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Project 2

Device for Tooth Extraction

Amey Damjee l 166130013

Guided by- Prof. Vijay Bapat

What is Tooth Extraction?

Dental extraction l tooth extraction l exodontia l exodontics l

or informally**, tooth pulling**

- Tooth extraction is a process of removing a teeth from the dental alveolus (socket) in the alveolar bone.
- It can be simple or complex process depending on the tooth which is extracted.

When should it be done?

Following are some of the conditions where it may be difficult to save the tooth:

- **A fractured tooth which cannot be restored**
- A tooth which is affected by infection
- Severe caries or gum diseases
- Baby teeth that remain leading
- Serious orthodontic problems
- Wisdom Teeth also called as third

Crack tooth Non-treatable

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Tooth Infection

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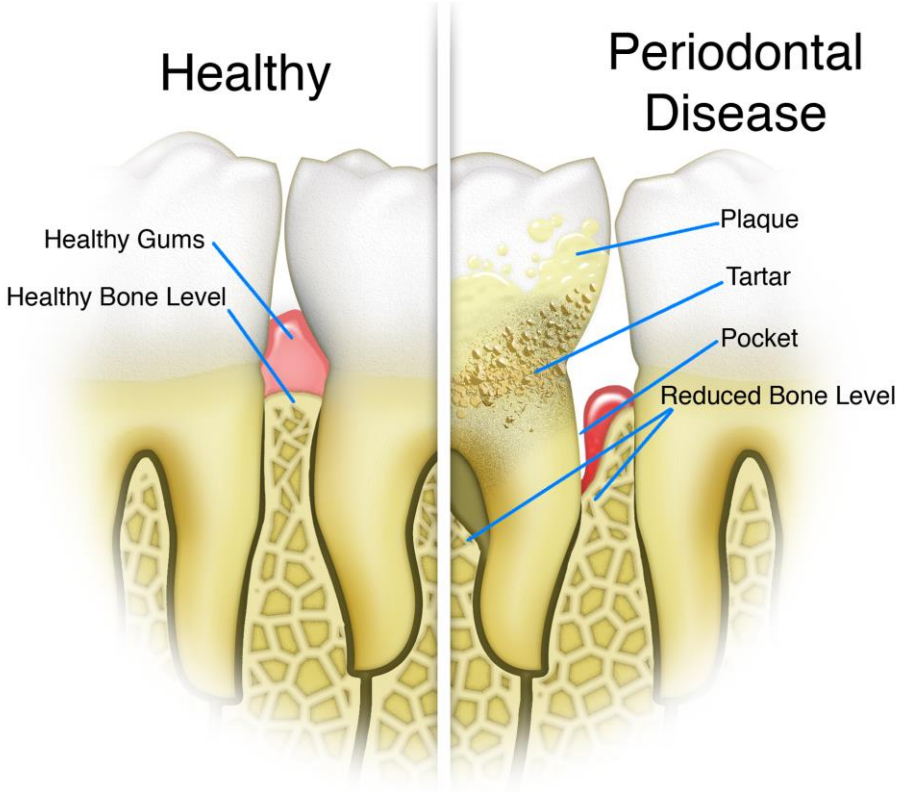

Gum diseases

When should it be done?

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Baby teeth Xray

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- A tooth which is affected by infection
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- **Serious orthodontic problems**
- Wisdom Teeth also called as third

Orthodontic Problem

When should it be done?

Following are some of the conditions where it may be difficult to save the tooth:

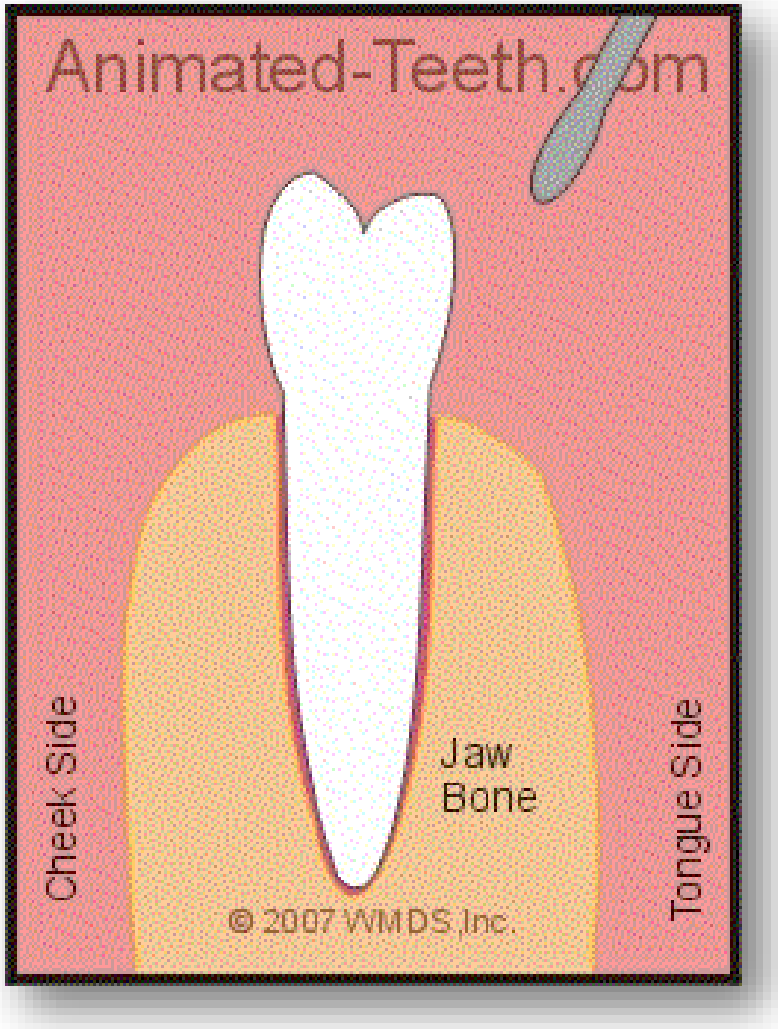
- A fractured tooth which cannot be restored
- A tooth which is affected by infection
- Severe caries or gum diseases
- Baby teeth that remain leading
- Serious orthodontic problems
- **Wisdom Teeth also called as Third molar**

Wisdom teeth

Conventional Extraction Technique

Dental Elevators

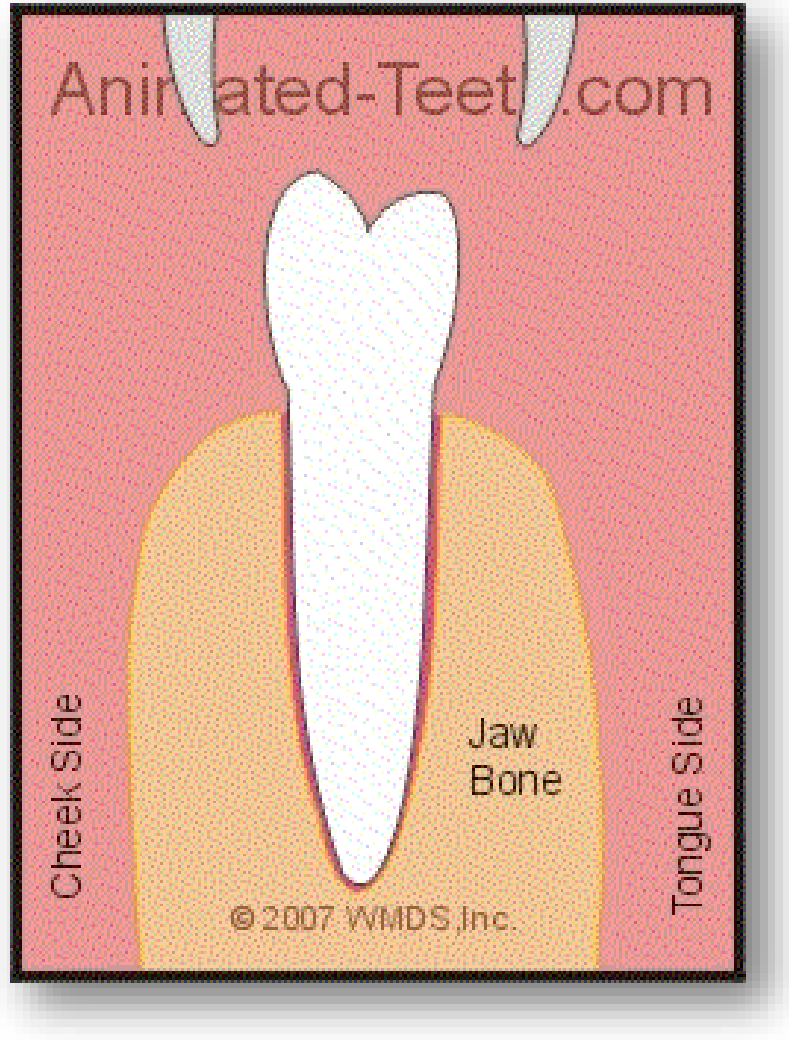
- Elevator **wedge** into the ligament space
- **Breaking the Periodontal** ligaments and expanding the bone socket.
- the tooth becomes mobile.
- Dentist may be able to **completely remove** the tooth just using their elevator.
- If not, they will switch to **using extraction forceps** to complete the job.



Conventional Extraction

Extraction Forceps

- Grip **firmly and deliberately rock**
- Bone socket will gradually start to **expand**
- The dentist will also **rotate the tooth back and forth**. This twisting action helps to **rip and tear** the tooth away from the ligament.
- At some point, the socket will be enlarged enough, and the ligament torn away enough, that the tooth can be easily removed.



Existing Tooth extraction tool and Device

Physics Forceps

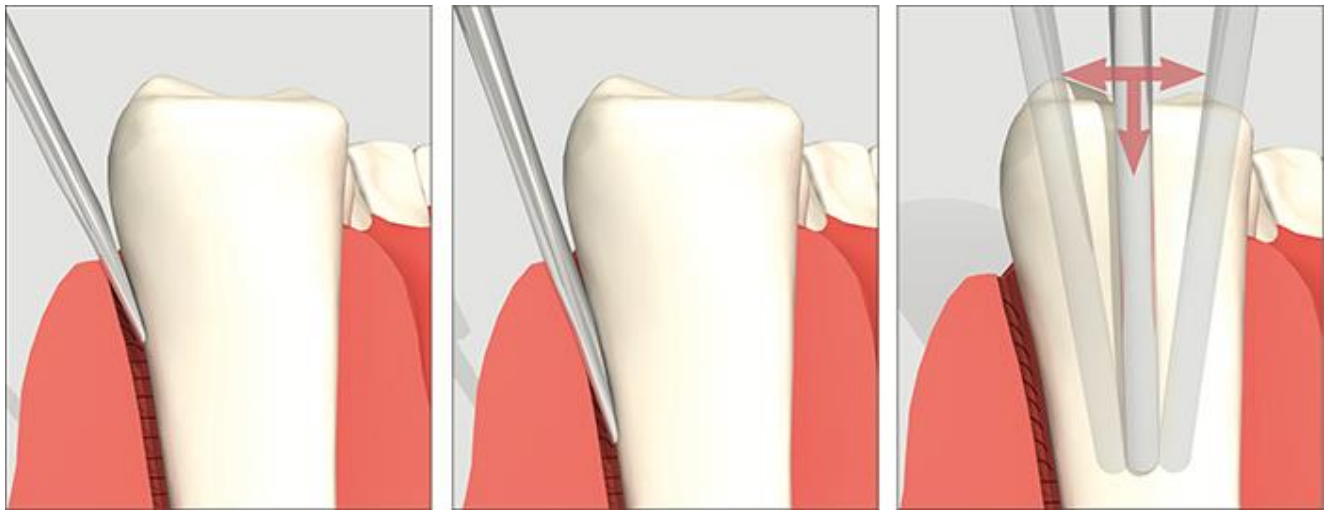
- Efficient extraction
- No need of clamping force
- Less fatigue to dentist

Existing Tooth extraction tool and Device

Proximators

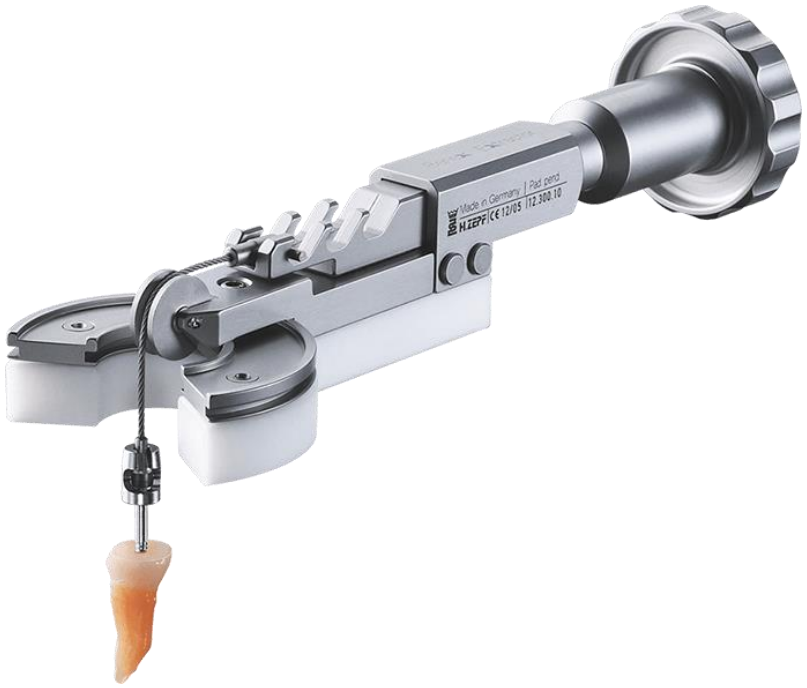
a) Periotome

- Least traumatic to bone as no force applied
- Time consuming



Existing Tooth extraction tool and Device

Benex Extractor and exomed



Existing Tooth extraction tool and Device

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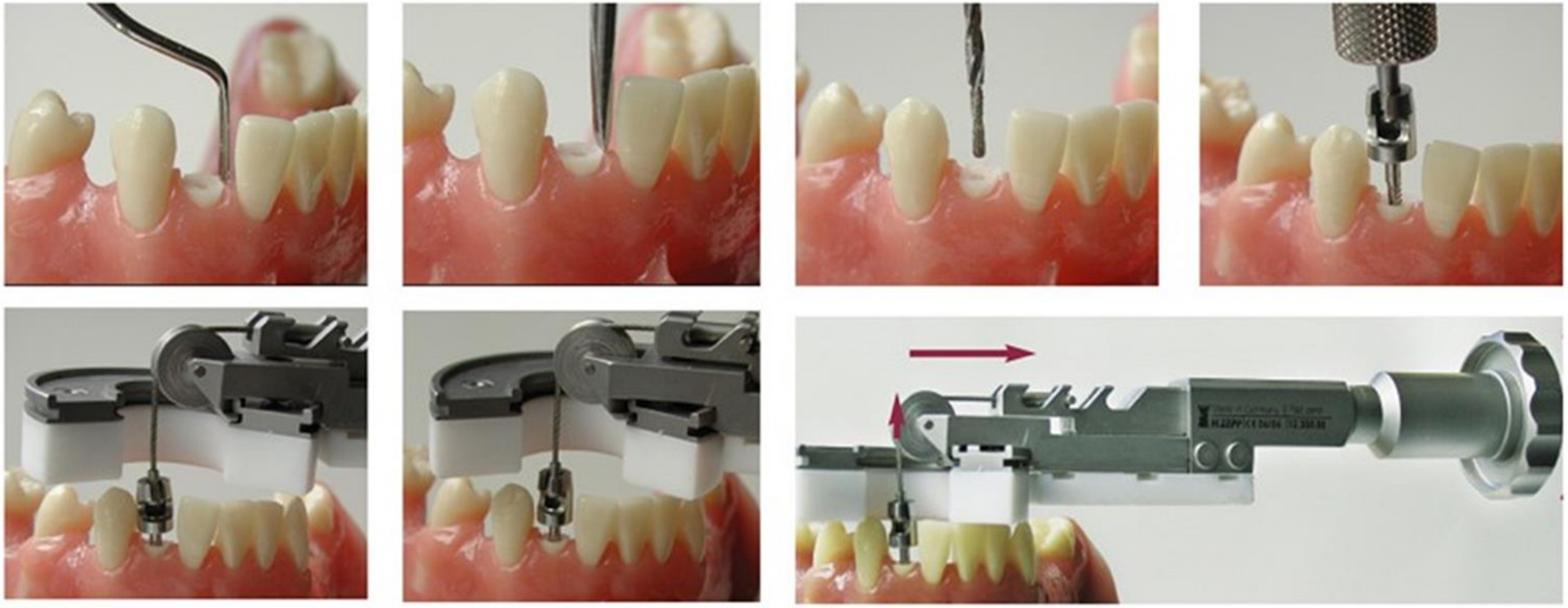

Clinical Immersion

Dentists Meets

Dr. Neeraj Rohida
(PhD - Orthodontics & Dentofacial Orthopaedics, BDS Orthodontics)

- **Atraumatic tooth extraction** without any bone fracture and expansion of socket is really necessary for dentists and paisiant both.
- **Stresses** on hand especially wrist is more you will feel **tired** after extraction
- In case of molar and healthy tooth **forces required** to remove tooth is much higher,and even control pressure application make it more difficult.
- physics forceps is **much quicker** tool but it leads to **fracture of alveolar** bone and **breaking of root** in bone cavity .

Clinical Immersion

Dentists Meets

Dr. Neeraj Rohida
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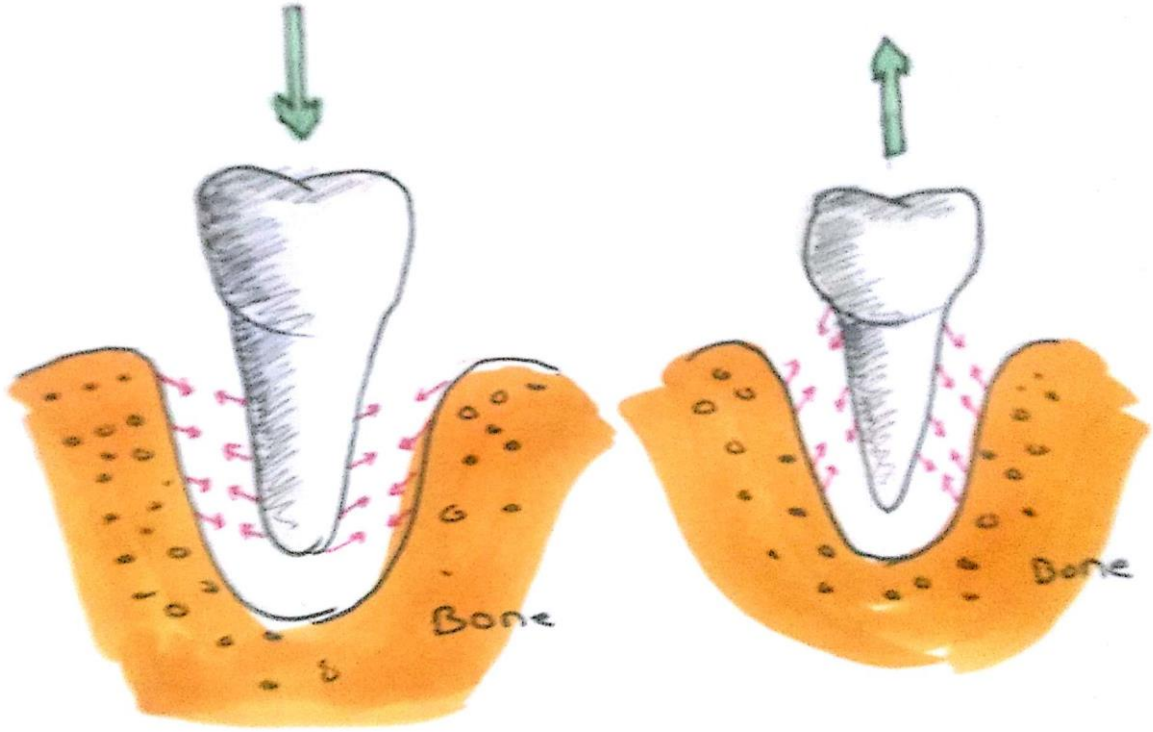
- Some **assistive tool** reducing forces required for extraction is needed
- There are **different forceps** for different type of tooth, Beak orientation and gripping portion will be different
- With conventional forceps movement and forces are **depend on skills** of the dentist
- For removal of incisor ,canine will be no problem as forces required are less and accessibility is more but in **premolar and molar** it becomes **difficult** and time consuming also

Need for tooth extractor

- Increase in use of implant creating the need of aromatic tooth extraction
- For immediate placement of the implant preserving bone socket is necessary
- **Stresses** on hand especially wrist is more you will feel **tired** after extraction
- Some **assistive tool** reducing forces required for extraction is needed
- For removal of **premolar and molar** it becomes **difficult**
- In case of molar and healthy tooth **forces required** to remove tooth is much higher, and even control pressure application make it more difficult.

Insights

PDL is very weak in tension as majority of its fibers are adept to handling compression and not tension.



