BME Design-Fall 2023 - Maggie MCDEVITT
Complete Notebook

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JACKI SZELAGOWSKI

on

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Isabelle Peters - Sep 15, 2023, 12:11 PM CDT

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Project description

Maggie MCDEVITT - Sep 29, 2023, 1:06 PM CDT

Course Number: BME 200/300

Project Name: Lock washer for dental implant-supported restorations

Short Name: Lock washer

Project description/problem statement:

After a patient undergoes surgery to receive a dental implant, their mouth must be restored using a screw which is torqued up to 35 Ncm. The most common failure tends to be the loosening of the screw, leading to patient discomfort, screw fracture, and other complications. The improved lock washer and screw method should be able to better withstand occlusal forces from everyday actions such as chewing or clenching the jaw. The goal is to create a dependable solution that reduces the occurrence of dental implants becoming dislodged.

About the client:

Dr. Tipple has Nakoma Dental for over thirty years, and a patient comes in with a loosened screw in an implant about once a year. He has always been curious as to why lock washers are not used to hold the screw in the implant in place and wants to see if it would be possible. Further, he dislikes the fact that it is not obvious when his screwdriver makes contact with the screw. It makes the surgery much more complex, and he would like a dependable solution as well as a possible simplification in the process of tightening the screw.

2023/9/15 - Questions for our client

Maggie MCDEVITT - Sep 15, 2023, 1:24 PM CDT

Title: Questions for Dr. Tipple

Date: 9/15/23

Content by: Maggie McDevitt

Present: Whole Team

Goals: To come up with a list of questions for our client to gather the information necessary to create our PDS.

Content:

Current method:

- Specific screw/washer he currently uses?
    - Manufacturer, part name, size?
    - Why does it not currently work?
    - What specific aspects to improve on?
    - What has worked best?
- What else has he tried in the past, and why hasn't that worked?
- What is the current method of implantation? (does he dry the mouth before?)
- Do you use different screws/washers for different procedures/treatments?
- Why is the torque different for different patients?

- Are you thinking of changing the geometry/shape of the washers, changing the materials, or both?
    - Any materials that we should absolutely not use? Preferred finish? (gold coating)
    - Texture of finish?
- Ask for samples!!!
- How often do you see patients coming back with loosened screws?
    - What impact does this have on the patient?
    - Have you noticed any specific action that the patient does that specifically loosens the screws? (Ex: chewing gum, grinding their teeth, eating hot food)
    - Most common procedure that you see this occurring afterwards?
    - Average time after procedure that a patient comes back with a loosened screw?
    - Expectation for how long this will be in patient's mouth…after a certain amount of years does it need to be replaced?
        - Does it corrode after a certain amount of time?
        - Does microleakage (bacteria, fluids around teeth) occur often? Does that cause it to need to be replaced?
    - Any patient-related concerns when considering a new solution?

- Are you familiar with regulations in the dentist industry (testing regulations, FDA, etc.)
    - (How much will we be able to test our design based on these regulations?)
- For cleaning and removal how does that currently work, and ideally how would you picture that happening in the future.

    - Does the implant need to be replaced after a certain amount of time, and what parts are replaced on it if so?

Expectations:

- Quantity made? Budget? (target product cost)
- Disclaimer: in this semester, how far can the project be taken? (due to regulations, etc.)
- What would you consider successful completion of this project by the end of the semester?

Conclusions/action items:

We will meet with our client on Monday to ask him these questions and document all of the important information that we gather. We will continue to research competing designs and the actual implantation process.

9/18/2023 Client Introduction meeting

Aaron Marattil - Sep 18, 2023, 7:16 PM CDT

Title: First Client Meeting

Date: 9/18/2023

Content by: Aaron

Present: Full group and Client

Goals: Meet with client, look at current designs ask questions

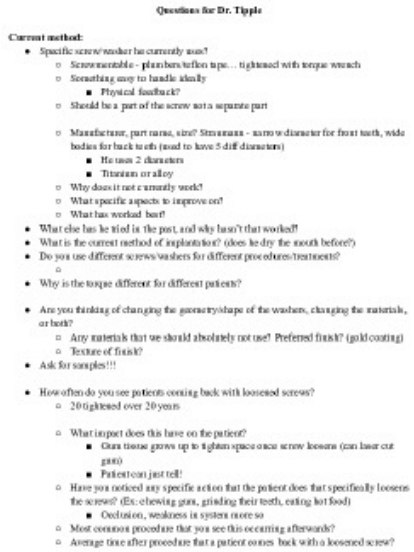
Content:

We met with the client and looked at the current design he uses. Additionally we asked multiple questions enumerated in the attached document.

