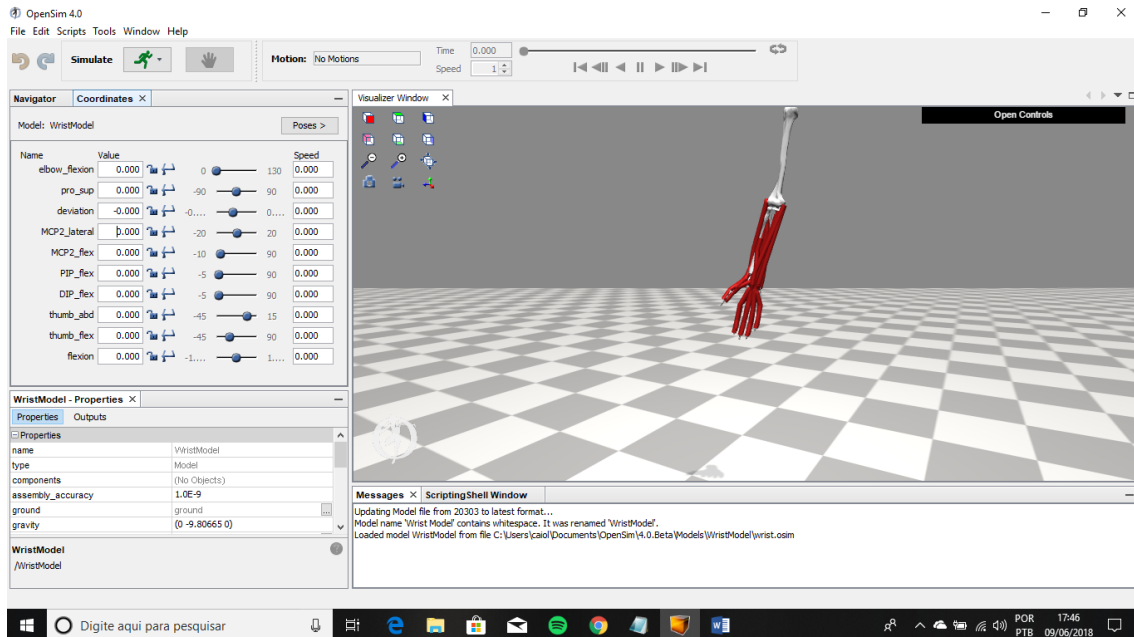


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## Tutorial 2



### Questions

1. Which motion is expressed in positive angles: wrist flexion or wrist extension?
2. Which motion is expressed in positive angles: radial deviation or ulnar deviation?

In this OpenSim model, muscles are grouped based on their function.

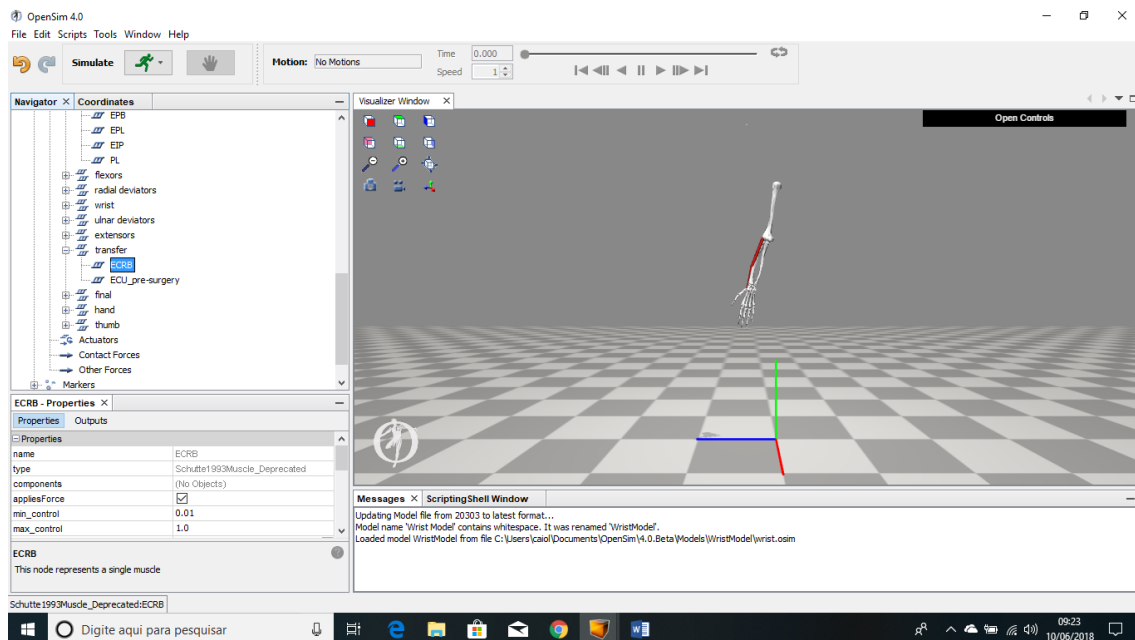
- In the Navigator, expand the **Forces** and **Muscles** headings. To expand a Navigator heading, click the plus icon  to its left.
- To hide all of the muscles in the model, **right-click** on the **all** muscle group heading, then choose **Display > Hide**.
- To show the *flexors* muscle group, **right-click** on the **flexors** heading, then choose **Display > Show**. Now the only muscles displayed should be the wrist flexors. To hide the wrist flexors, **right-click** on the **flexors** heading again and select **Display > Hide**.
- Repeat the same steps to display the **extensors**, **radial deviators**, and **ulnar deviators** muscle groups individually.