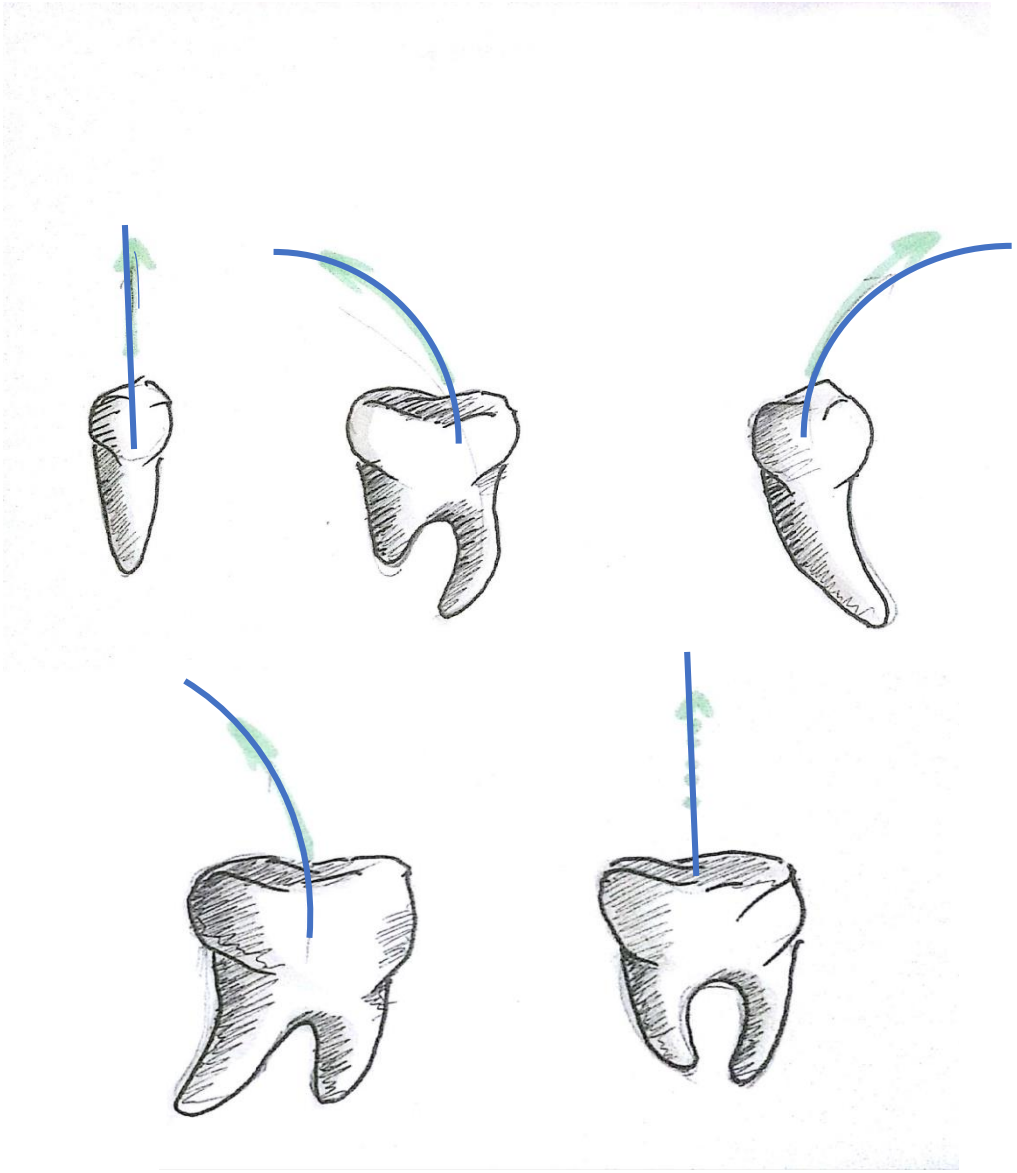
Compressive load on PDL
While chewing

Tensile load on PDL
While extraction

Insights

- PDL is very weak in tension as majority of its fibers are adept to handling compression and not tension.

Minor force required to breakdown PDL and major contributor to resistance to tooth orientation and bone lock.



Vector direction of extraction

Insights

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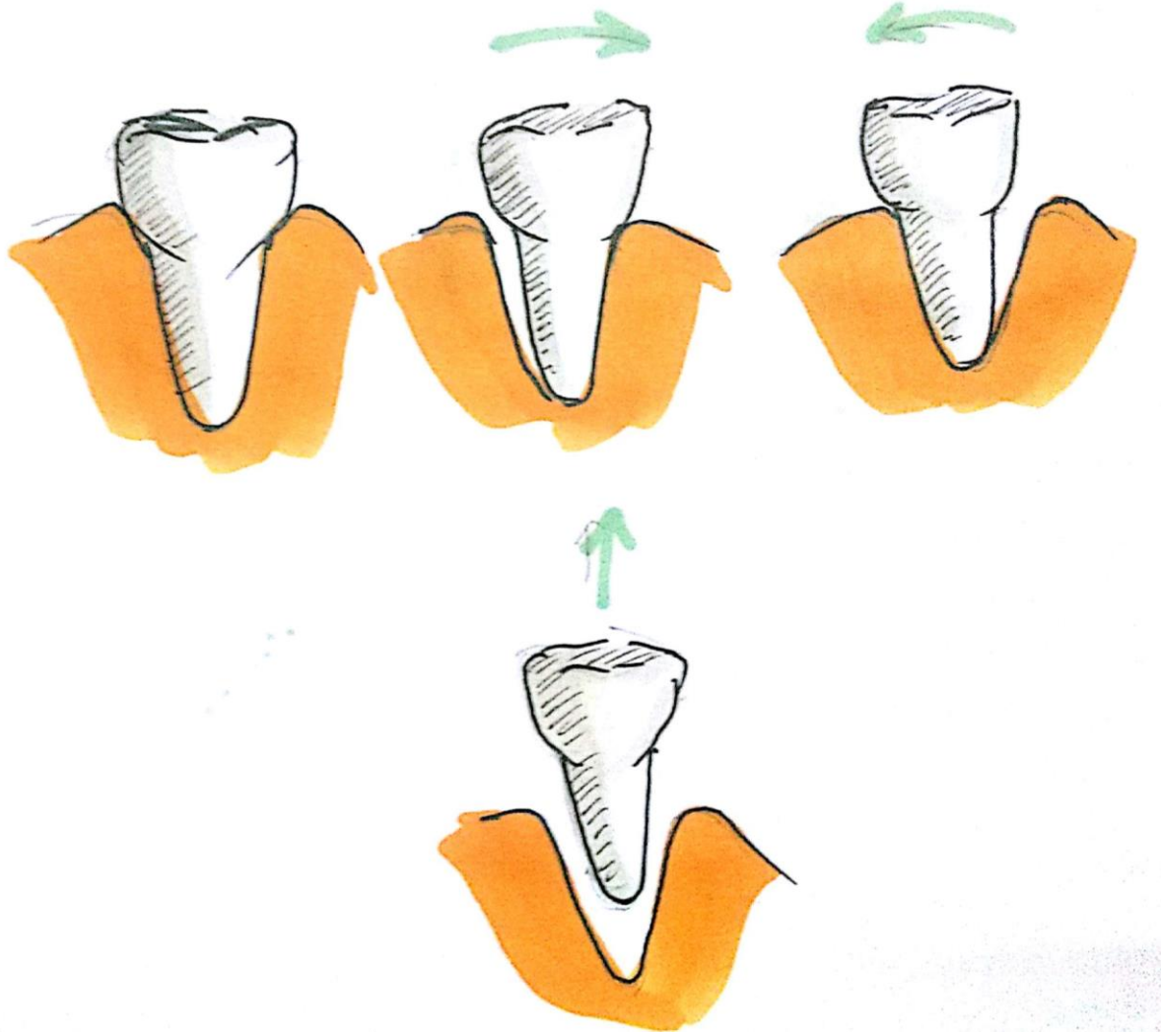
Alveolar bone is porous and deformable.



Tooth rocking to compress alveolar bone

Insights

- PDL is very weak in tension as majority of its fibers are adept to handling compression and not tension.
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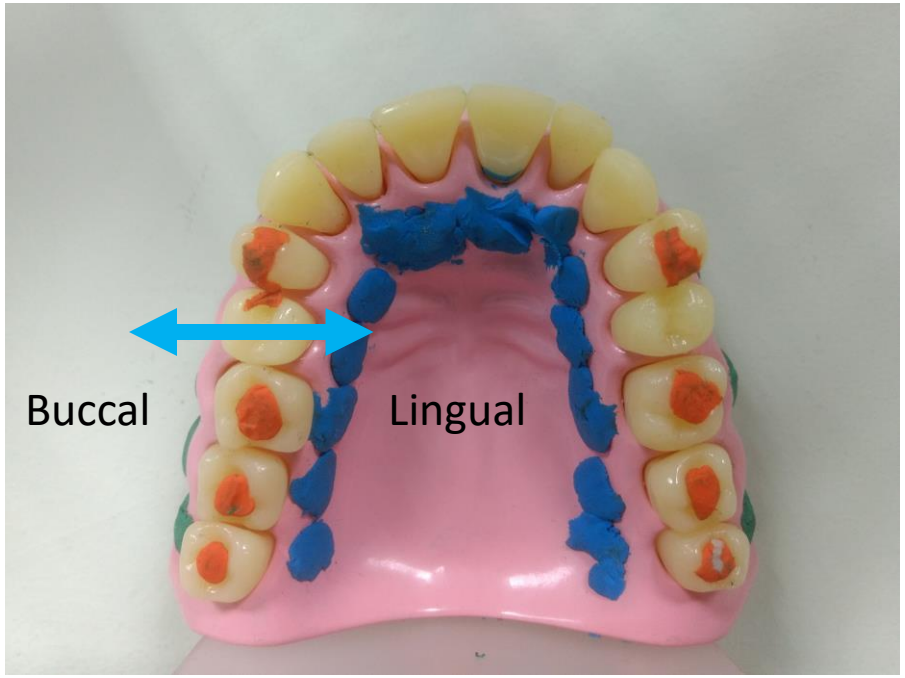
Bone thickness-difficult to extract in mesial or distal direction as adjacent teeth are present so it always extracted in buccal and lingual direction



Buccal and lingual direction

Insights

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Bone thickness-difficult to extract in mesial or distal direction as adjacent teeth are present so it always extracted in buccal and lingual direction

Bone thickness marking

- Thinner bone
- Relatively thicker bone

Bone thickness marking

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Some teeth difficult to extract and reasons of difficulty

Teeth difficult to extract

Difficult to extract marking

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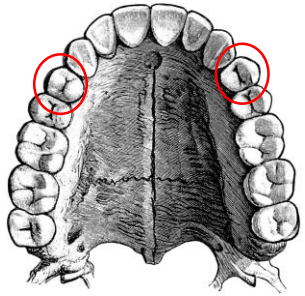
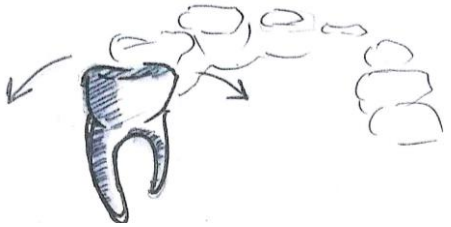
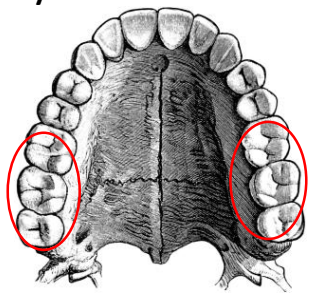
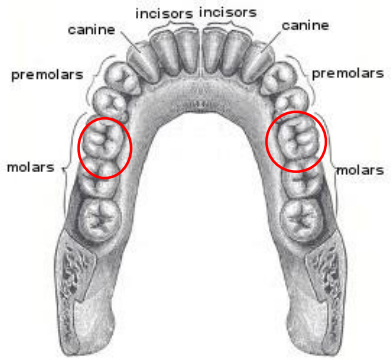
Some teeth difficult to extract and reasons of difficulty

Type of tooth	Reason
Maxillary 1st premolar 	Teeth have 2 slender roots in buccal and lingual 
Maxillary Molars 	Molar have 3 roots. 1st molar have widely diverge 
Mandibular 1st molar 	2 roots in mesial and distal direction. Surrounded by Thickest b 

Insights

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- Alveolar bone is porous and deformable.
- Bone thickness-difficult to extract in mesial or distal direction as adjacent teeth are present so it always extracted in buccal and lingual direction
- Some teeth difficult to extract and reasons of difficulty

Brief

Objective

“Developing an easy to use tooth extraction device for dentist to minimize trauma”

Brief

“Developing an easy to use tooth extraction device for dentist to minimize trauma”

Primary Need

- Ergonomic and easy to use.
- Withstand autoclave temperatures.
- Assist dentist with mechanical or some kind of assistance.
- Device should work in small available space.

Brief

“Developing an easy to use tooth extraction device for dentist to minimize trauma”

Primary Need

- Ergonomic and easy to use.
- Withstand autoclave temperatures.
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- Device should work in small available space.

Secondary Need

- Device might include Light for better visibility.

Brief

“Developing an easy to use tooth extraction device for dentist to minimize trauma”

- **User related issues**
  - Easy to make tool ready for specific tooth extraction
- **Servicing issues**
  - Withstanding class II device sterilisation

Brief

“Developing an easy to use tooth extraction device for dentist to minimize trauma”

- **User related issues**
  - Easy to make tool ready for specific tooth extraction
- **Servicing issues**
  - Withstanding class II device sterilisation
- **Manufacturing issues**
  - Medical grade material to be used
  - The material should be easy to clean
- **Operating condition**
  - To be used in sterile conditions after sterilization
  - Devices should be placed properly on tray near the dentist within easy reach of at least the assistant

Functional Requirements

“Developing an easy to use tooth extraction device for dentist to minimize trauma”

- Autoclavable
- Device should be smart and easy to use
- Time required should be minimal
- Roots/root tip should not break while extraction
- No trauma to bone
- device should also work on broken crowns
- Easy extract multi rooted teeth and teeth with curved roots

Scope

The device will address to need of Atraumatic tooth extraction for multy rooted pre-molar and molars

high chances of bone fracture , gum trauma and root tip breakage. Bone preservation becoming priority for implants

Feature not addressed

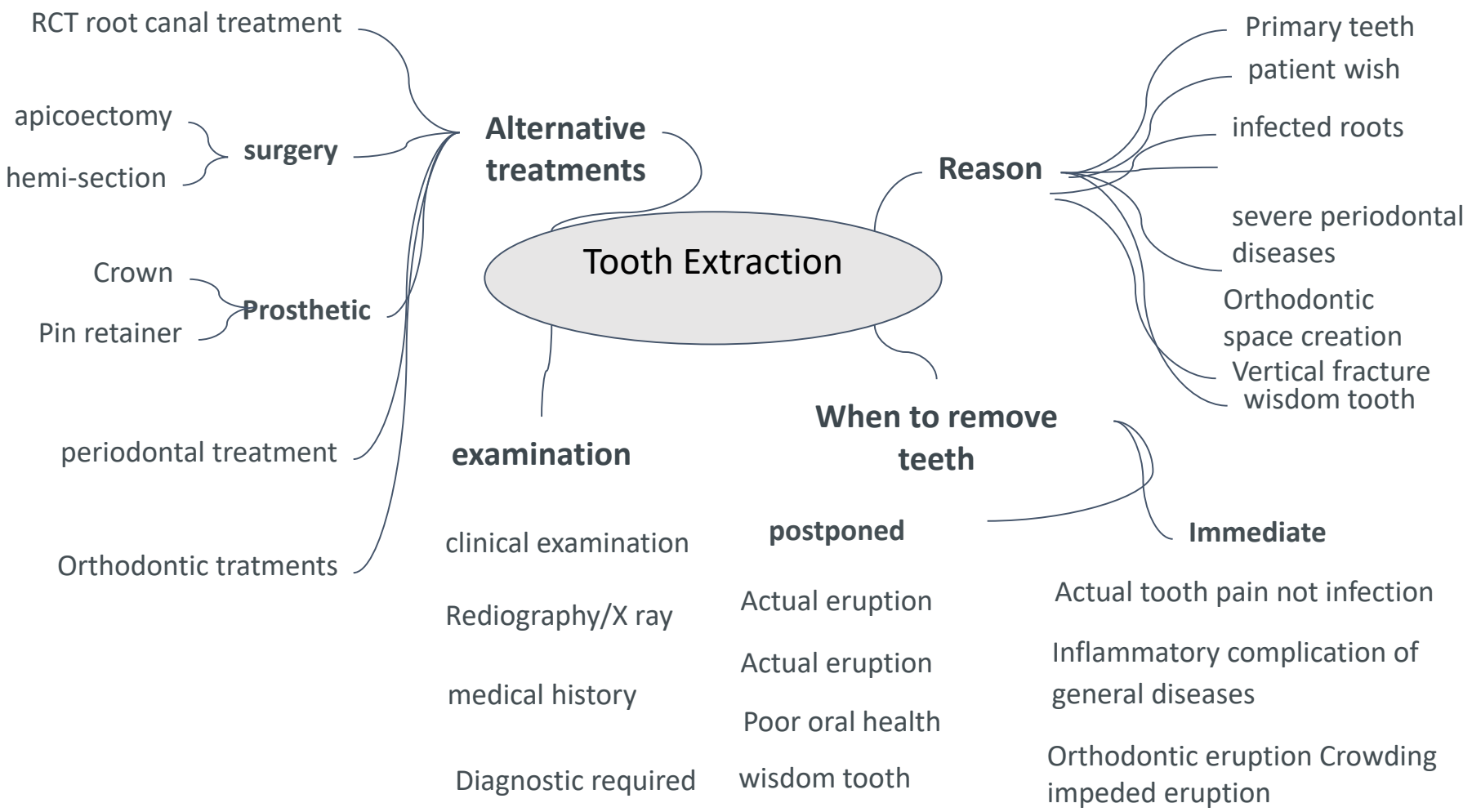
Singe rooted incisors and canons extraction

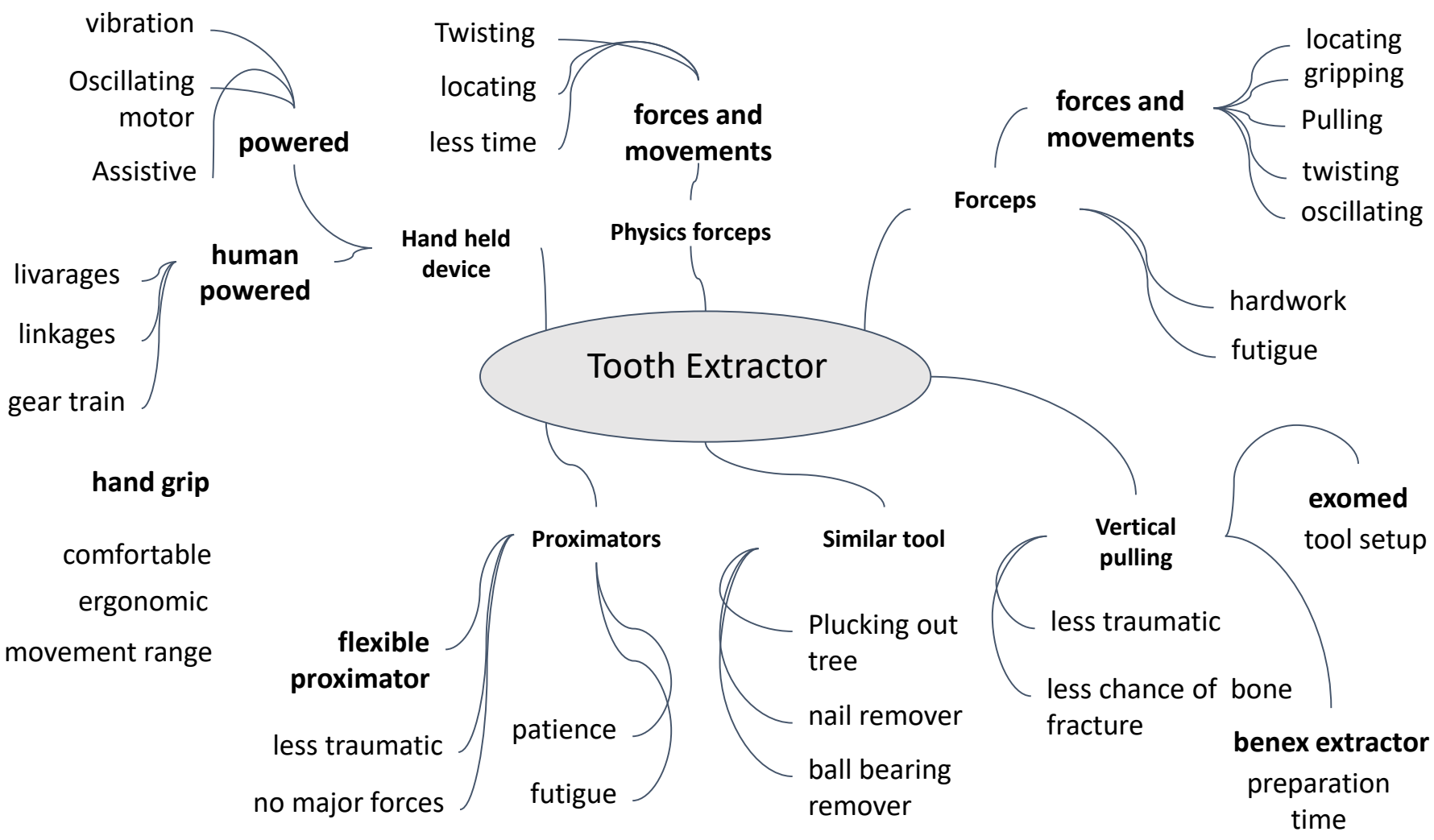
extraction of single rooted tooth is easy

Wisdom tooth extraction

wide variation –totally different surgical operation required

Ideations

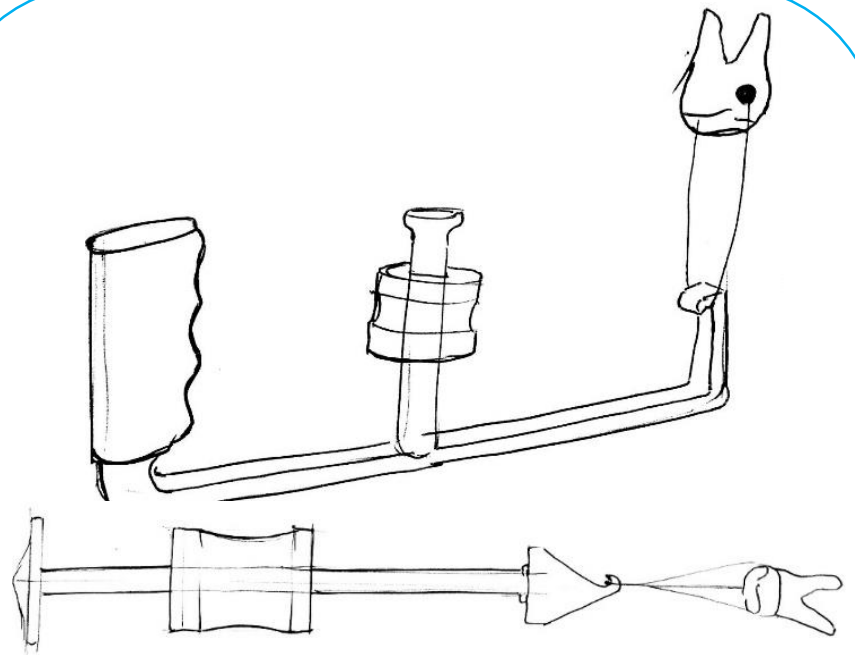

Tooth Extraction
Alternative treatments
RCT root canal treatment
surgery
apicoectomy
hemi-section
Prosthetic
Crown
Pin retainer
periodontal treatment
Orthodontic tratments
Reason
Primary teeth
patient wish
infected roots
severe periodontal diseases
Orthodontic space creation
Vertical fracture
wisdom tooth
examination
clinical examination
Rediography/X ray
medical history
Diagnostic required
When to remove teeth
postponed
Actual eruption
Actual eruption
Poor oral health
wisdom tooth
Immediate
Actual tooth pain not infection
Inflammatory complication of general diseases
Orthodontic eruption Crowding impeded eruption