Conclusions/action items:

Obtain specifications of current design and begin brainstorming solutions

Aaron Marattil - Sep 18, 2023, 7:16 PM CDT



Questions for Dr. Tipple

Current method:

- Specific screw/washer he currently uses?
  - Screwmentable - plumbers/teflon tape… tightened with torque wrench
  - Something easy to handle ideally
    - Physical feedback?
  - Should be a part of the screw not a separate part
  - Manufacturer, part name, size? Straumann - narrow diameter for front teeth, wide bodies for back teeth (need to have 5 diff diameters)
    - He uses 2 diameters
    - Titanium or alloy
  - Why does it not currently work?
  - What specific aspects to improve on?
  - What has worked best?
- What else has he tried in the past, and why hasn't that worked?
- What is the current method of implantation? (does he dry the mouth before?)
- Do you use different screws/washers for different procedures/treatments?
  -
- Why is the torque different for different patients?
- Are you thinking of changing the geometry/shape of the washers, changing the materials, or both?
  - Any materials that we should absolutely not use? Preferred finish? (gold coating)
  - Texture of finish?
- Ask for samples!!!
- How often do you see patients coming back with loosened screws?
  - 20 tightened over 20 years
  - What impact does this have on the patient?
    - Gum tissue grows up to tighten space once screw loosens (can laser cut gum)
    - Patient can just tell!
  - Have you noticed any specific action that the patient does that specifically loosens the screws? (Ex: chewing gum, grinding their teeth, eating hot food)
    - Occlusion, weakness in system more so
  - Most common procedure that you see this occurring afterwards?
  - Average time after procedure that a patient comes back with a loosened screw?

Download

Questions_for_Dr._Tipple_9_18.pdf (67.5 kB)

2023/11/5 - Client Meeting

Maggie MCDEVITT - Nov 05, 2023, 9:00 PM CST

Title: Client Meeting

Date: 11/5/23

Content by: Maggie McDevitt

Present: Whole team and client

Goals: To discuss our team's progress thus far, our ideas, and budget.

Content:

- The team explained the ideas that we have been looking into thus far; essentially what we presented at show and tell
- Client concerns:
    - Would like to see some testing/results/proof that this idea is feasible before purchasing a 3D printed washer
    - He would like us to test without spending lots of money
        - stainless steel washers, larger scale
    - Wants to wait on 3D washer, electroplating, etc.
- Gettings two screws from him tomorrow
- Doesn't necessarily want a final prototype that can be used in application yet

Conclusions/action items:

While it is a little late in the semester, it is important that we listen to our client's feedback and focus on testing this next week. We need to show that this idea is feasible before going ahead with ordering something expensive.

2023/9/15 - Advisor Meeting

Maggie MCDEVITT - Sep 15, 2023, 1:31 PM CDT

Title: First Advisor Meeting

Date: 9/15/23

Content by: Maggie McDevitt

Present: Whole team and Dr. Puccinelli

Goals: To present our initial research, ask questions, and prepare for our upcoming client meeting.

Content:

- Discussed research found:
  - different materials used and torques necessary
  - need to organize research
- Figure out the exact models/products that Dr. Tipple currently uses - what else he has tried, and why it doesn't work
  - Get some samples!
- What is the scope of the washer - specific screw he uses? Different types of implants, do they use different screws?
  - Direct application of washer
  - Regulations (for testing, procedures that would need to be completed, etc.)
    - How far can it be taken in a semester? What would be successful?
    - Torque testing (E-hall), mechanical testing
    - Can't work with titanium in TEAMLab
    - Could 3D print one (could try non-metal...look at longevity)
      - geometry of washer
- Look into patents - figure out why some things have never been used
- Will need to choose a material to design a lock washer (gold, titanium, etc.)
- Look into FDA regulations when it comes to dental implants (existing products too)
- Watch YouTube video of a procedure

Conclusions/action items:

We will look into the actual procedure, FDA regulations regarding dental implants, and various materials that we could use either in the TEAMLab or Makerspace through 3D printing. We will come up with a list of questions for our client based on the PDS rubric.

