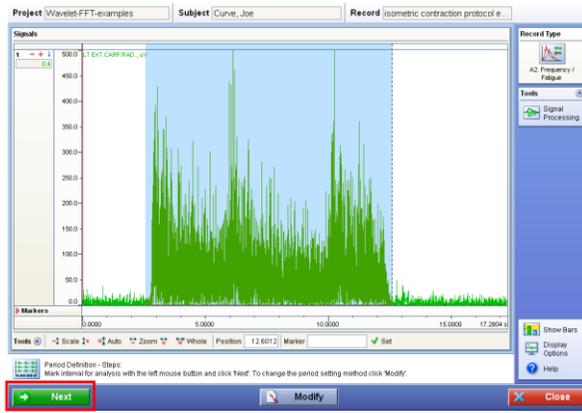
Record the measurement and click “Finish” when you are done and enter a name to save the recording.

A wizard will walk you through the steps to the Frequency/Fatigue report.



After saving the record, the Freq/Fatigue Protocol will automatically Signal Process the data. Review the Signal Processing, which in this case is Rectification. If the Signal Processing is correct, click Next.

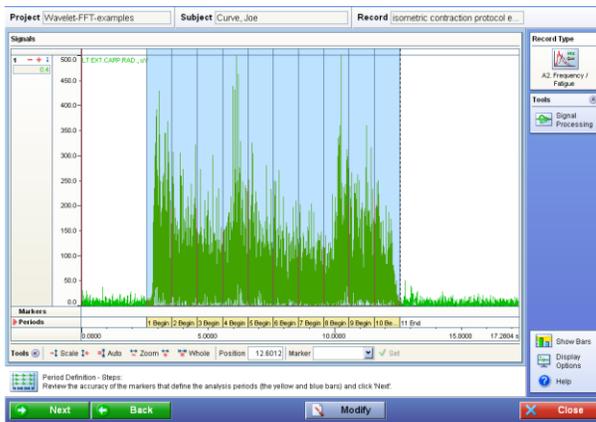
Frequency/Fatigue Report



For this record, I do not want to analyze the entire record, so I highlight the section I am interested in.

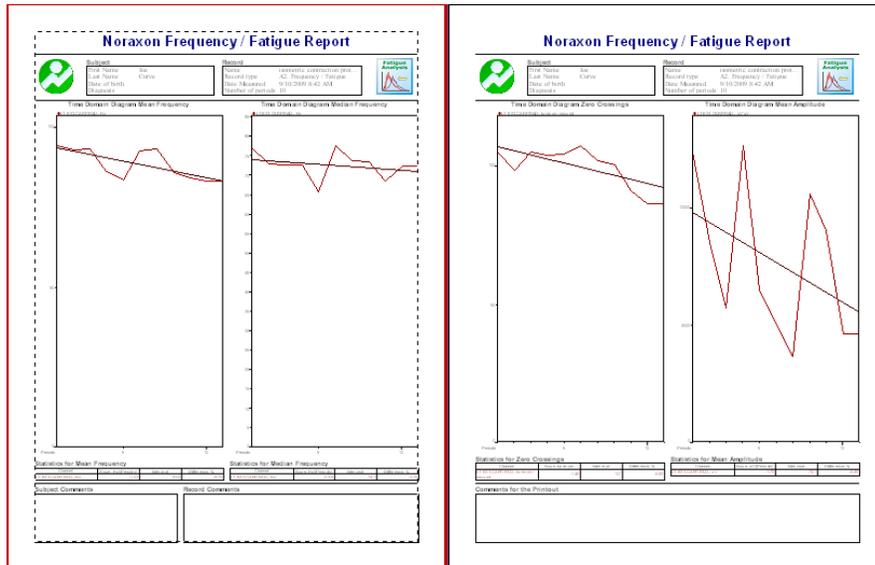
The periods will be set in 1 second steps in the highlighted region. If you would like to analyze the entire record, you do not need to highlight a region.

When you click "Next", the periods will be set in 1 second intervals. In this example, the periods will only be set in the highlighted region.



Review the Period settings. In this example, the period settings match the Periods I wanted. Click "Next".

If the period settings are not what you wanted to analyze, click "Back" and reset the Periods



Review the report and export the data if desired.

Frequency/Fatigue Report

If you want to use the **Master Mode** of the software, you will need to manually create the settings.

A. Measure, Save and View the record.

B. Add Signal Processing

1. In the Record Viewer, click on the Signal Processing icon.
2. Delete any processing operations from the Selected Operations.
3. Insert the Rectification operation into the Selected Operations.
4. Click OK on the Signal Processing window.
5. Review the applied Signal Processing and verify that it is what you want.

C. Analyze the Record (Data)

1. Click Analyze
 - If you only want to analyze a section of the record, highlight the section, then click Analyze

Select the Report

2. In the "Select Report" window, click on the "Standard Report" Tab and locate the "Frequency/Fatigue" Report.
3. Click on the Frequency/Fatigue Report, then click OK.
 - Alternatively, you can double-click on the Report.

Select the Report Settings (Report Setup Step Scheme Window)

Select Channels

5. The first step is to select the channels to analyze.
 - The default is "Channels by Type" – EMG.
 - If you do not want to analyze all the EMG channels in the record, click on the pull-down arrow and select "Channels by Number". Double-click in the box by the channels you want to analyze.
6. Click "Next"

Select the Periods

7. For the Frequency/Fatigue report, click on the period method "Steps".
8. Select the number of seconds for each interval.
 - The default is 1 second.
 - If the record is long, e.g. over 30 seconds, you may want to select a longer step interval, e.g. 10 seconds.
9. Click "SET". **This step is very important!!!**
 - If you skip this step, the periods selected will not appear on the record.
 - If you already have periods set for this record, first click "Delete All", then click "SET".
10. Click "Next"

Choose Comparison

11. Leave the "Enable Comparisons" box unchecked.
12. Click "Finish"

The Frequency/Fatigue Report is displayed.