Tooth Extractor
Hand held device
powered
vibration
Oscillating motor
Assistive
human powered
livarages
linkages
gear train
hand grip
comfortable
ergonomic
movement range
forces and movements
Twisting
locating
less time
Physics forceps
Forceps
forces and movements
locating
gripping
Pulling
twisting
oscillating
hardwork
futigue
Proximators
flexible proximator
less traumatic
no major forces
patience
futigue
Similar tool
Plucking out tree
nail remover
ball bearing remover
Vertical pulling
less traumatic
less chance of fracture
exomed
tool setup
bone
benex extractor
preparation time

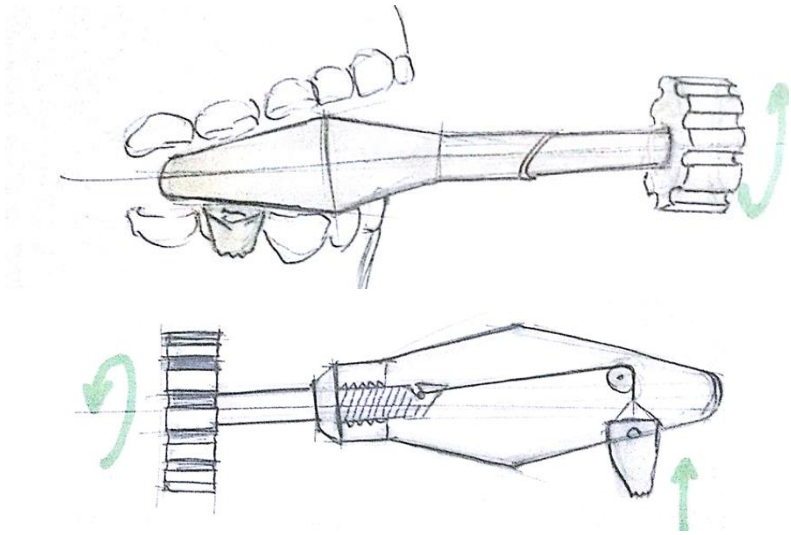
Brainstorming

Sr.No.	Technique	Advantages	Disadvantages
1	Pulling	Used by exomed and benex	Chance of fracture
2	Taping screw	No bone expansion	Process time
3	Vibration	Helps to loosen up	
4	Cut PDL cutter	periotoms	Time consuming
5	Burn PDL		localization
6	squeeze bone		Bone damage
7	Make bone grow		Time consuming
8	Water jet/Air jet		localization
9	Micro robot breaking PDL		Technology, space
10	fatigue		
11	Micro explosion		Bone tissue damage
12	sectioning	Used for molars	Time consuming
13	Braces and chewing action		Time consuming
14	Ultrasonic		
15	Thread winding		
16	Oscillating arm	Loosen up the teeth	

Brainstorming

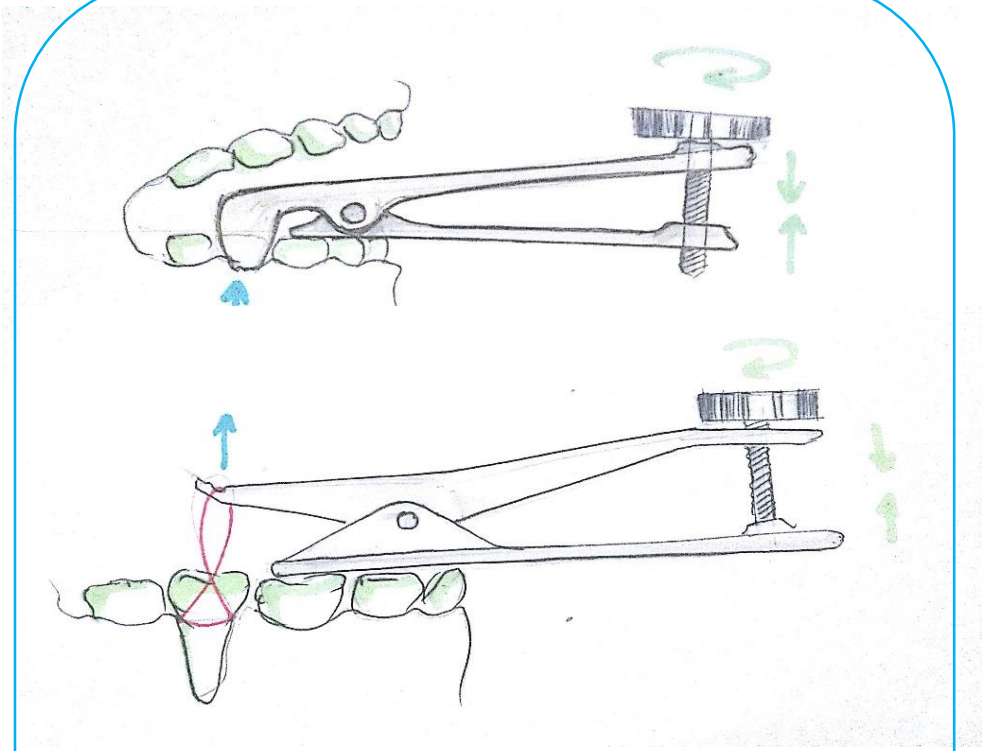


Manual Hammer

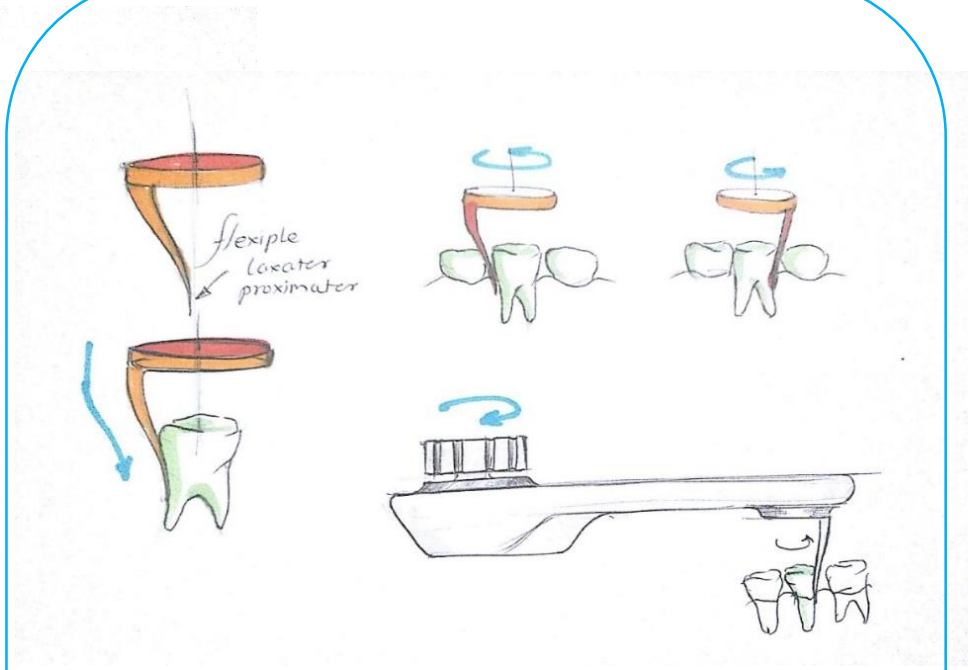


Gum bite inspired tooth crane

Brainstorming

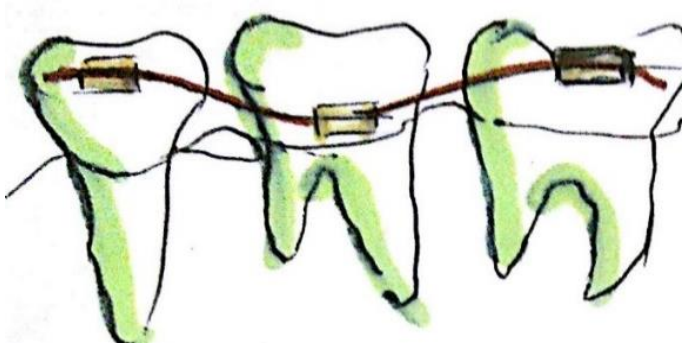


Screw-jack mechanical assistive system

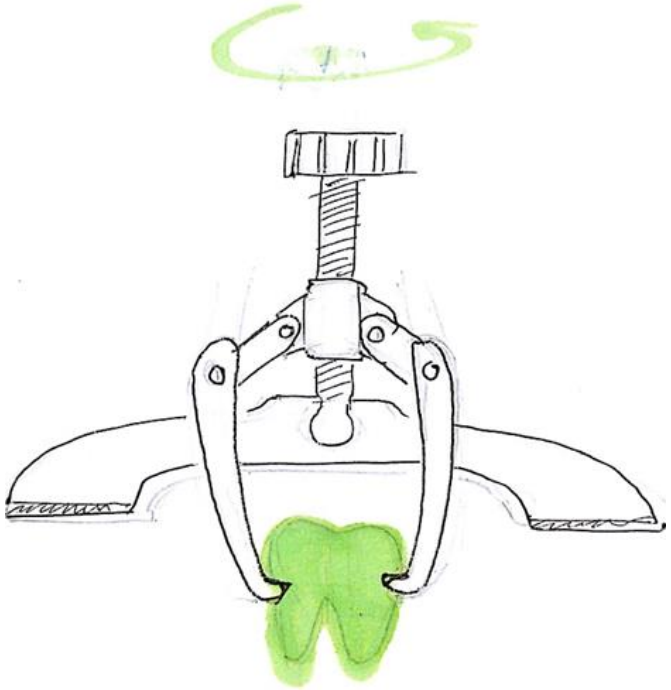


Flexible blade

Brainstorming

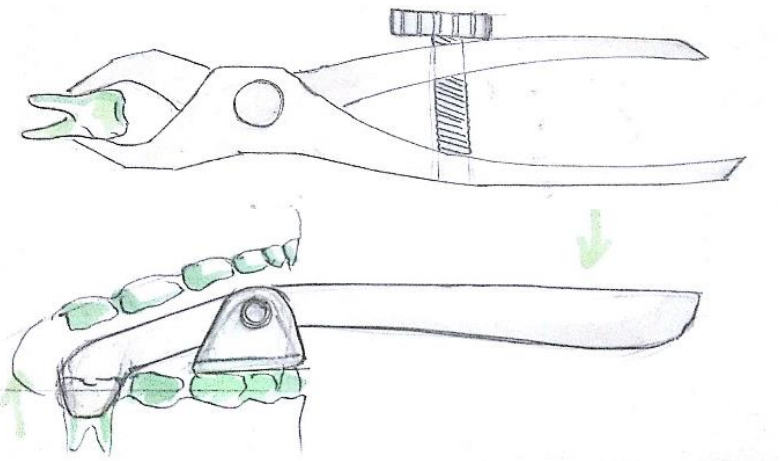


Dental braces

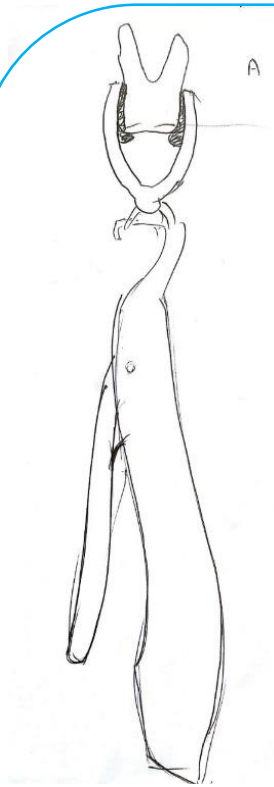


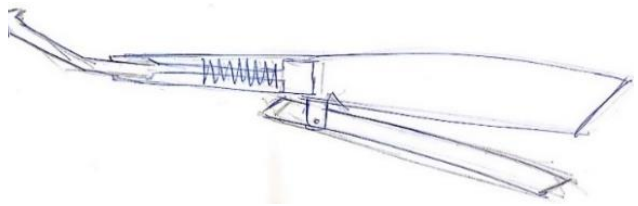
Inspired from bearing remover

Brainstorming



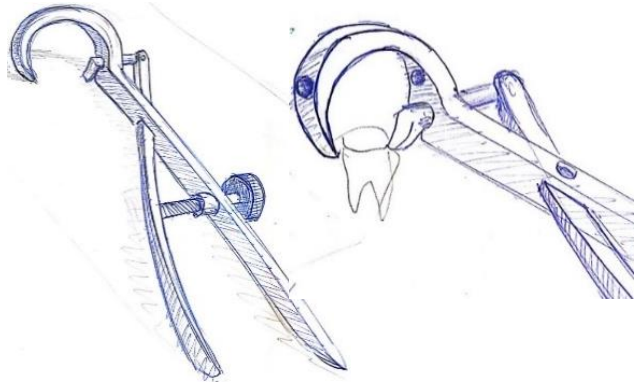
Locking plier which take leverage



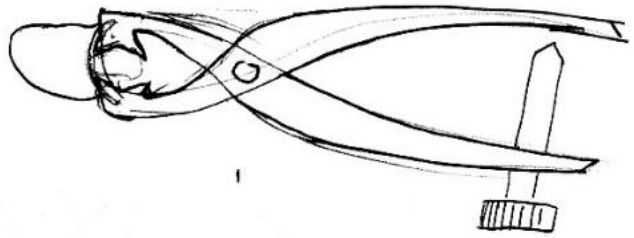


Vibrator

Brainstorming

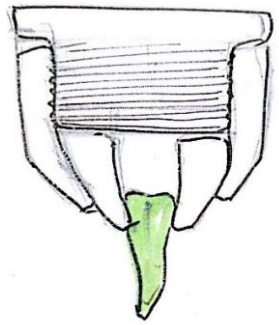


Offset plier

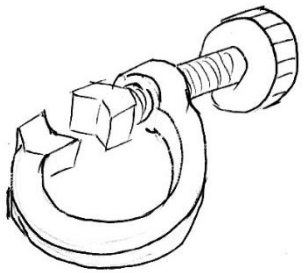


Locking plier

Tooth grippers

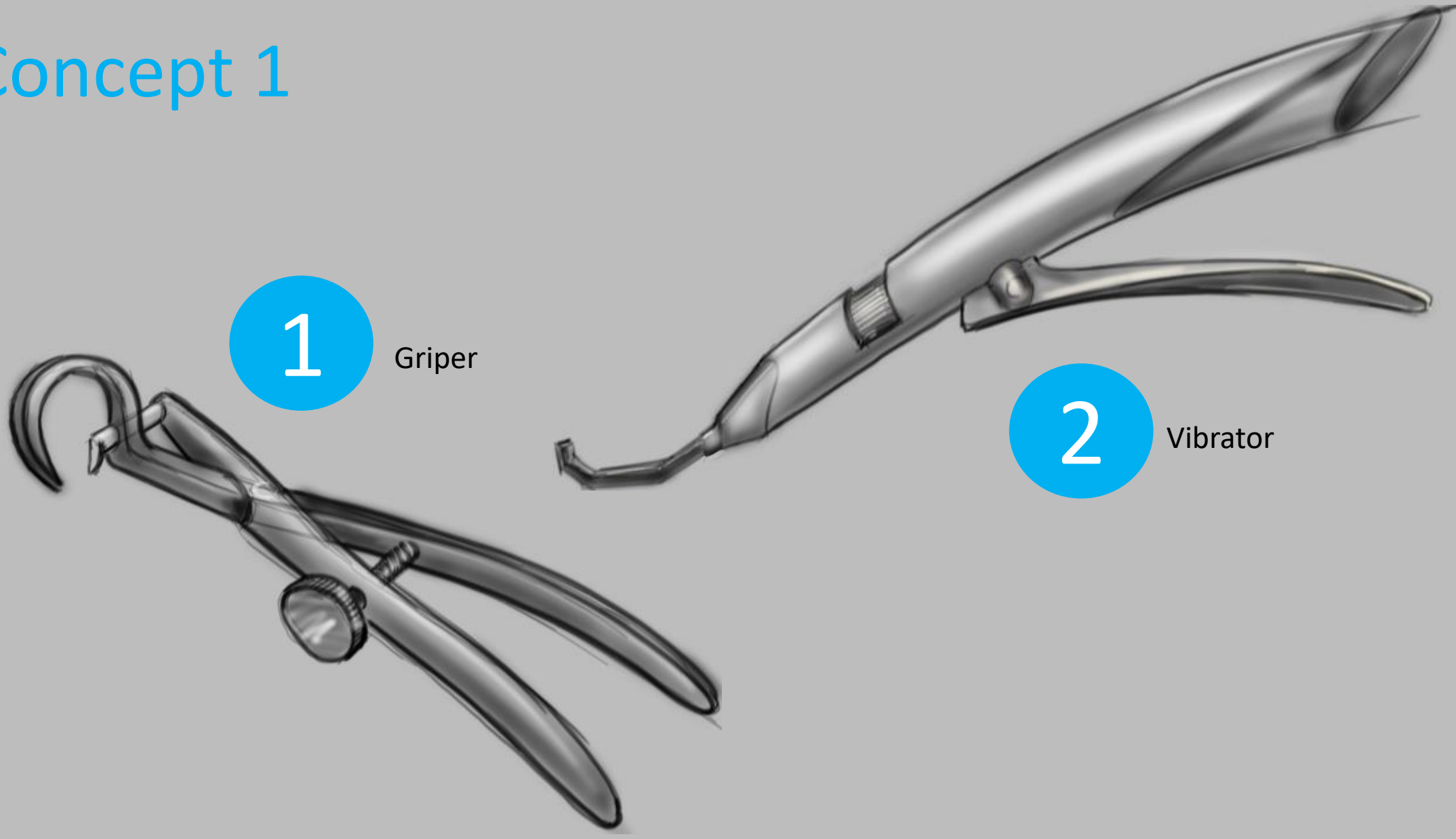


Drill chuck



C clamp

Concept 1



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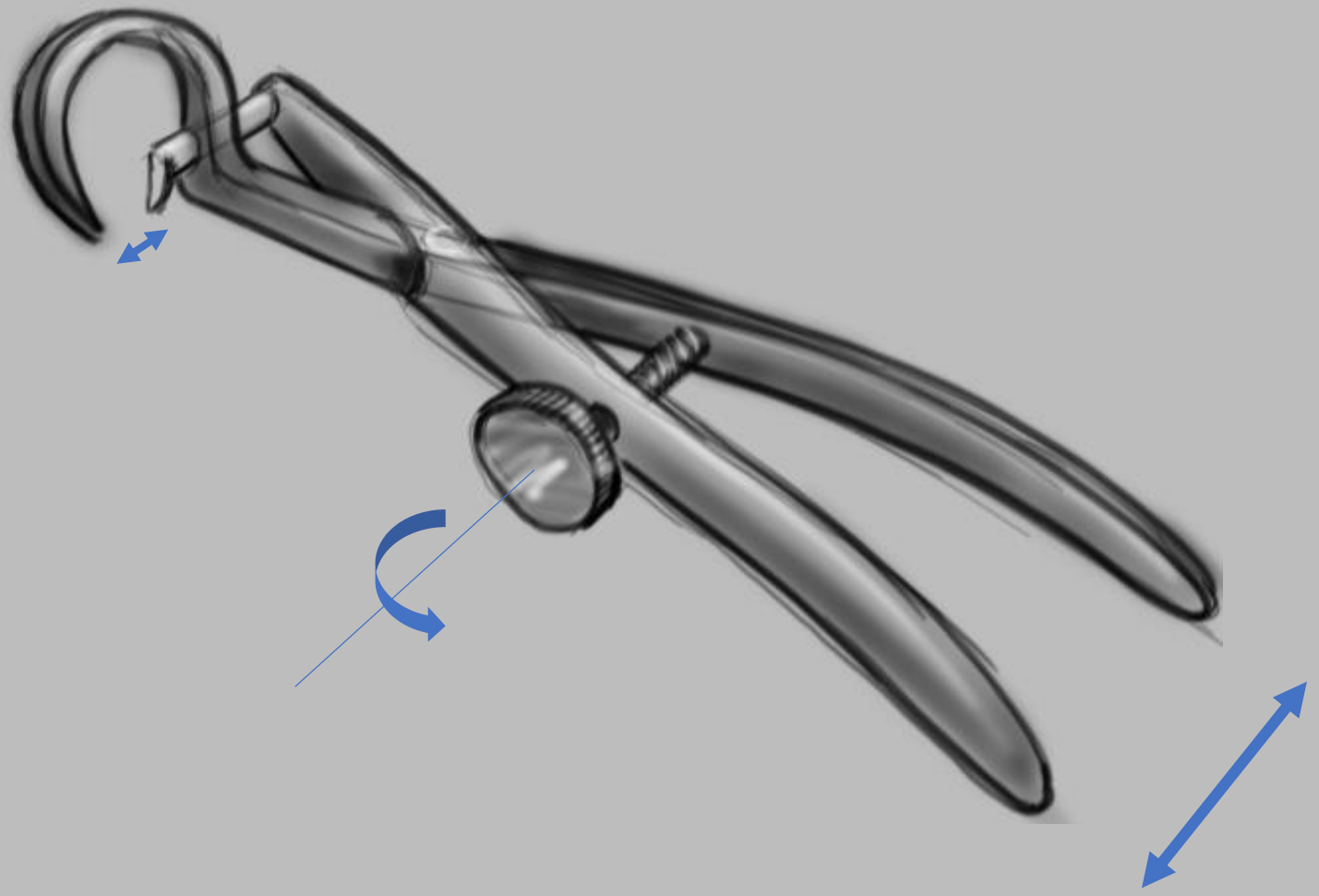