3. What are the functions of the Extensor Carpi Ulnaris (ECU) muscle? Check or circle all that apply.

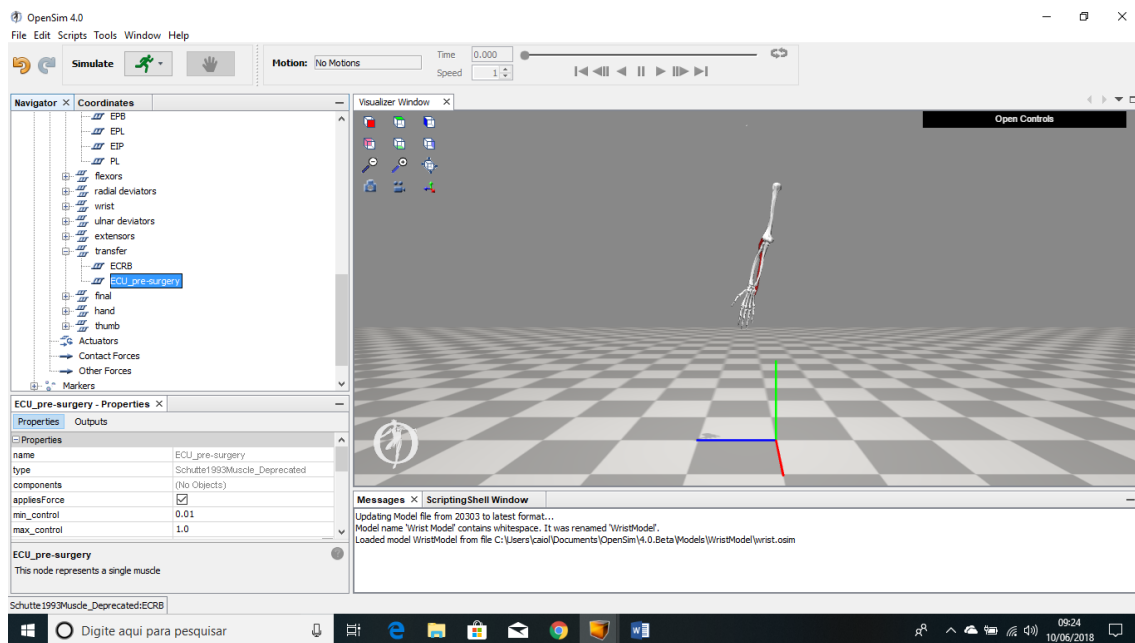
☐ wrist extension ☐ wrist flexion ☐ radial deviation ☐ ulnar deviation ☐ hip extension

