Crunching the Numbers of In Vivo Bite Forces:
Evaluating the Safety of Post-Surgical Dietary Advice

Introduction to Mandibular Surgery

Mandibular surgery is a type of operation on the jawbone. Sometimes, due to injuries or other conditions, like birth defects, the jawbone gets broken or fractured. To fix this, surgeons use plates and screws to hold the bone fragments together. This helps the bone heal properly. However, while the bone is healing, it's important to be careful with what you eat. Certain foods can put too much stress on these plates and screws, potentially causing them to fail and disrupt the healing process.

The Problem with Current Dietary Guidelines

After surgery, doctors usually recommend eating soft foods. This is because chewing hard foods can put a lot of pressure on the jaw, which can damage the surgical implants. However, the advice on what foods to eat is often vague and based on personal experiences rather than scientific evidence. This means patients might accidentally eat foods that are too hard, risking their recovery.

Project Overview

Our project aimed to solve this problem by developing a special device to measure the forces produced when chewing different foods. With this information, we can create clear, evidence-based guidelines on what foods are safe to eat after jaw surgery. This helps ensure patients can recover without damaging their surgical implants.

The Chewing Force Measurement Device

Design and Function

We created a mouth splint that contains a force sensor. This splint is similar to a mouthguard but has a sensor that can measure how much force your teeth produce when you chew. The key component, the TekScan A201 FlexiForce Sensor, is sensitive, flexible, and fits comfortably in the mouth. Here's how it works:

1. **Mouth Scanning**: Scan the patient's mouth for an accurate model.
2. **3D Printing**: Print a dental model based on the scan.
3. **Vacuum-Forming**: Form a thin plastic disc over the model to create the splint.
4. **Sensor Placement**: Place the sensor in the splint to directly contact the molar, the tooth mainly used for chewing.

Calibration

Before using the splint to test different foods, we needed to ensure the force readings were accurate. We did this by:

1. Using an Instron Machine to apply known forces to the sensor.
2. Recording the sensor's voltage output at each force level.
3. Creating a conversion chart to translate voltage readings into force measurements.

Testing Different Foods

With the calibrated splint, we tested a variety of foods to determine the chewing forces they require. Force thresholds were set:

- **Safe Foods** (chewing force < 80 N)
- **Unsafe Foods** (chewing force > 90 N)
- **Potentially Unsafe Foods** (80 N < chewing force < 90 N)

Updated Dietary Guidelines

Based on our research, we created new guidelines for post-surgical diets. These guidelines specify which foods are safe, which are not, and how to prepare certain foods to make them safe.

Computer Modelling

To further understand the impact of chewing forces on the jaw, we used computer simulations. We created a 3D model of a mandible in SolidWorks and applied different forces to see how the jaw would strain. The results showed a clear relationship between the applied force and the amount of strain on the jawbone. This information helps us understand how different foods might affect healing after surgery.

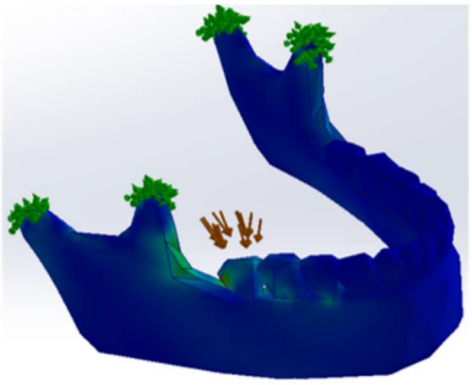
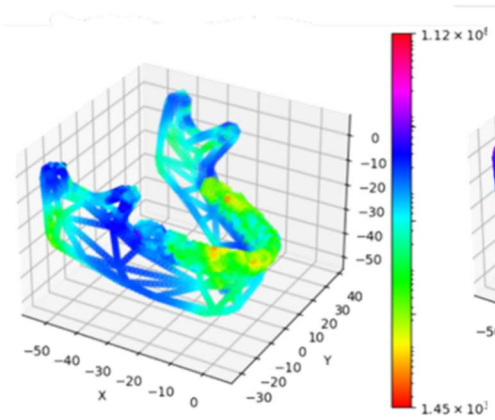
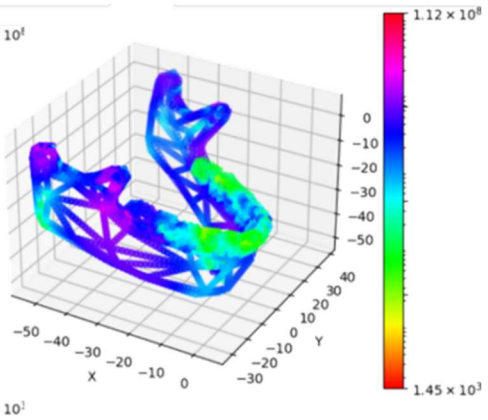


Figure 21: Restrained FEM Modelling



(a) 50 N applied chewing force



(c) 200 N applied chewing force

Future Work

While our research has provided valuable insights, more testing is needed to refine these guidelines further. We aim to test the device on a larger group of people from different demographics to ensure the results are generalisable.

Conclusions

Our project has made significant strides in ensuring the safety of post-surgical dietary advice for jaw surgery patients. By using a specially designed force sensor mouth splint, we've been able to measure the forces involved in chewing different foods accurately. This allows us to create clear, evidence-based dietary guidelines that help patients recover safely and effectively.

Thank you for participating in our workshop. We hope you found this information helpful and interesting!

Workshop Activity: Evaluating Chewing Forces in Foods

Objective:

To understand the importance of dietary guidelines after mandibular surgery and to learn how to evaluate foods based on chewing forces.

Materials Needed:

- A variety of food samples (clementine, banana, pear, apple, pepper, milk chocolate, honeycomb chocolate, cake, bread, baguette)
- Paring Knife

Activity Plan:

1. Introduction

- Purpose of the activity: to determine which foods are safe to eat after jaw surgery based on chewing forces.

2. Food Sampling and Hypothesis

- Make initial guesses about which foods you think are safe, potentially unsafe, or unsafe based on prior personal experience.

3. Measuring Chewing Force

- Chew each item and mark down if you think it is safe to eat or not. Write down if any specific preparation is required to make it safe to eat

4. Analysing and Categorising

- Compare your initial guesses with the actual measurements and discuss any surprises or insights.

5. Discussion and Conclusion

Worksheet Template:

Food Safety Evaluation Worksheet

Food Item	Initial Guess (Safe/Potentially Unsafe/Unsafe)	Final Guess (Safe/Potentially Unsafe/Unsafe)	Any Specific Required Preparation