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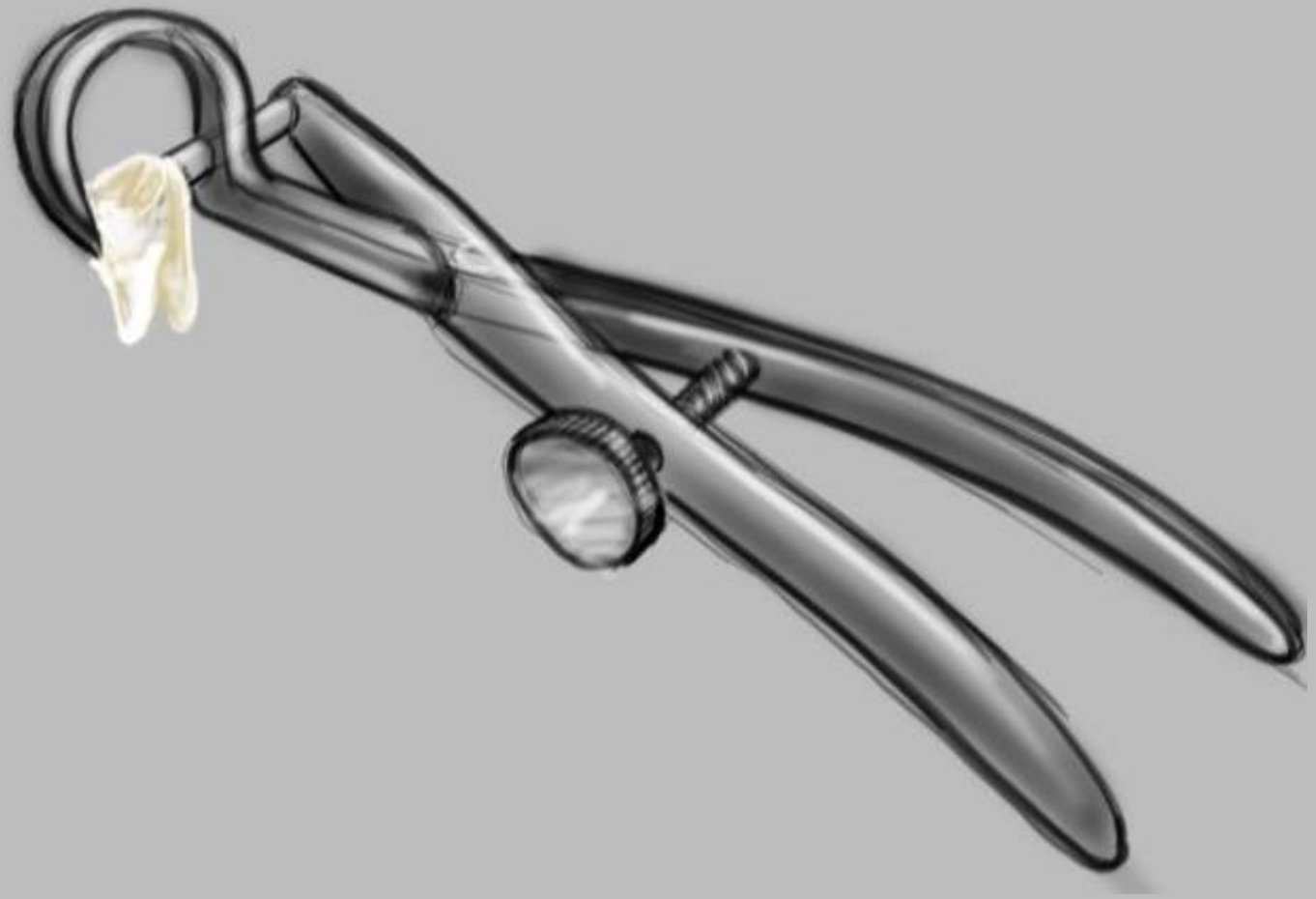

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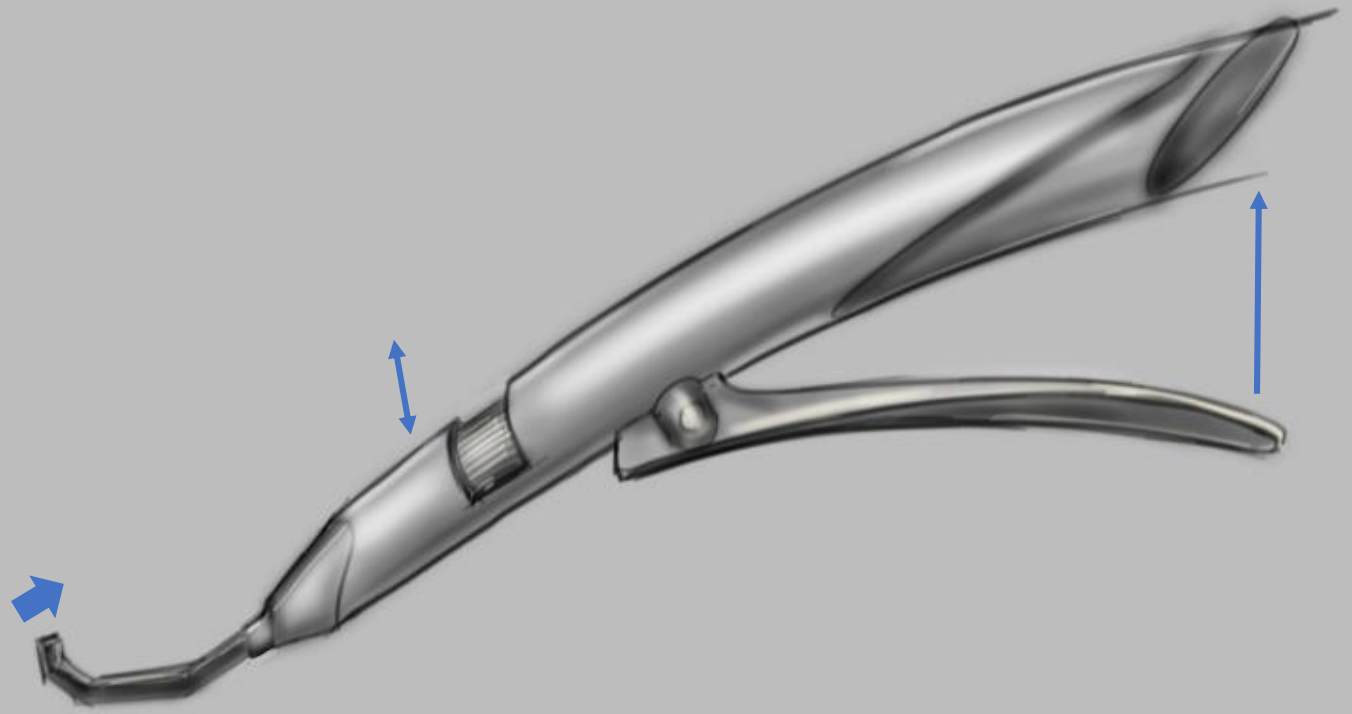

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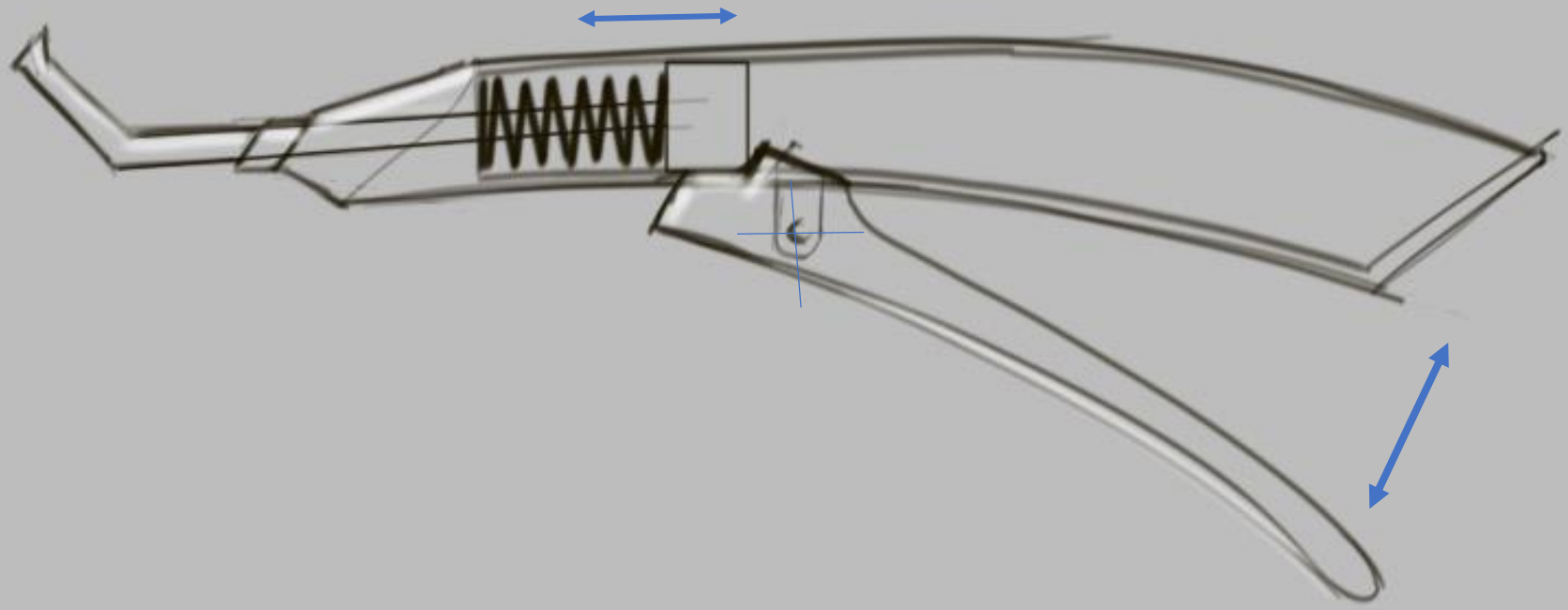

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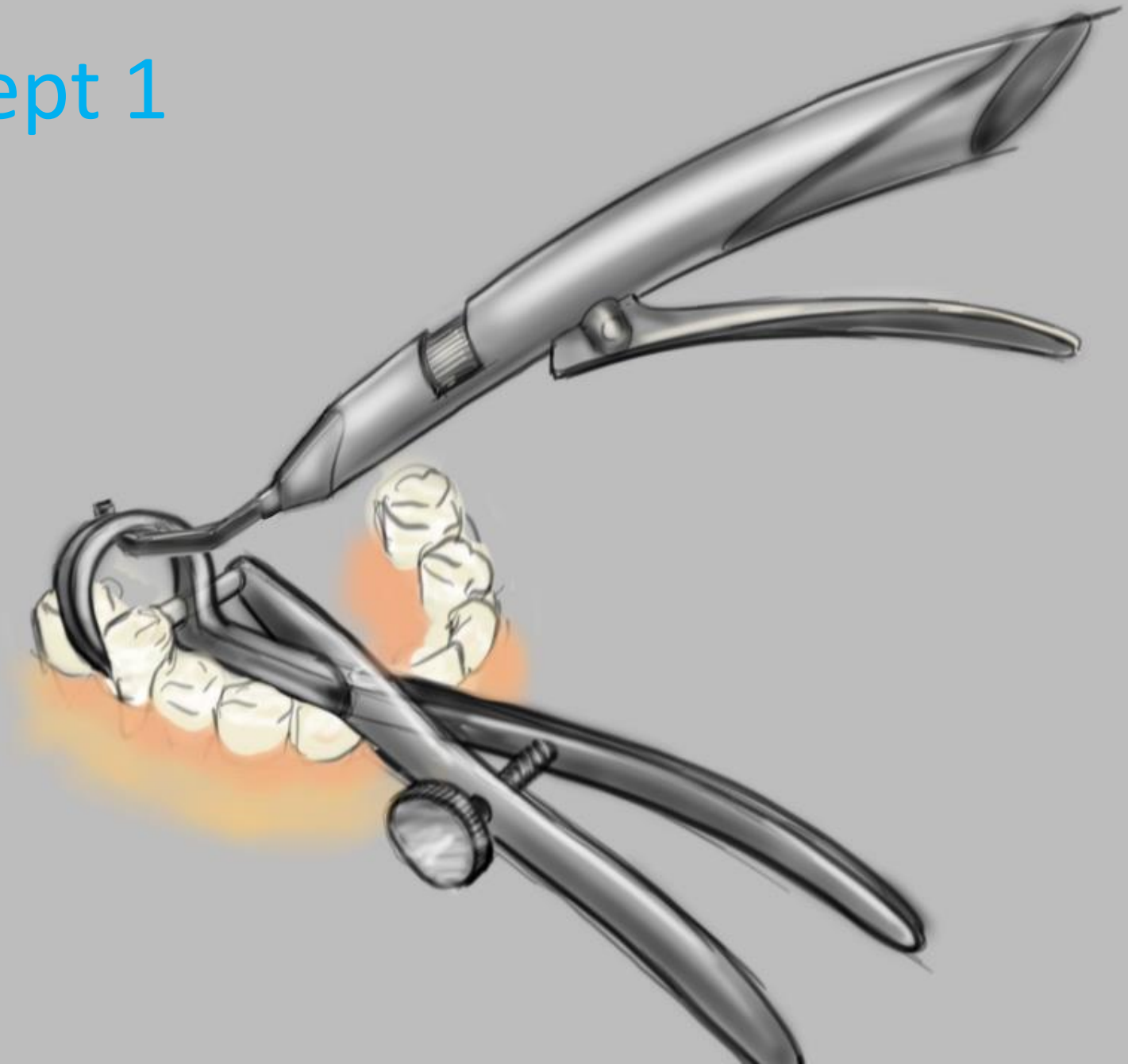
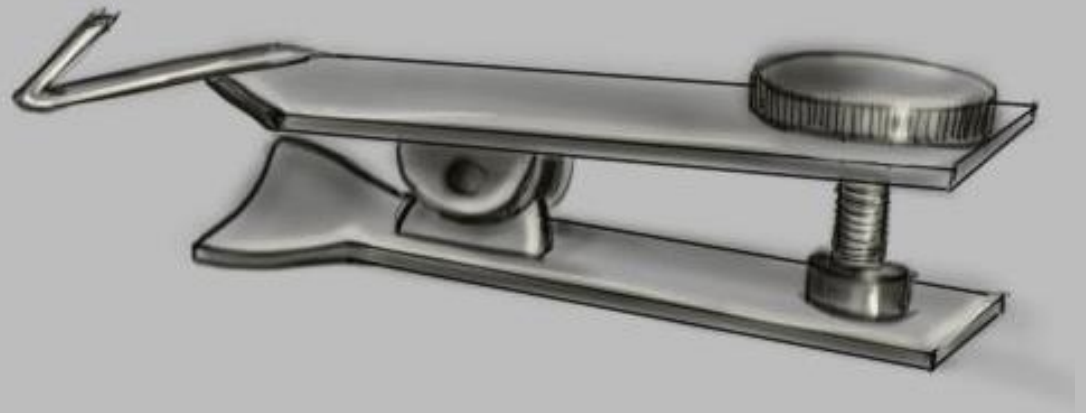