4. What are the functions of the Extensor Carpi Radialis Brevis (ECRB)? Check or circle all that apply.

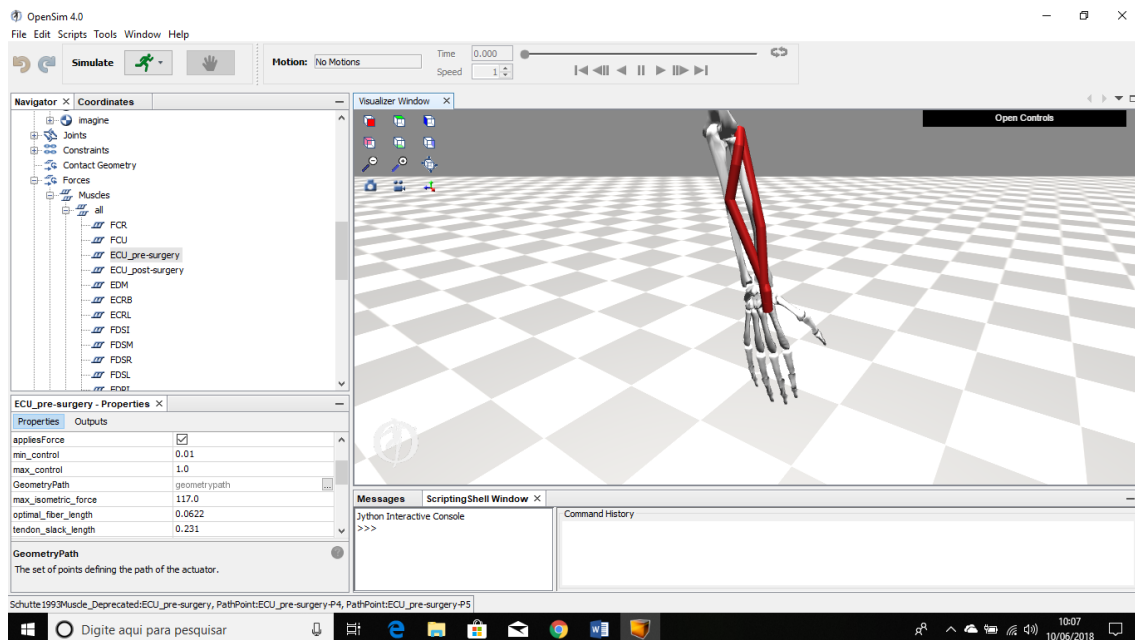
☐ wrist extension ☐ wrist flexion ☐ radial deviation ☐ ulnar deviation ☐ hip extension



ECRB



ECU-Pré Surgery



## Questions

5. Is the sign of the extension moment positive or negative?

6. What happens to the maximum moment of the wrist extensors if the ECU muscle is transferred to the ECRB?

*Hint: Remember, one of the goals of the surgery is to increase wrist extension strength.*

Now let's examine the effects of the transfer on the deviation strength of the wrist muscles.

- To delete the previous curves, select all the names from the **Curves List** and click **Delete**.  
*Note: To select multiple curve names, hold down **ctrl** while selecting.*
- Click **Y-Quantity** and select **moment > deviation**.
- To clear the muscle selection list, click the **deselect all shown** check box.
- Filter the **ulnar deviators** group and click the **select all shown** check box.
- To de-select the *ECU\_post-surgery* muscle, "un-check" the **ECU\_post-surgery** checkbox.  
*Note: Ensure the **sum only** checkbox is still selected and keep the muscle selection window open.*
- Click **X-Quantity** and select **deviation**.
- Edit the plot title to read **Wrist Deviation Moment vs. Deviation Angle**.
- Edit the **Curve Name** text to read **Before Transfer**. Then click **Add**.

Again, a curve labeled "Before Transfer" will appear on the plot, which is the sum of the isometric moments generated by all of the *wrist deviators* before the surgery. Do *not* to close this plot, as you will add more curves to compare the strength of the deviators after the transfer.

- To compare the strength of the ulnar deviators after the transfer, **de-select** *ECU\_pre-surgery* and **select** *ECU\_post-surgery* by clicking the appropriate check boxes in the muscle selection window.
- Edit the **Curve Name** text box to read **After Transfer**. Then click **Add**.

### Questions

7. *Is the sign of the ulnar deviation moment positive or negative?*
8. *What happens to the maximum moment of the ulnar deviators if the ECU muscle is transferred to the ECRB location?*
9. *One goal of this tendon transfer surgery is to decrease excessive ulnar deviation. Has your simulated surgery achieved this goal?*

After answering these questions, close the plotter window.

You are now going to take a more in-depth look at the effects of the tendon transfer on the function of the *ECU* muscle.