Concept 2

1 Adhesive clip



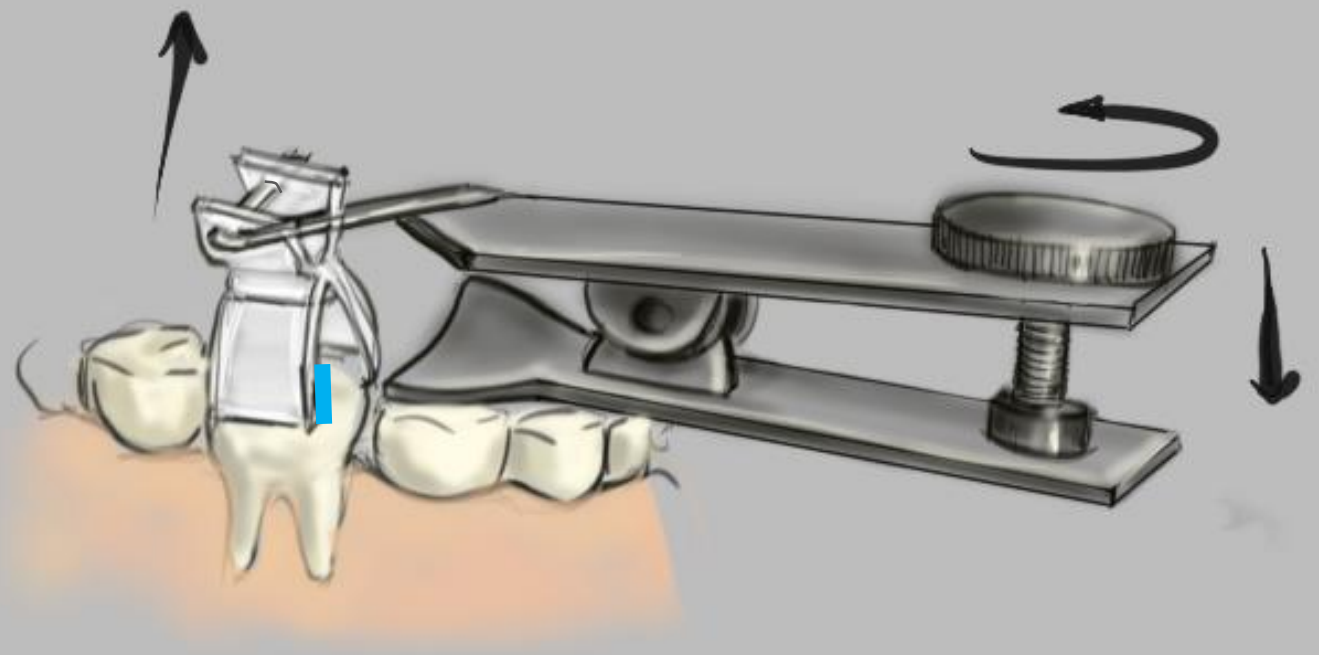
2 Elevator

Concept 2

holes

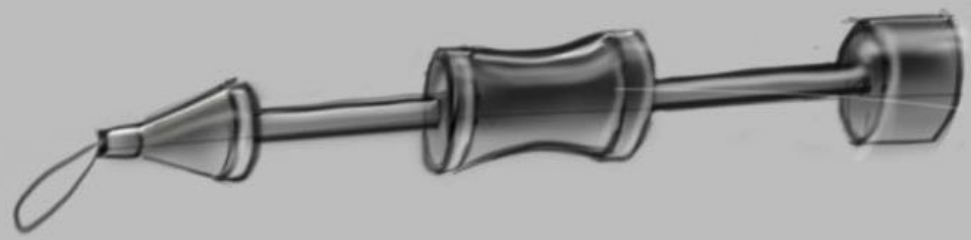
Biocompatible adhesive

Concept 2



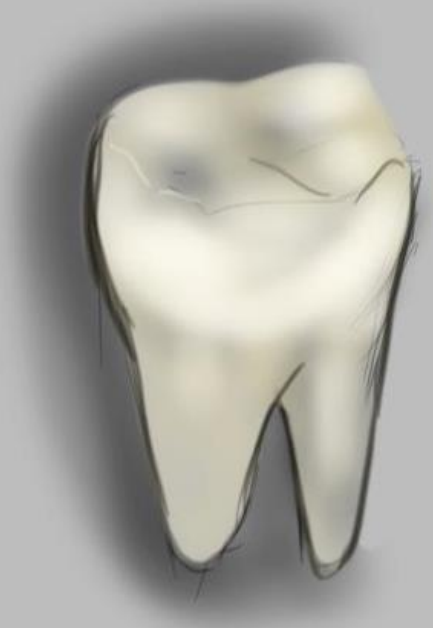
Concept 3

1 Tooth anchor



2 Hammer

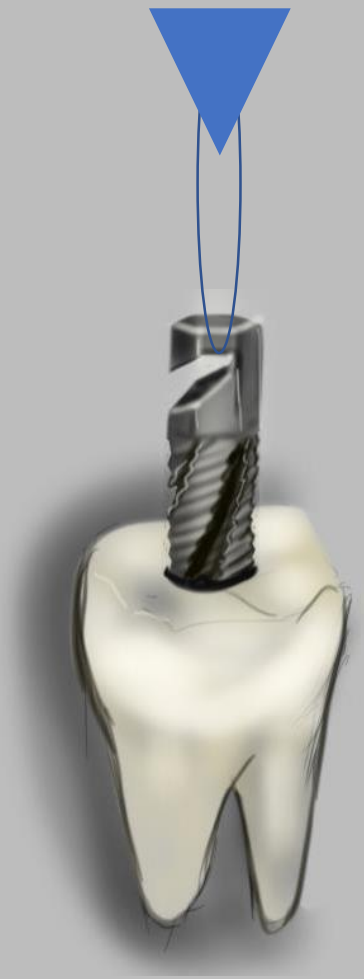
Concept 3



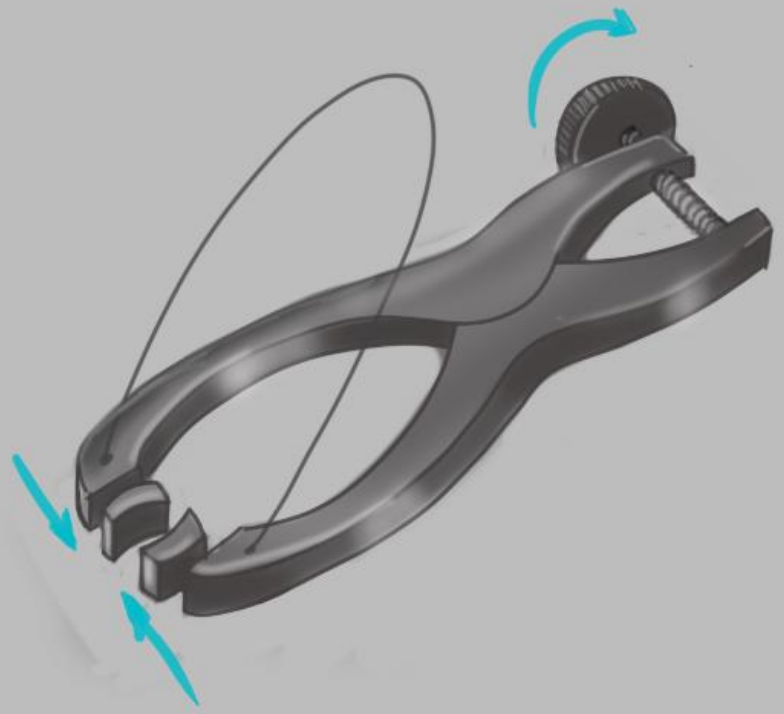
Drilling

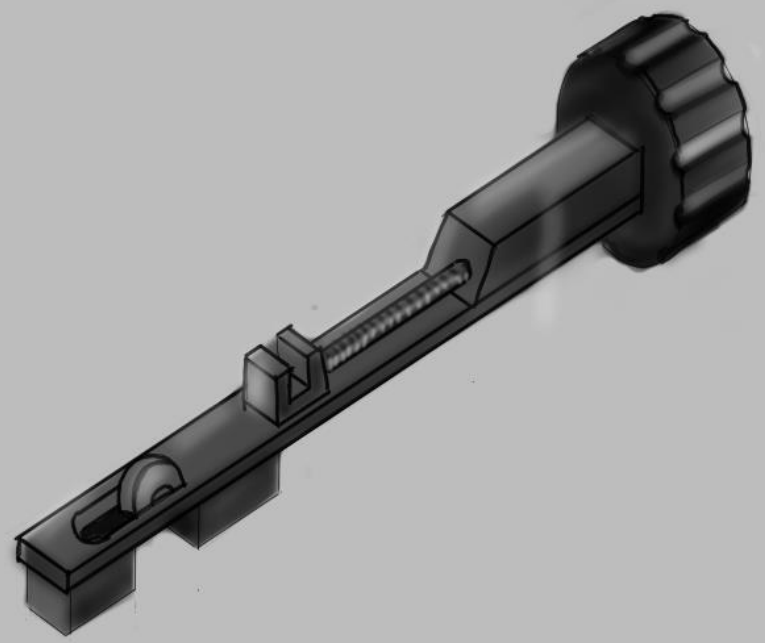
Self tap anchor

Concept 3



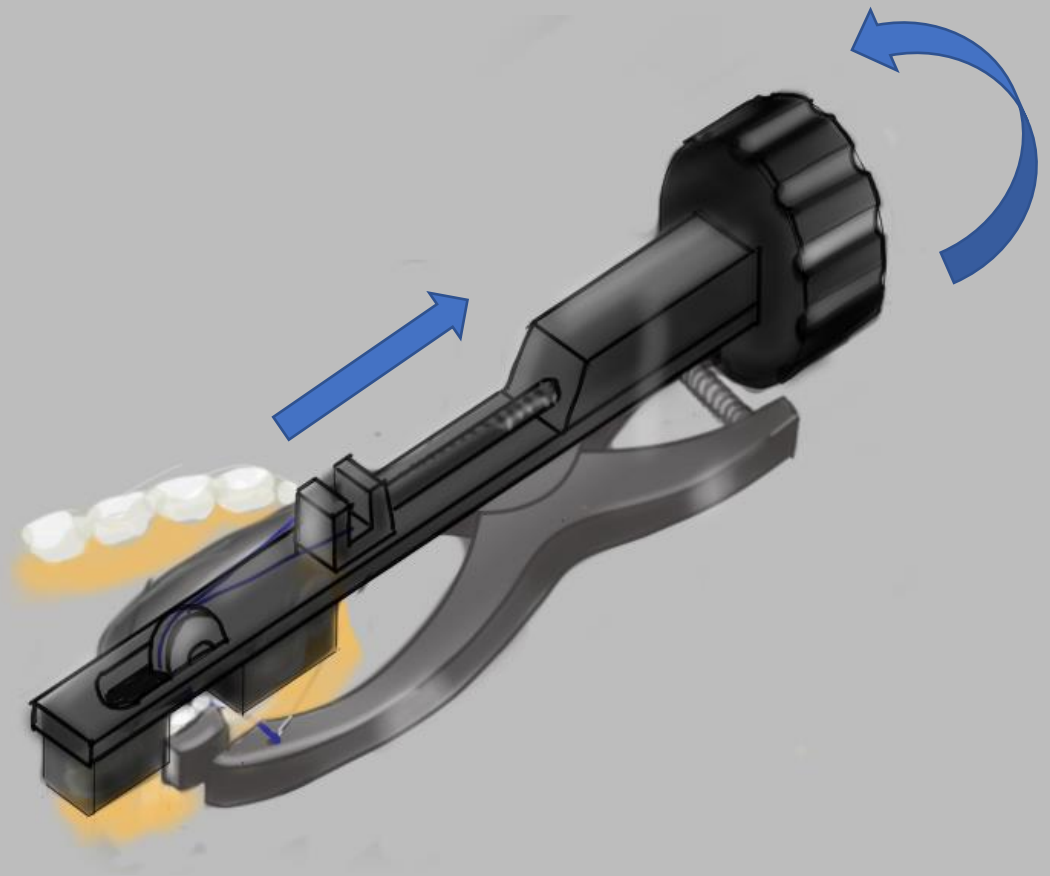
Concept 4



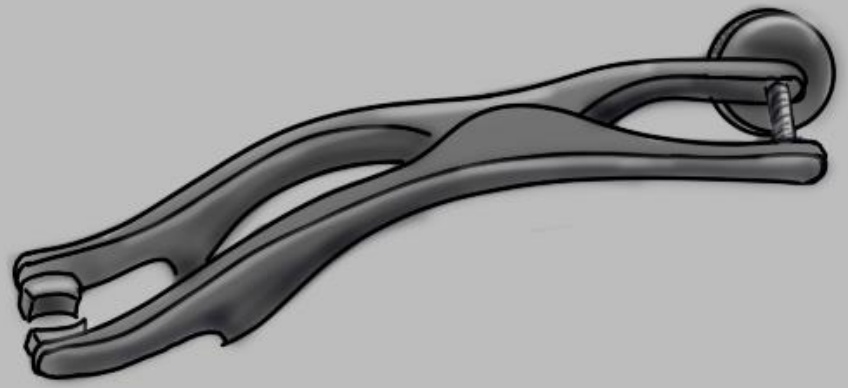


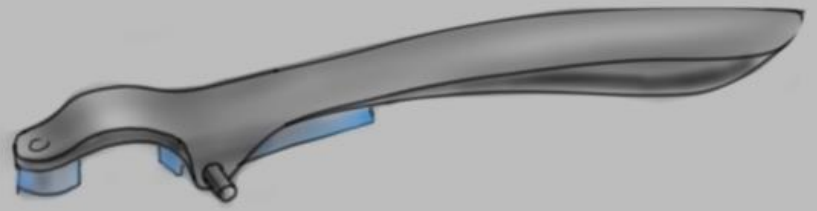
Concept 4

Concept 4

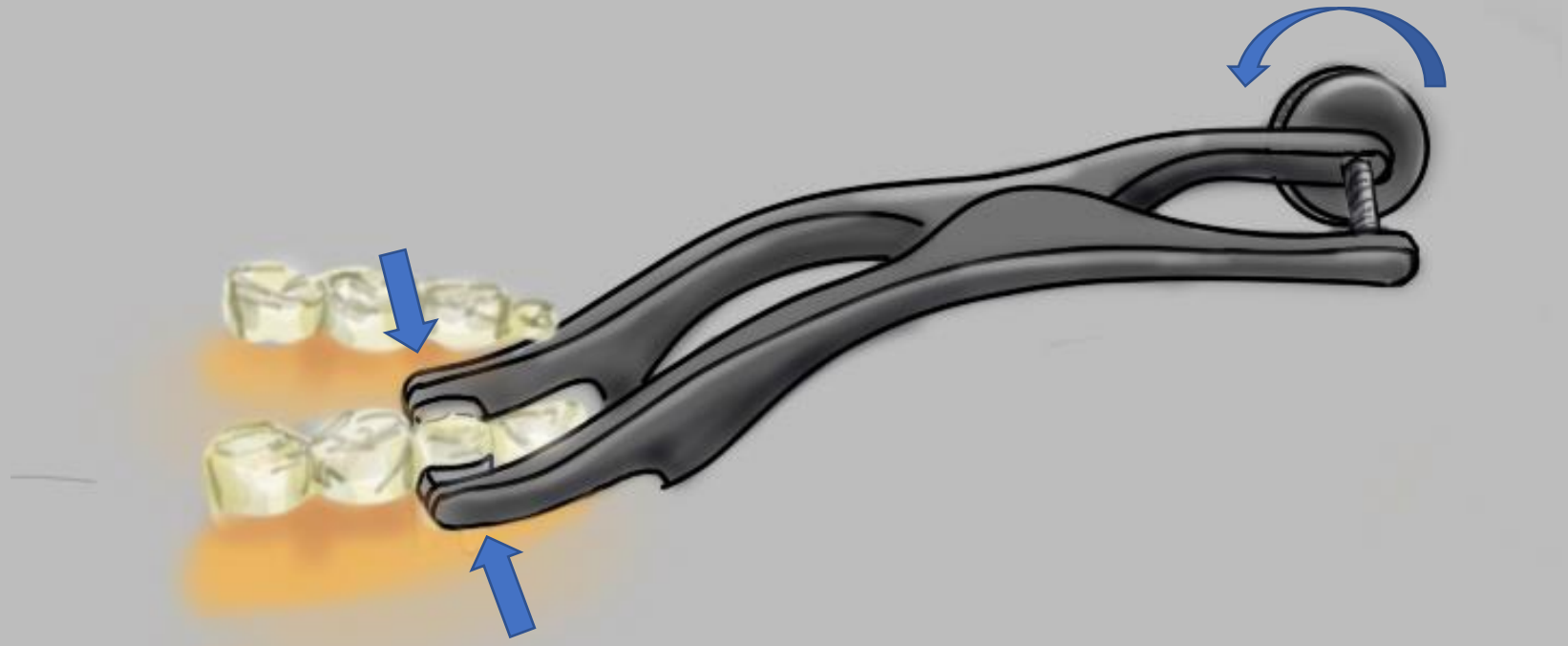


Concept 5

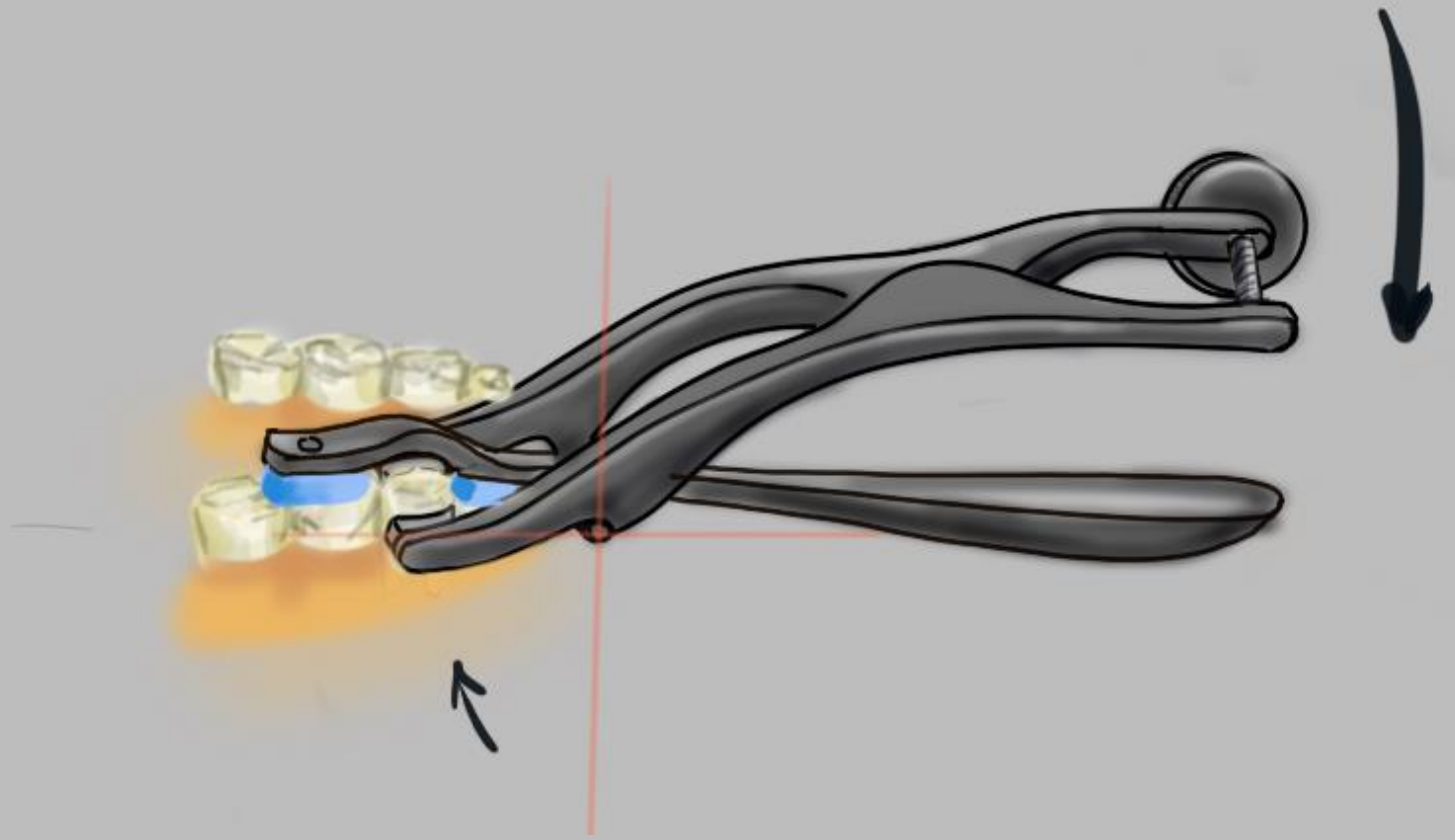




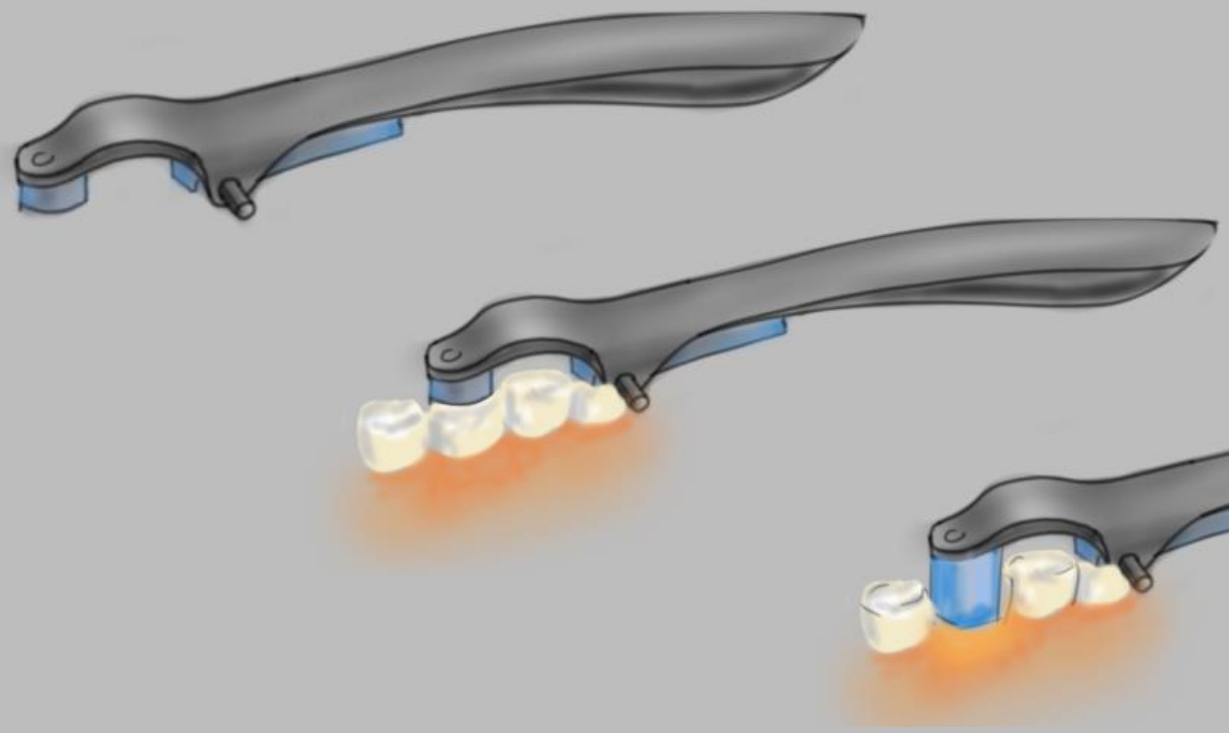
Concept 5



Concept 5



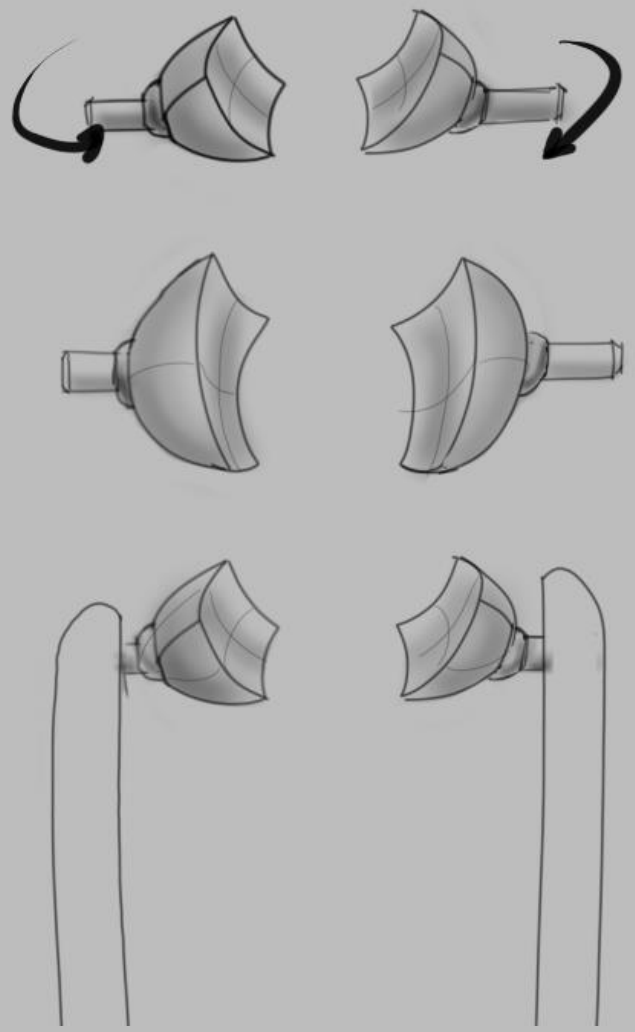
Concept 5



Bridge

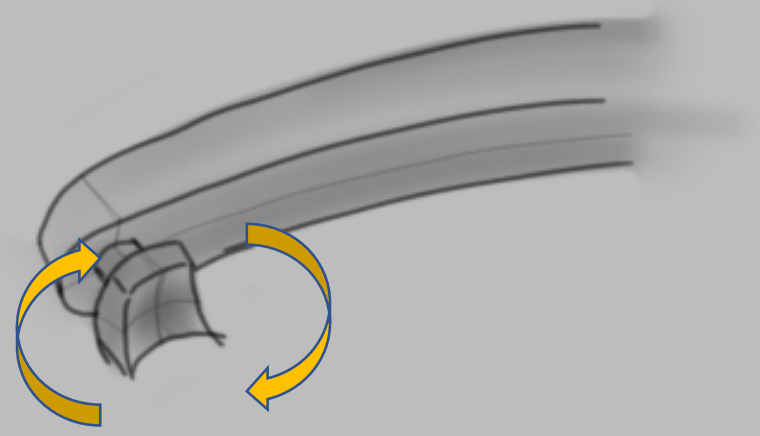
- Removable tooth support rubber pads
- Bridge can fit on 3rd molar gums with attachments
- Bridge can take support lost tooth gums

Concept 5



Tooth gripper

- Replicable grippers
- Different grippers for different tooth according to their profile
- One pair of griper having two gripping size



Clinical Immersion

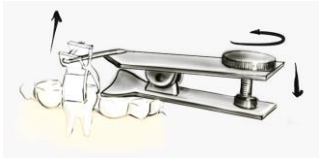
Remarks of Dr. Shrungesh Shah on concept mockup

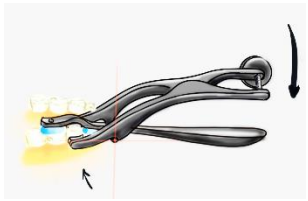
Clinical Immersion

*Remarks of **Dr. Shrungesh Shah** on concept mockup*

- **Vibration** are good for tooth cap removal but in tooth extraction vibration might not work satisfactorily as PDL are flexible and sustain in vibrations.
- **Mechanical advantage** will allows them to extract tooth vertically which will be good for bone preservation, which is not possible in existing systems because of its difficult too generate that force by plier.
- Including light and vibration in device will be good idea but it should not affect the **robustness of the product** .
- Available **tooth adhesives** are not that strong that they will sustain forces apply for extraction

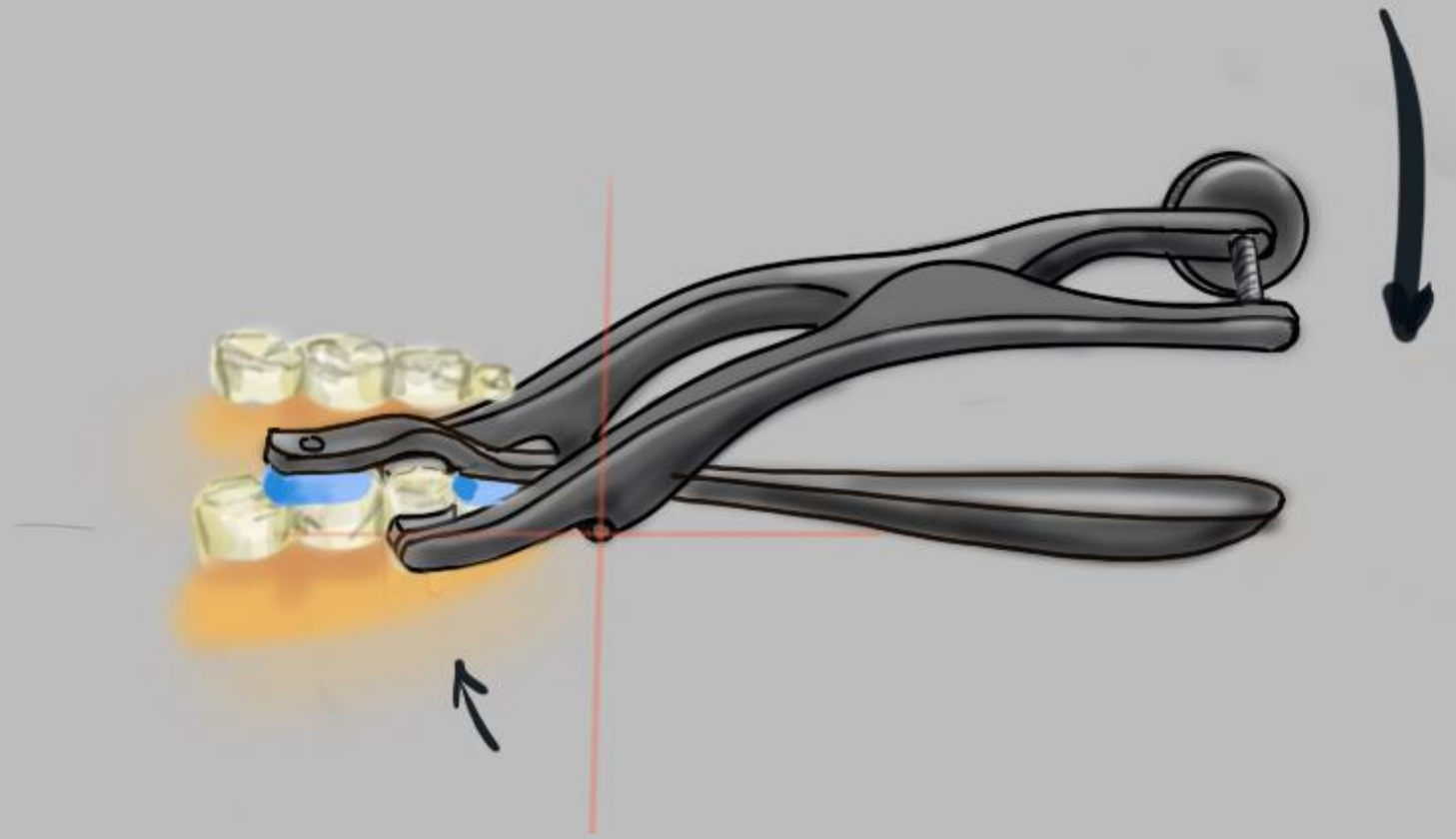
Concept evaluation



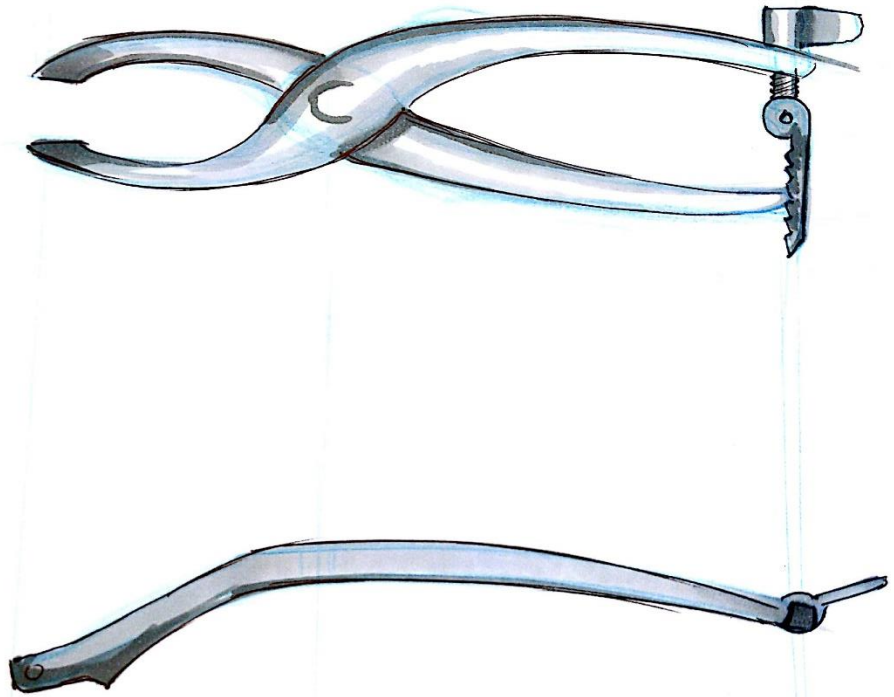


	Concept 1	Concept 2	Concept 3	Concept 4
Compatibility to all tooth	More favorable	More favorable	More favorable	More favorable
Visibility	More favorable	Favorable	More favorable	More favorable
Accessibility	More favorable	Favorable	More favorable	More favorable
Effort required	favorable	More favorable	More favorable	More favorable
Setup time	favorable	Less favorable	Less favorable	favorable
Disturbance to healthy tooth	Favorable	favorable	Less favorable	favorable
Learning curve	favorable	Less favorable	favorable	favorable