- Open a new plot, and click **Y-Quantity** and select **moment > flexion**.
- Click the **Muscles** button and select *ECU\_pre-surgery* and *ECU\_post-surgery* from the list.
- Click **X-Quantity** and select **flexion**.
- Edit the plot title to read **Wrist Moment vs. Flexion Angle**, and then click **Add**.
- **Hover** the cursor over a curve on the plot to see a tool tip that gives the coordinates of that particular point on the curve.

### Questions

10. *What is the peak value of the ECU extension moment before transfer? At what flexion angle does it occur?*  
*Note: Remember, extension moments are negative.*
11. *What is the peak value of the ECU extension moment after transfer? At what flexion angle does it occur?*
12. *Does the moment-generating capacity of the ECU vary more with flexion angle before or after the simulated surgery?*

Investigate the differences in wrist strength further by creating plots of **tendon force vs. flexion** and **flexion moment arm vs. flexion** for the *ECU\_pre-surgery* and *ECU\_post-surgery* muscles. *Note: You can open multiple plotter windows simultaneously. When finished, you should have created three three plots (flexion moment, tendon force, moment arm) in three separate plotter windows with two curves each.*

### Questions

13. Write down the peak values of each curve (**flexion moment, tendon force, moment arm**), the joint angle at which the peak occurs, and describe the general shapes of the curves.

OpenSim's Property Editor allows you to examine and edit the muscle parameters used to estimate the force-length curve of this muscle.

- To view the properties of a muscle, **click** on the muscle name in the Navigator. The muscle parameters are visible below the Navigator in the **Properties** window.

### Questions

14. What is the optimal fiber length of the ECU\_pre-surgery muscle?

15. What is the optimal fiber length of ECU\_post-surgery?

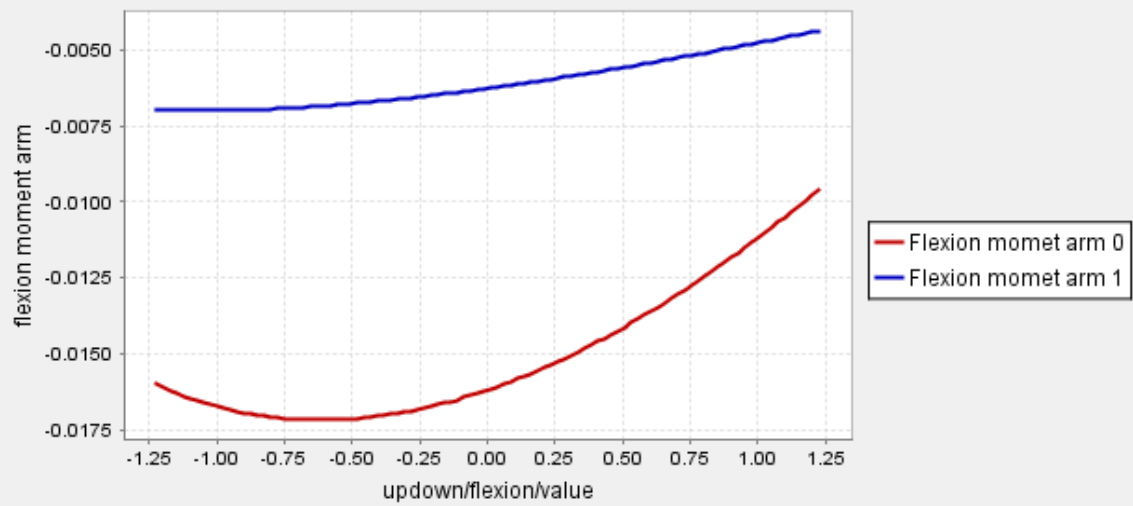
16. Calculate the ratio of optimal fiber length to peak moment arm for ECU\_pre-surgery and ECU\_post-surgery.

17. Explain the differences in the isometric moment vs. wrist flexion angle plots for the ECU\_pre-surgery and ECU\_post-surgery muscles, based on the plots of force and moment arm and the ratio of optimal fiber length to peak moment arm.

18. Specifically, what does the difference between the ratios of optimal fiber length to moment arm for the ECU before and after the tendon transfer tell you?

After answering these questions, close all of the plotter windows.

**Tendon force vs flexion**



**Tendon force vs flexion**