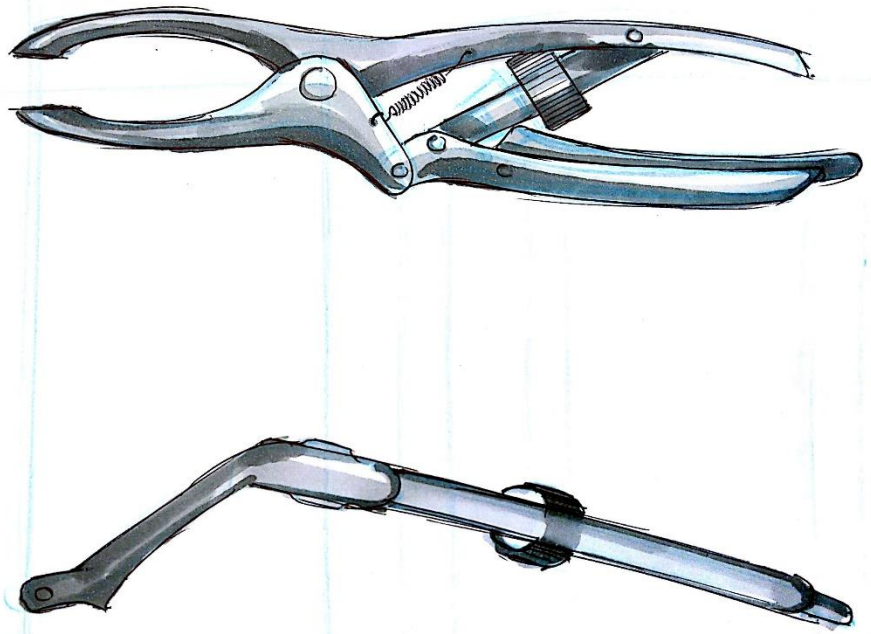
Final Concept



Exploration of griper mechanism

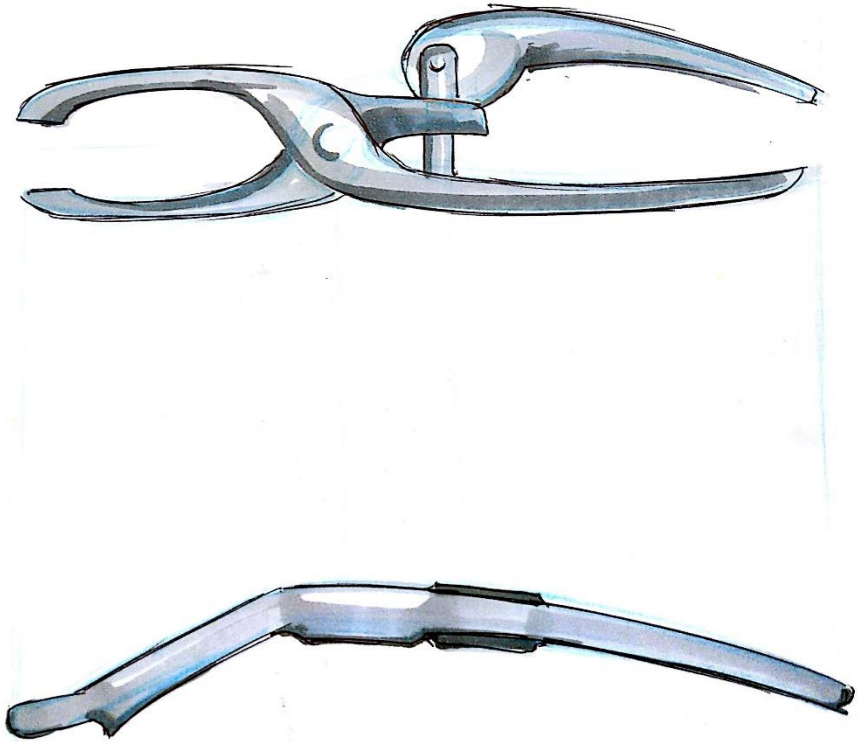


Ratchet

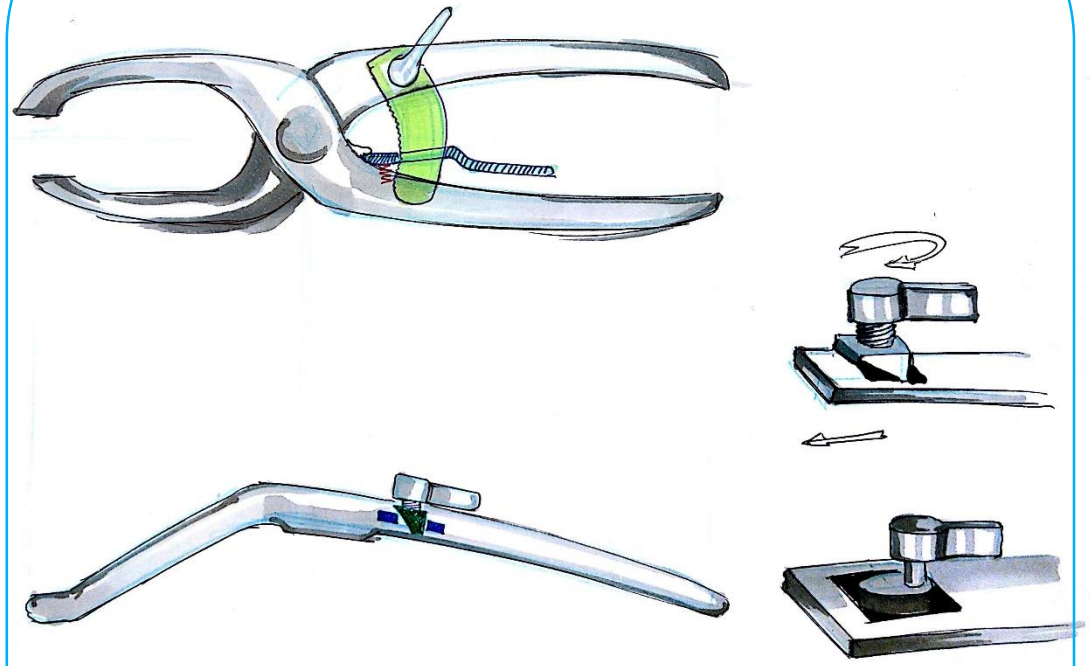


Quick clamps

Exploration of griper mechanism

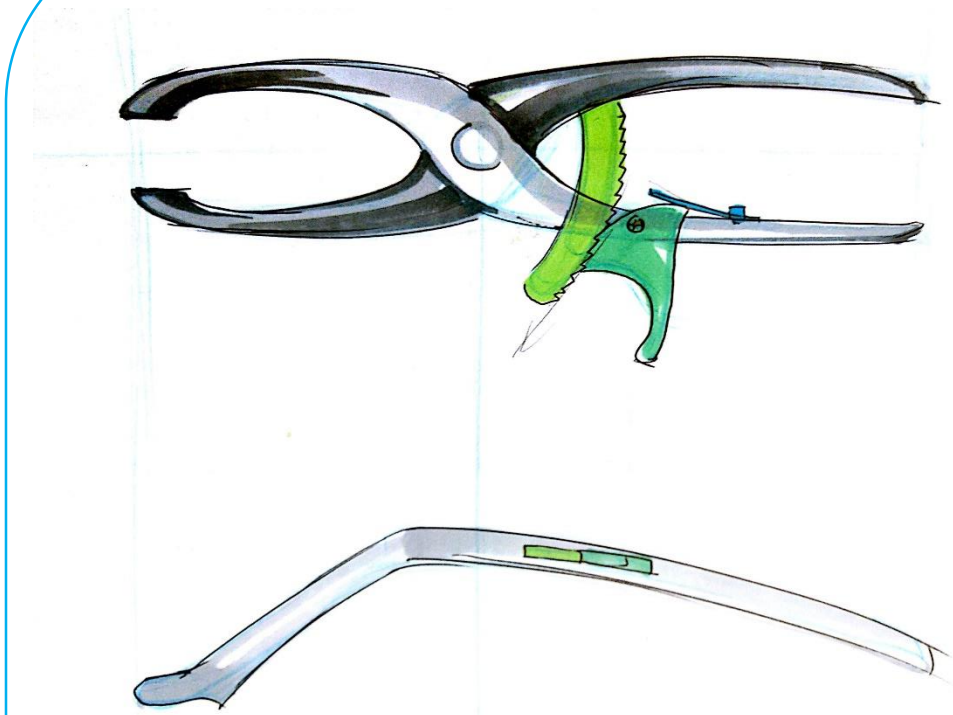


Face cam

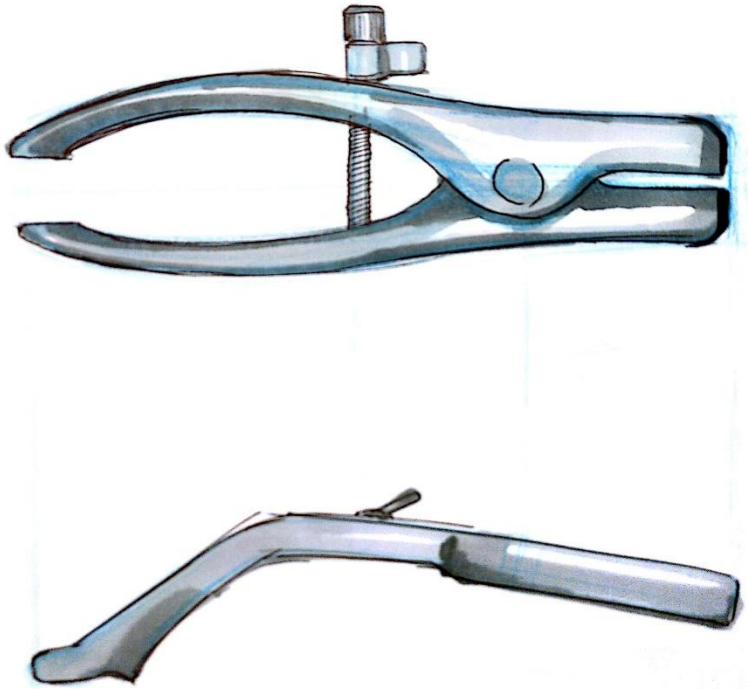


Quick clamps

Exploration of griper mechanism



Ratchet



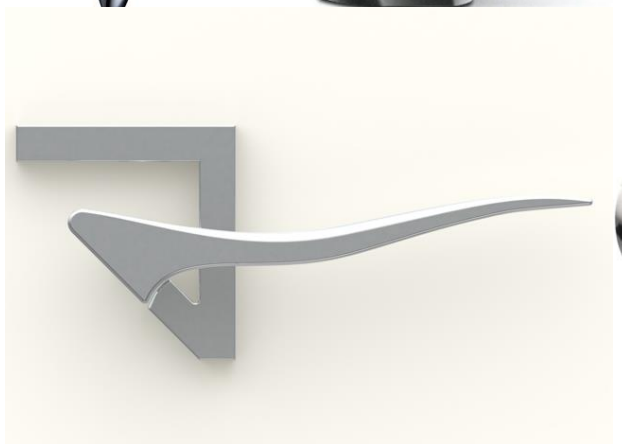
Screw

Mood board

Edge - curve - transforming - transition



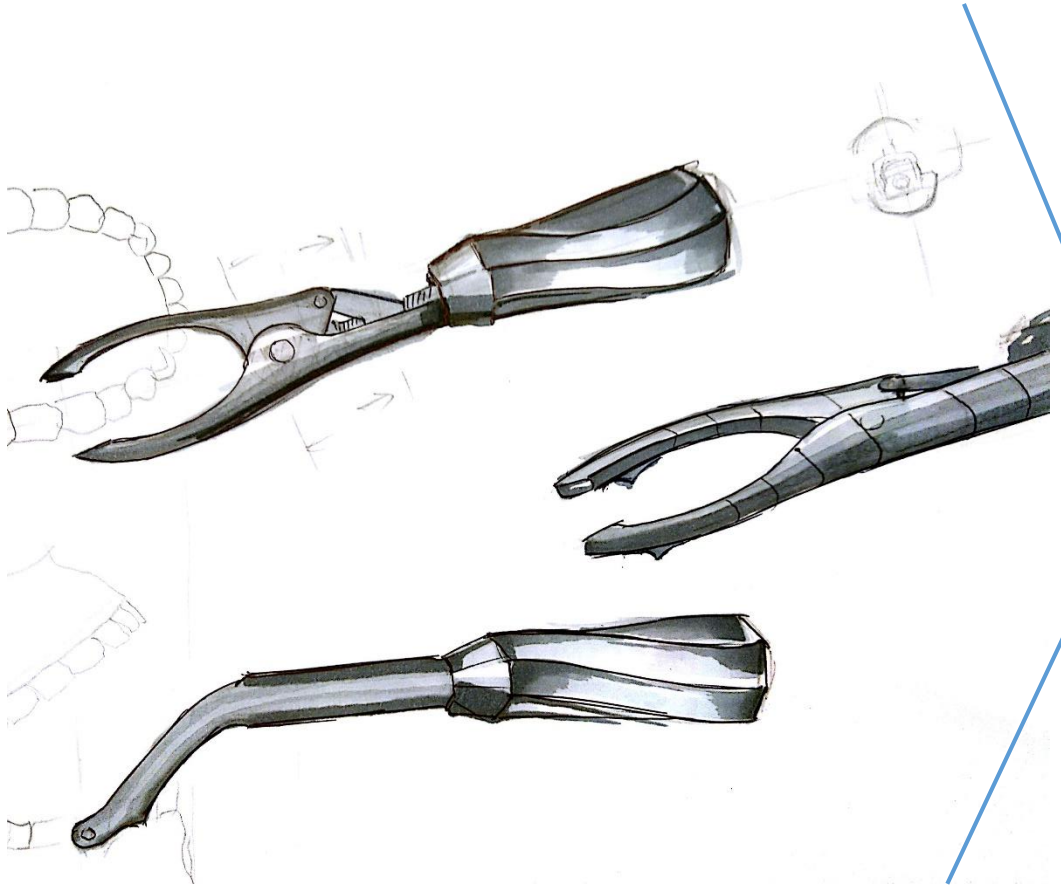


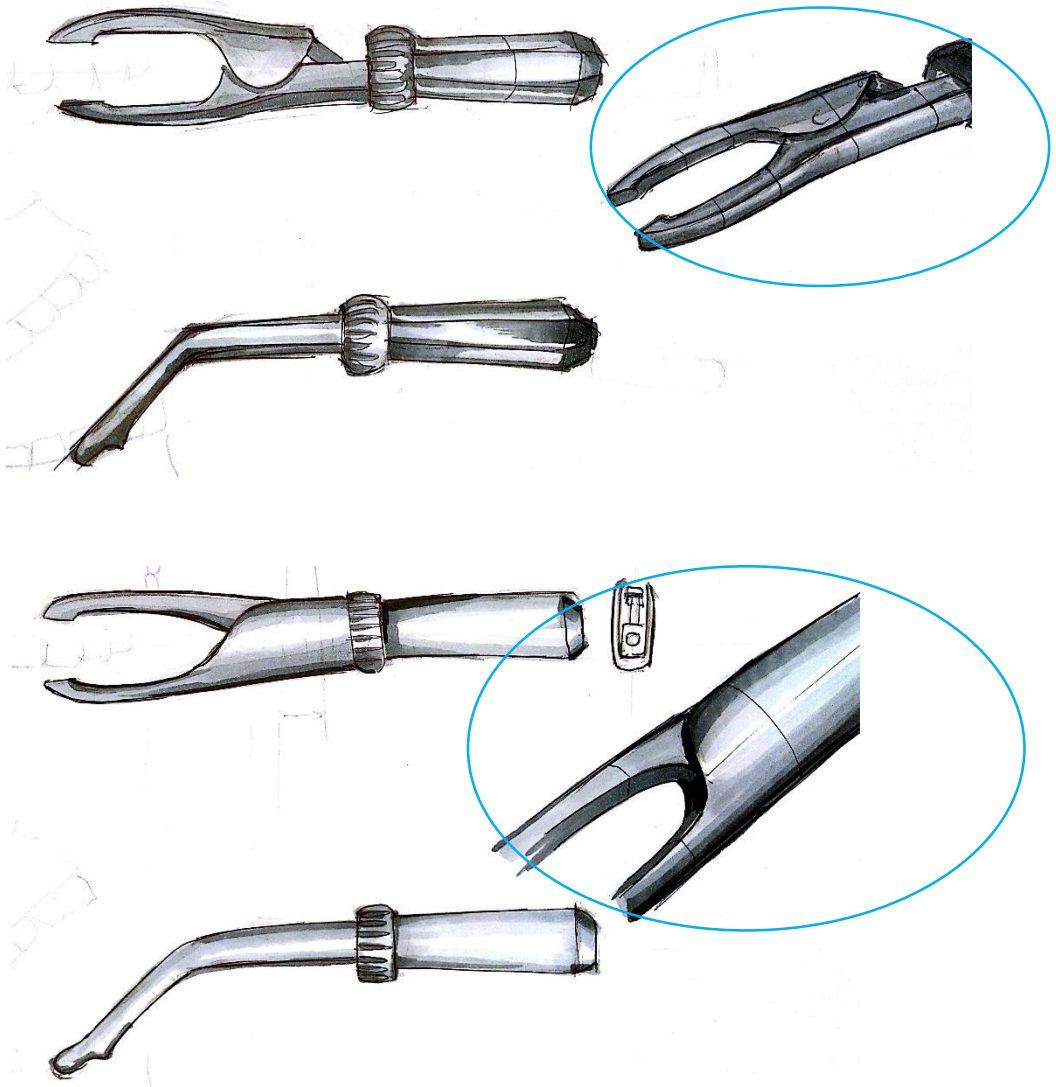




Mood board

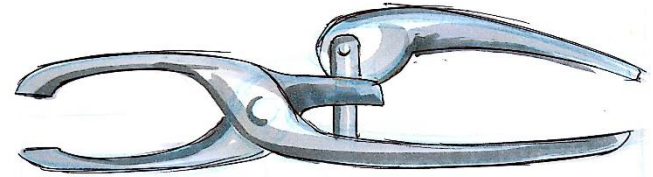
Roundish - volume - radii - bulky

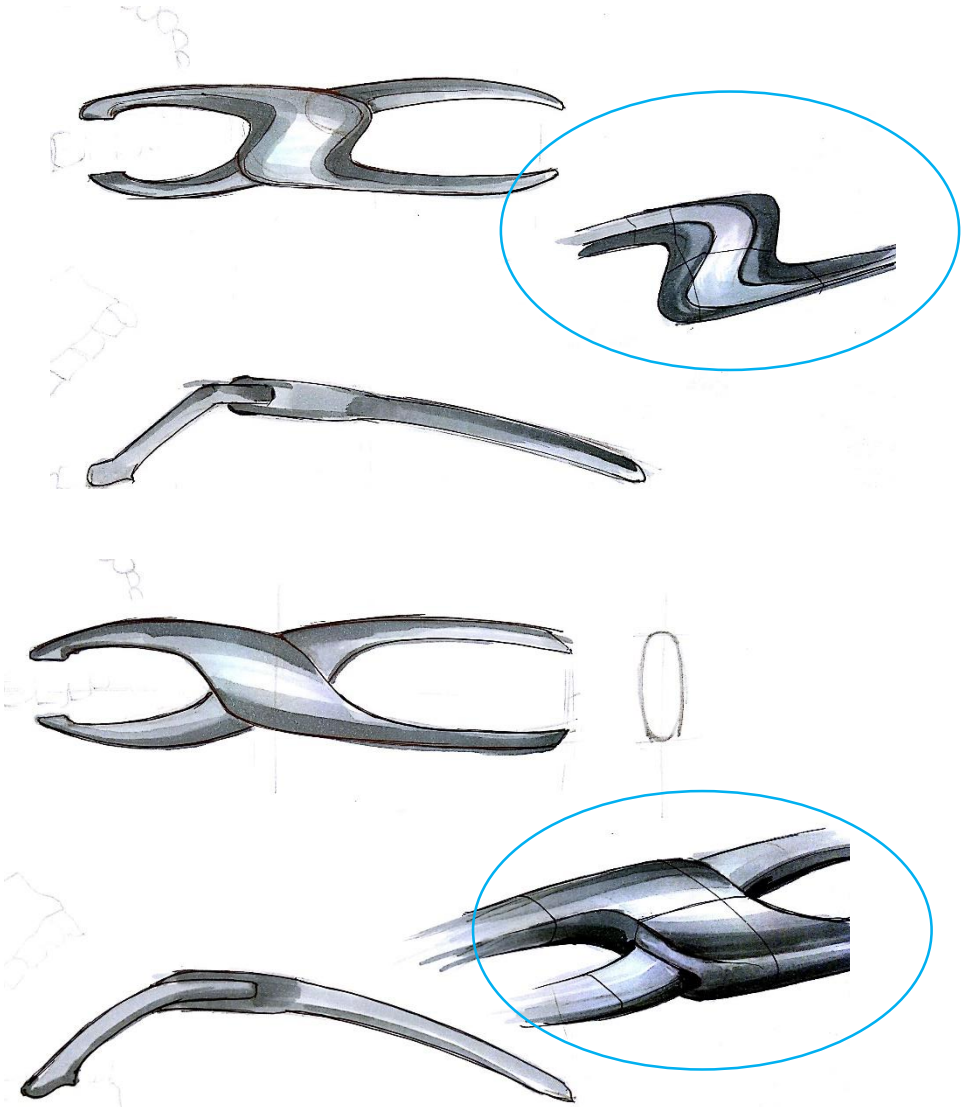
Form explorations



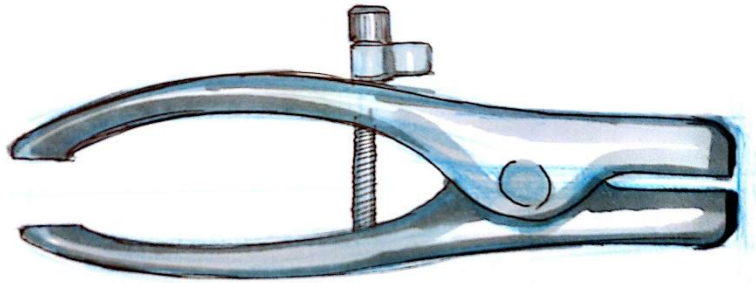


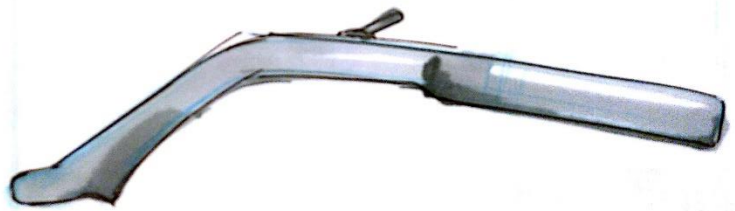
Form explorations





Form explorations

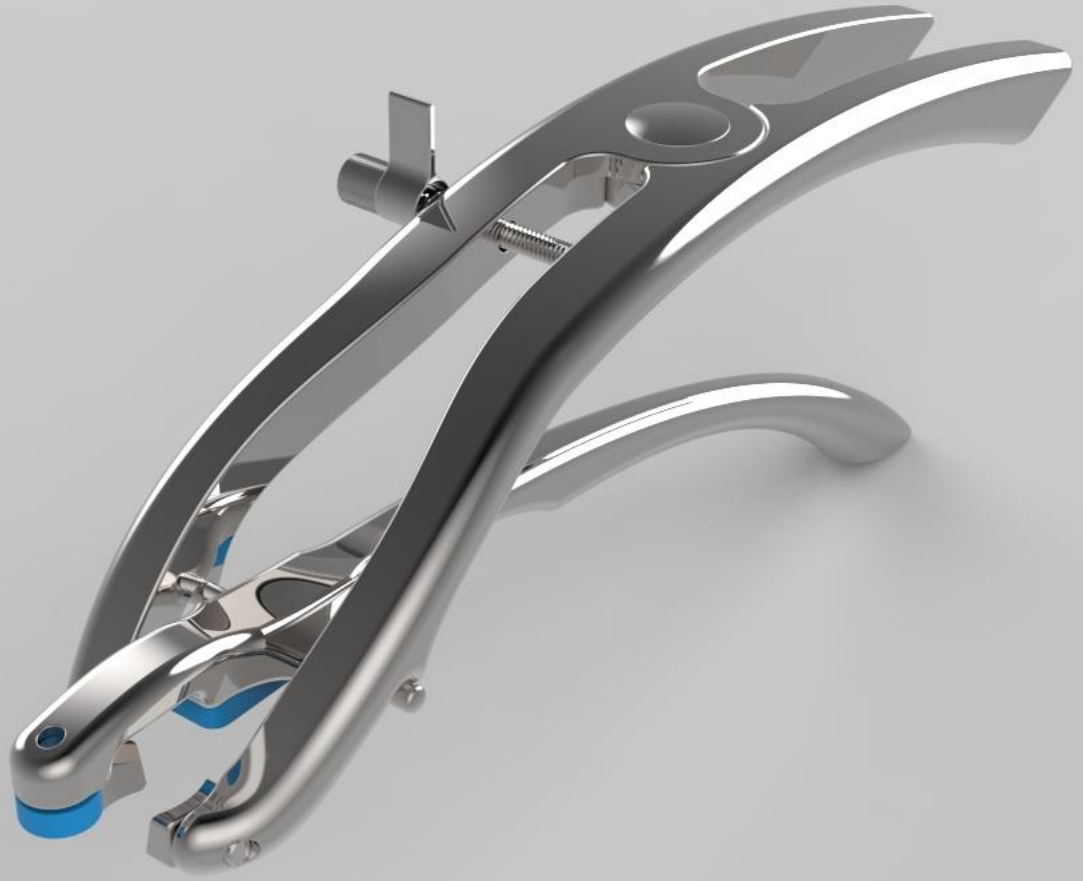


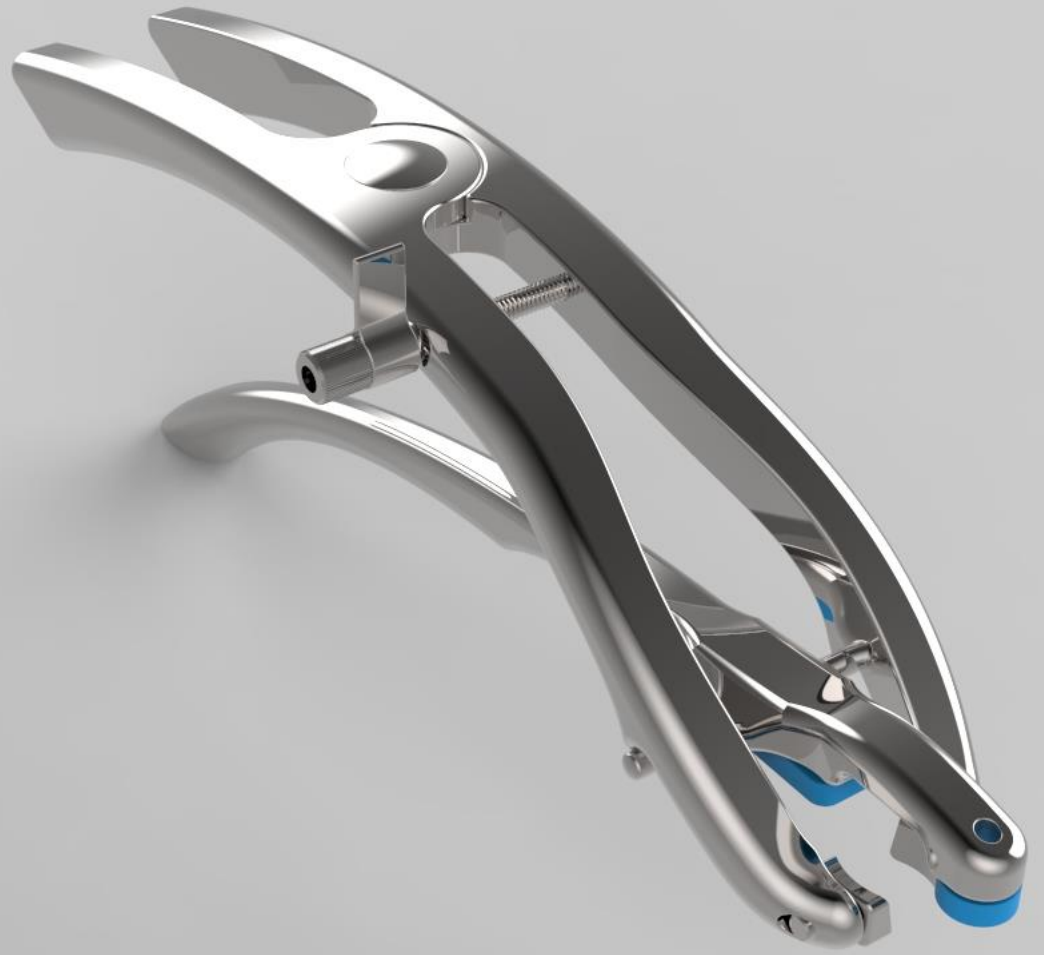


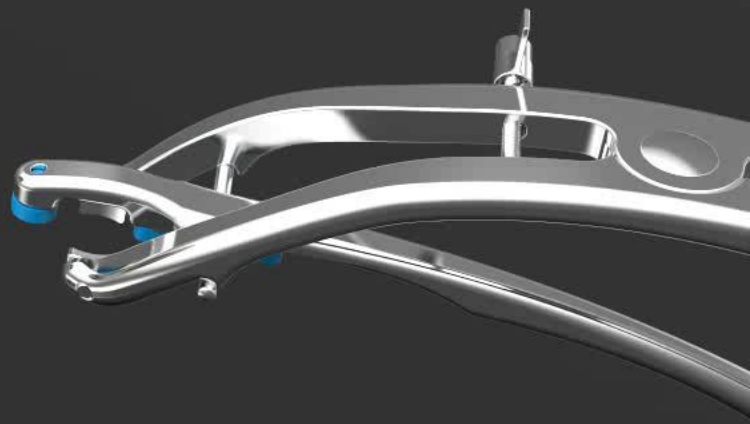
Form explorations

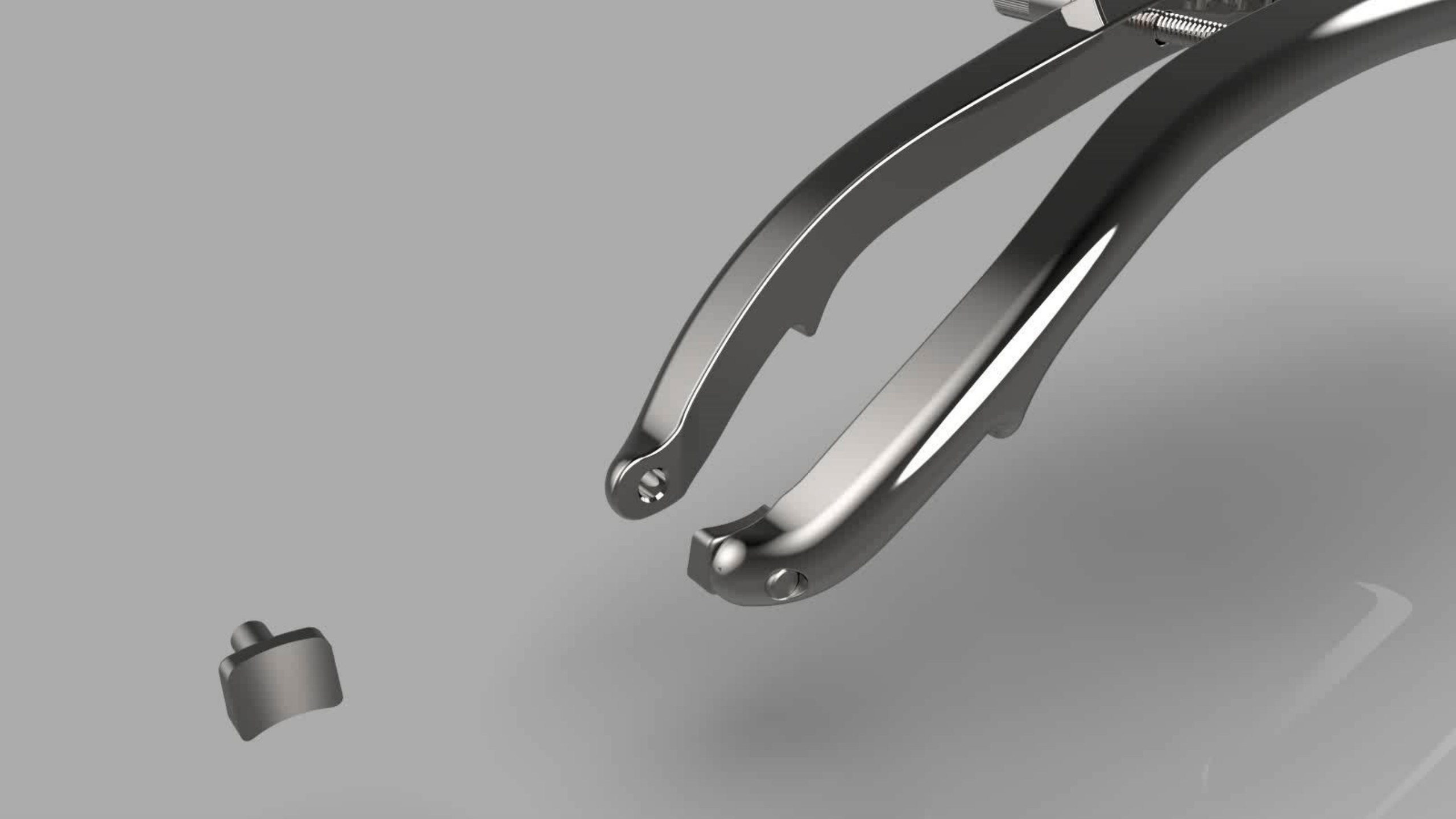
Form explorations

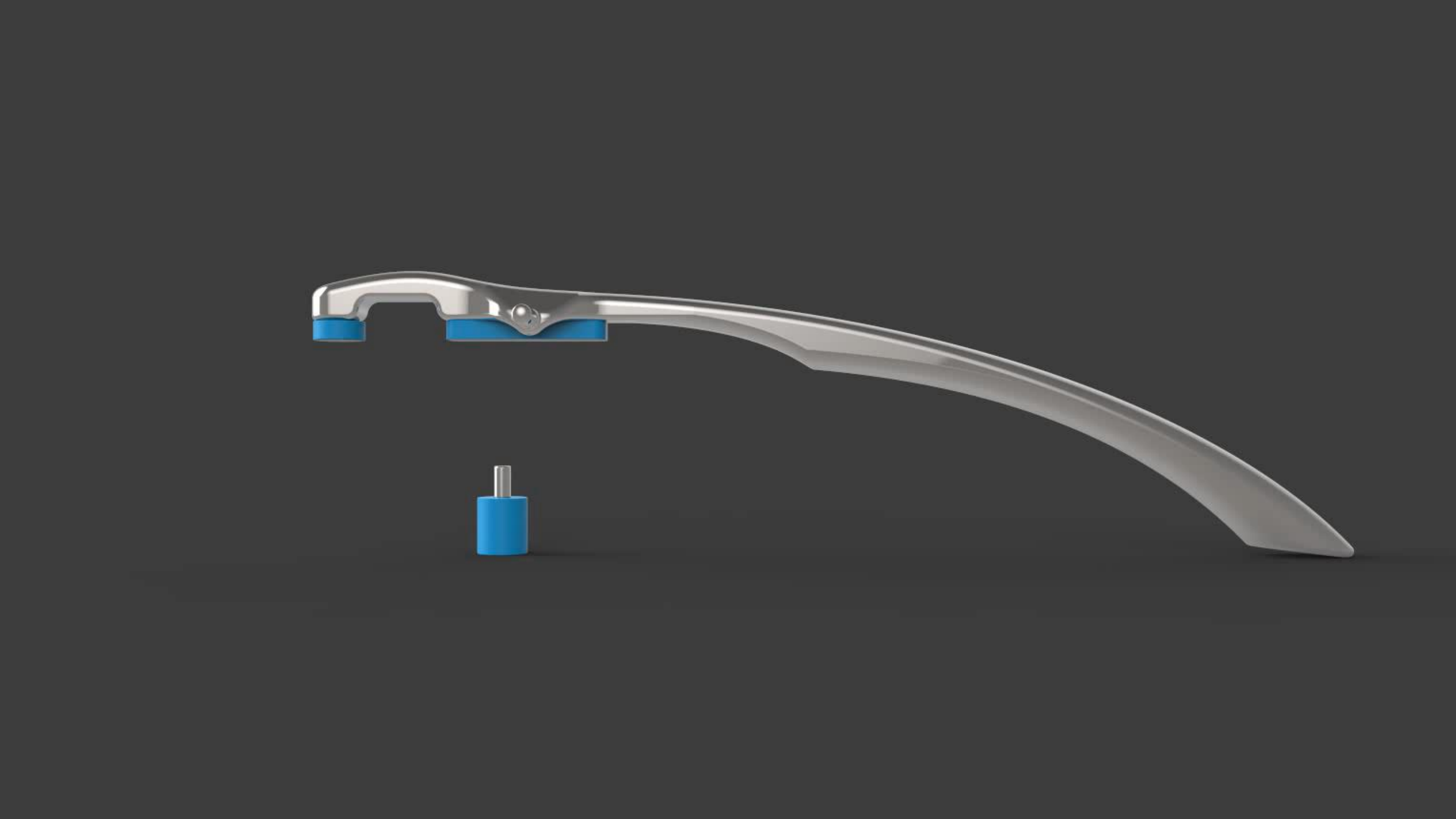
Form explorations

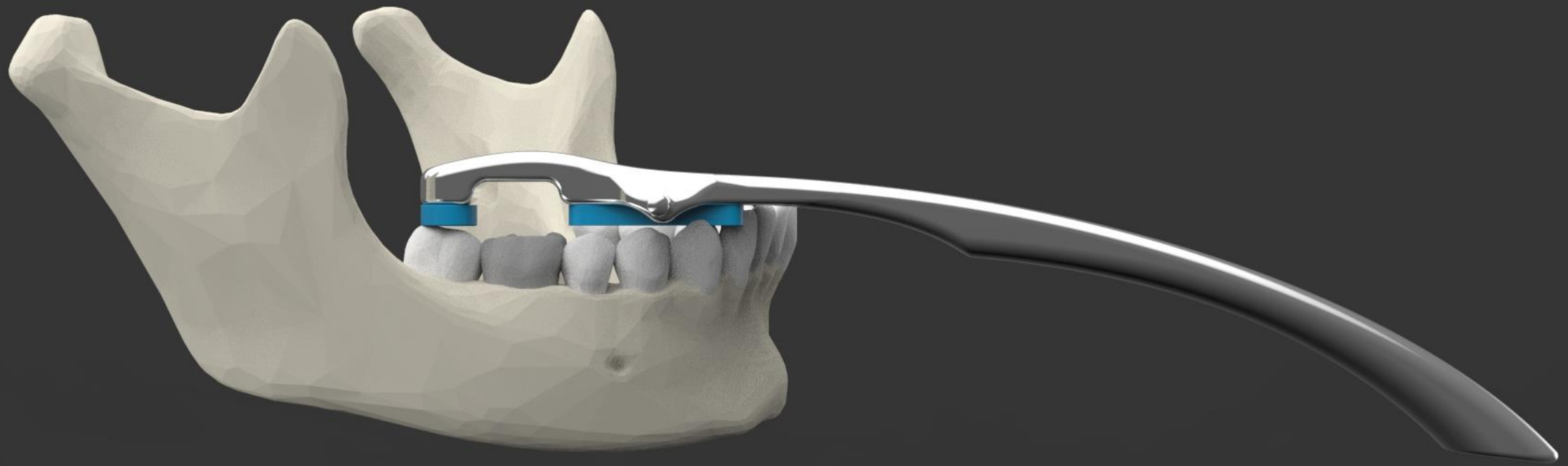


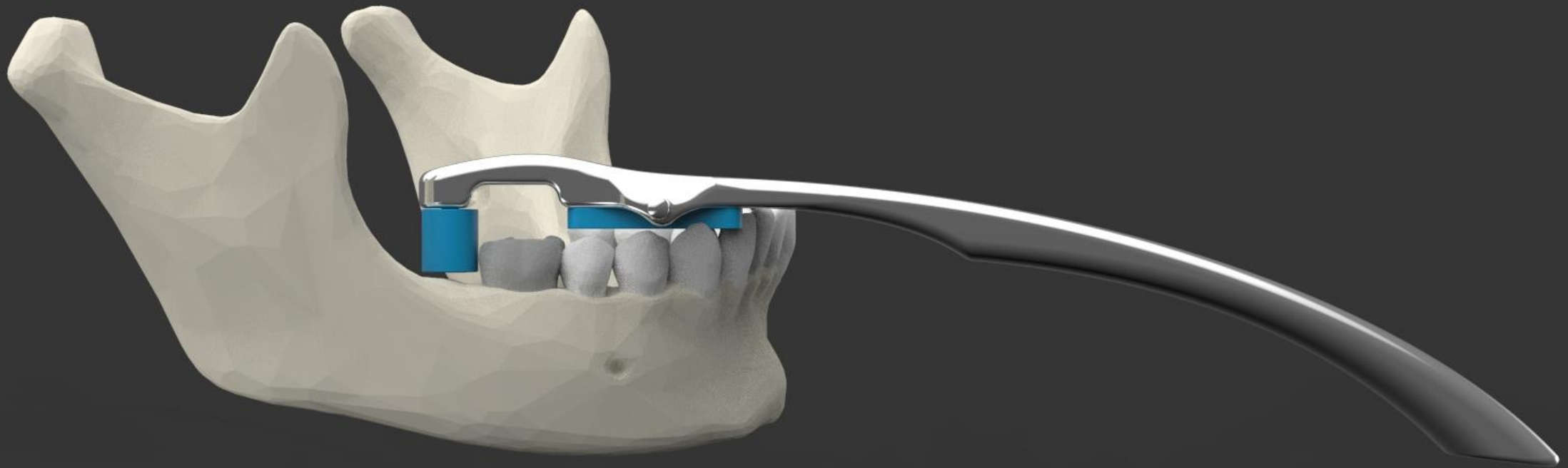


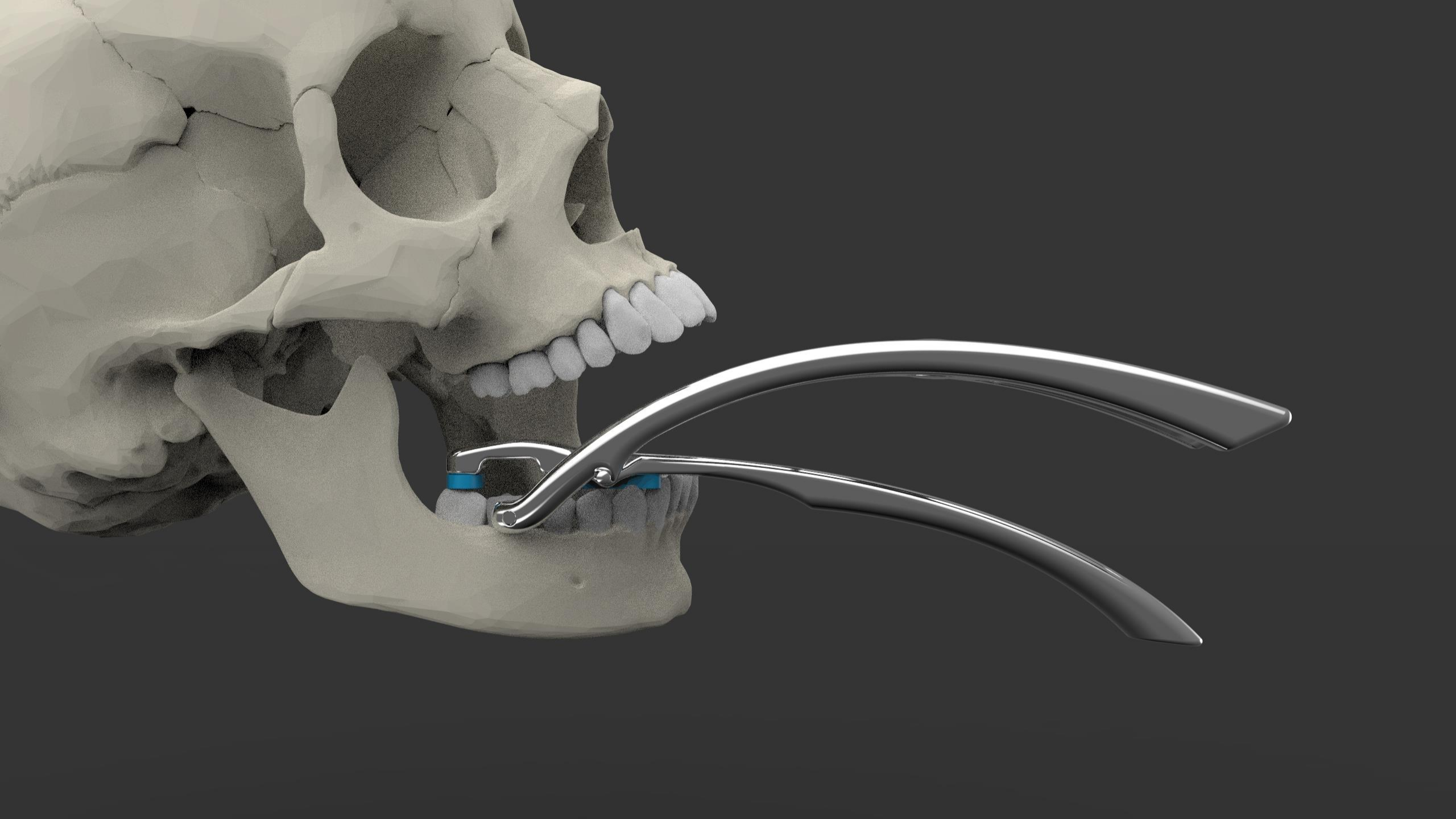


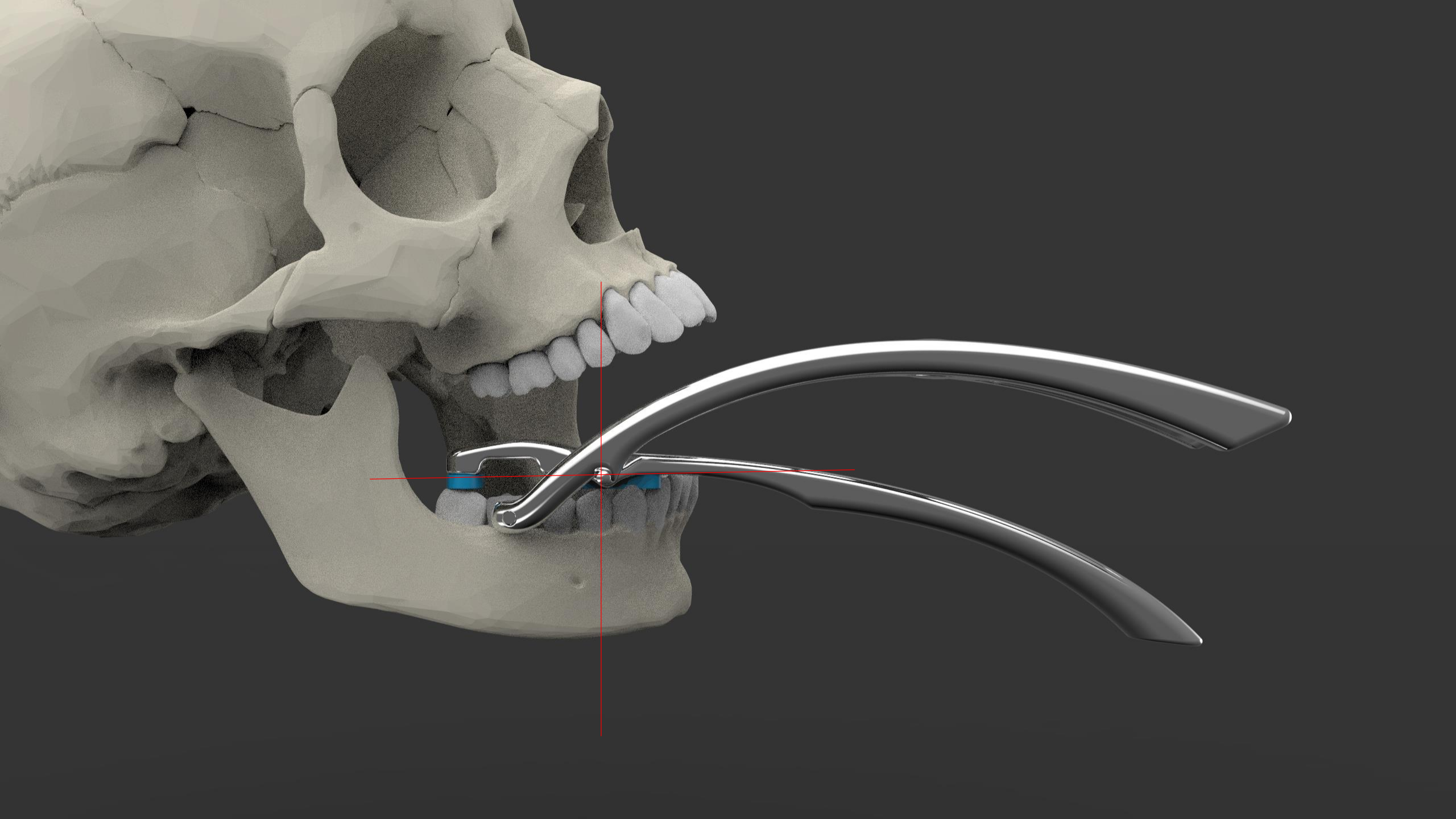


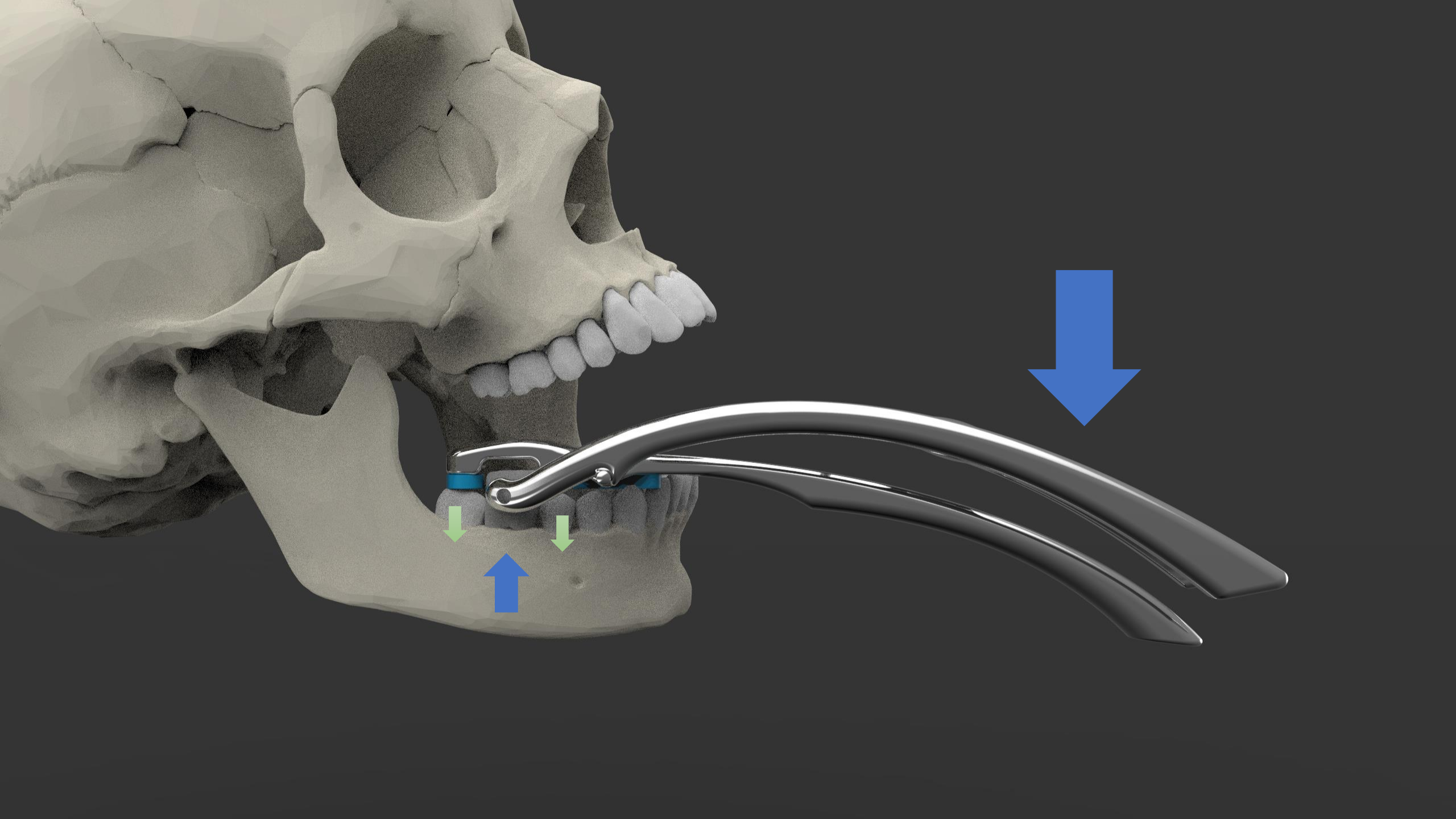


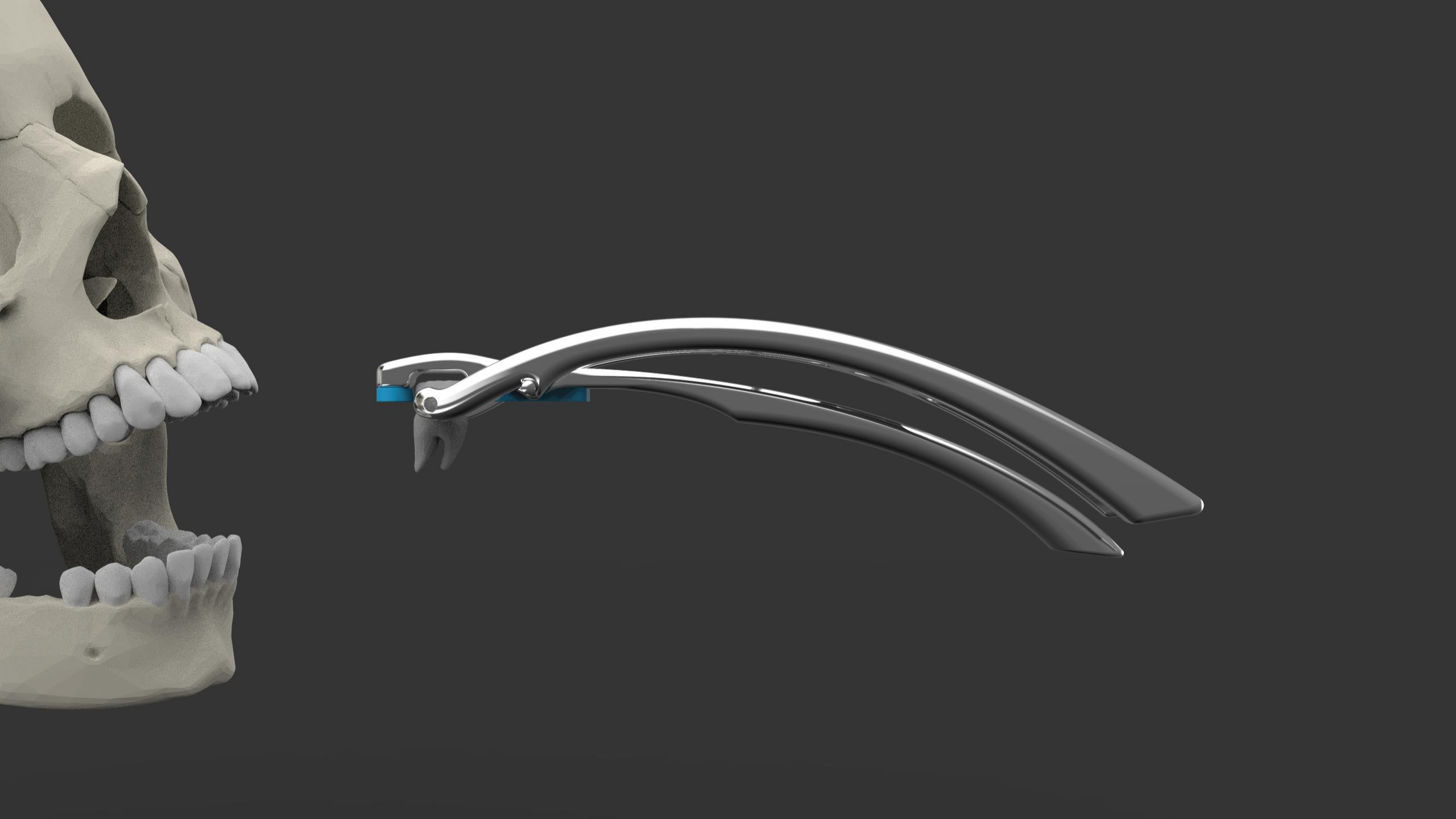






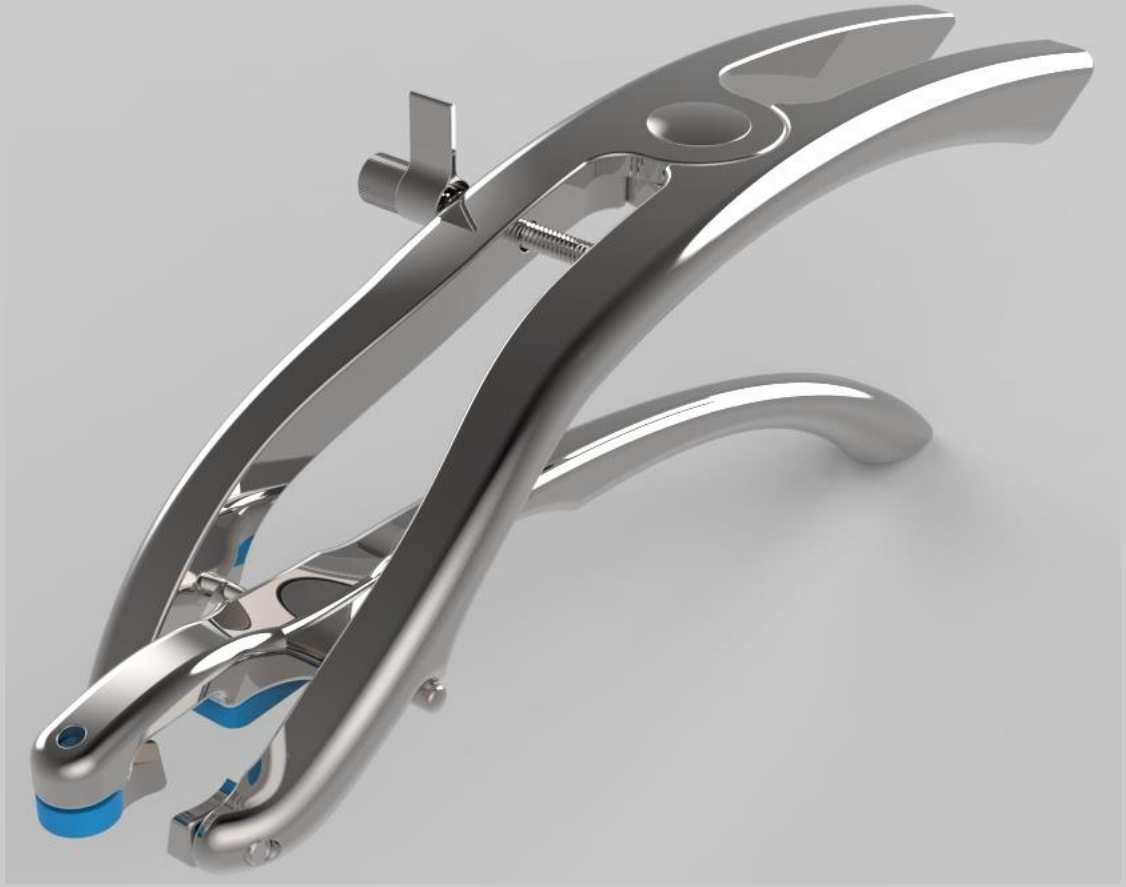






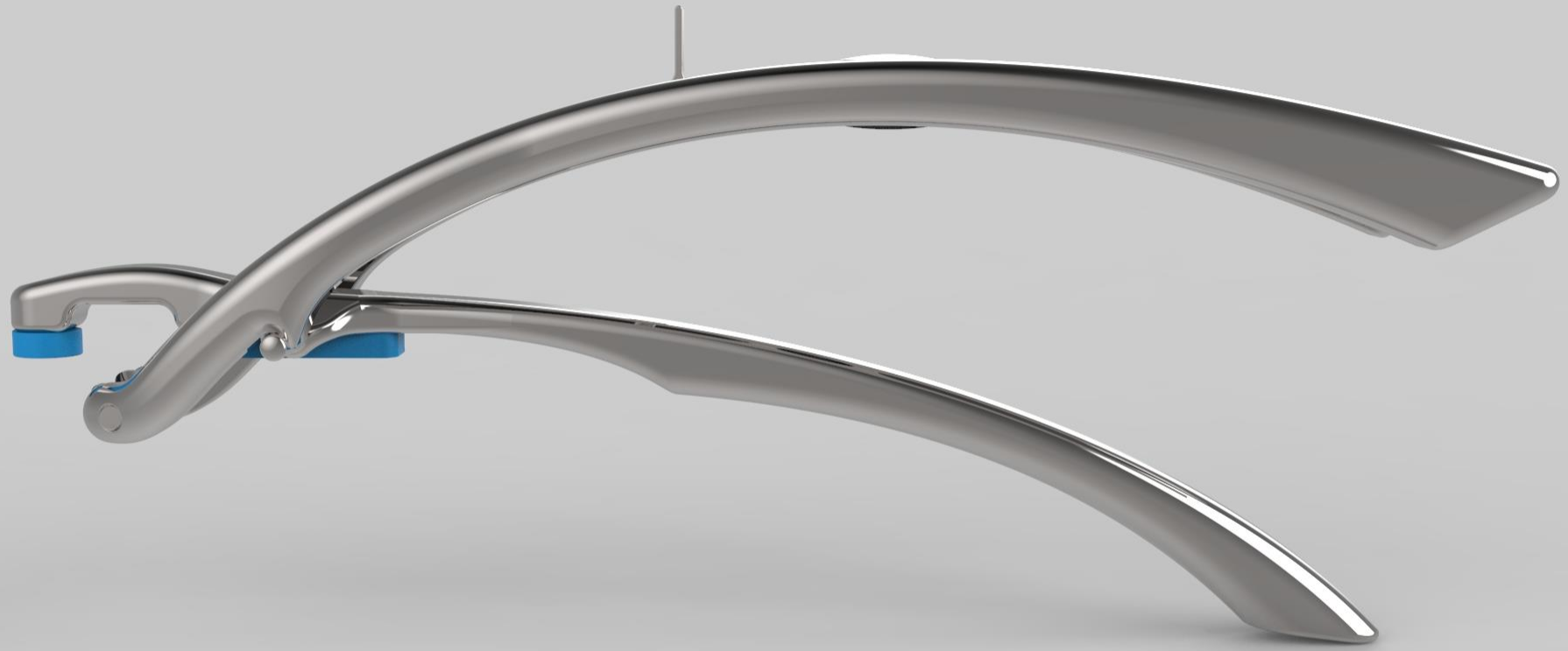
Design USP

- Effort required for extraction is minimised
- One device is compatible to extract all premolars and molars with attachments



Future scope

- Developing device in Medical grade stainless steel for testing
- First stage test on goat mandibular
- test on patient with collaboration of doctors.
- Branding and packaging design



Thank you !..