2023/9/22 - Team Meeting

Maggie MCDEVITT - Sep 22, 2023, 12:55 PM CDT

Title: Team Meeting in Place of Client Meeting

Date: 9/22/23

Content by: Maggie McDevitt

Present: Whole Team

Goals: To make the final edits on our PDS and begin talking about prototypes/ideas for our design matrix.

Content:

- Organized citations in PDS, and continued to add information.
- Discussed meeting next Monday, and all coming prepared with design ideas and possibly SolidWorks drawings.
- Client did not give us a clear budget, but explained that in the past he has been fine giving upwards of $300 to groups.
    - Decided that based on how small our prototypes will be, we will only be using a fraction of that.
- Jacki uploaded progress report to the website
- Aaron is still waiting on a response from the client about the actual screw sizes that he uses, although we do know the manufacturer (Straumann)

Conclusions/action items:

We will come prepared for our meeting on Monday so that we can make our design matrix and go right into creating the criteria and ranking each design option.

2023/9/29 - Advisor Meeting

Maggie MCDEVITT - Sep 29, 2023, 2:19 PM CDT

Title: Advisor Meeting

Date: 9/29/23

Content by: Maggie McDevitt

Present: Whole Team, Dr. P, and Tyler

Goals: To discuss our design matrices, our progress so far, and what are next steps should be.

Content:

- Discussed our main difficulty as we don't know the exact screw dimensions, as this impacts the size of the lock washer that we need
  - could go to hardware store this week to get sample lock washers
- Could use dental glue to keep the washer on the screw while dentist handles it - more of a temporary fix
- 3D printing - scale it out
- local businesses capable of manufacturing titanium
- look into MSE department - if anyone works with titanium
  - learn how things are made...ask how to go about our project
- can 3D print in titanium
- Protolabs in Minnesota...upload files and get prices (different ways of making things)

Conclusions/action items:

Send our preliminary presentation slides to Dr. Puccinelli by Wednesday of next week (highly recommended) if we would like our slides to be reviewed. We need to fix our PDS based on the comments that we received. Also, we need to reach out to our client to get the exact part name of the screw that he uses. Lastly, we need to follow through on Dr. P's recommendations of reaching out/looking into these manufacturing companies that make Titanium alloys, and reach out to someone in the MSE department as well.

2023/10/13 - Advisor Meeting

Maggie MCDEVITT - Oct 13, 2023, 2:15 PM CDT

Title: 10/13 Advisor Meeting

Date: 10/13/23

Content by: Maggie McDevitt

Present: Whole team, Dr. Puccinelli, and Tyler Ross

Goals: To discuss our next steps and consider what else we should be working on.

Content:

- Imaterialise: 3rd company to get a quote from
- Jesse Darley - design engineer at Makerspace
    - help figuring out calculations for thickness, etc.
    - spring force... scalable resistance to torque
- think about varying the thickness and angle of washer
- Think about ordering 5 - 10 washers

Conclusions/action items:

I will reach out to Jesse/see when he is available in the Makerspace to meet. Also, this week we will upload the SolidWorks file to the different printing companies and compare the quotes.

2023/10/20 - Advisor Meeting

Maggie MCDEVITT - Oct 22, 2023, 9:13 PM CDT

Title: Advisor Meeting 10/20/2023

Date: 10/20/2023

Content by: Maggie McDevitt and Izzy Peters

Present: All group members present

Goals: Update Tyler on our progress made this week, including information learned during our meeting with Jesse Darley

Content:

- How much force is exerted on screwhead to resist unthreading?
- simulated complete compression
- create FEA plot - showing how geometry of washer (pitch) effects maximum force
- Electrical discharge machining - tiny holes in screws?
- Focus on: material selection, focus on simulating split lock washers with different dimensions
- Solidworks: how to model a screw tutorial, and YouTube videos
- Show and Tell: 3D printed washer, as well as larger ones from design matrix??

Conclusions/action items:

Research laser cutting. Research what materials we will want to use and if titanium is truly the best option. Research if micro-3d printing will work or if the porosity will pose problems in our project. Do work in Solidworks testing how to increase the strength in our project.

2023/10/27 - Advisor Meeting

Maggie MCDEVITT - Oct 27, 2023, 2:26 PM CDT

Title: 10/27 Advisor Meeting

Date: 10/27/2023

Content by: Maggie McDevitt

Present: Whole Team

Goals: To present our findings in terms of quotes and SolidWorks testing.

Content:

- Quotes from laser cutting companies and 3D printing companies
  - $63 from Imaterialise and Sculpteo
- Jacki - 3D Microprint
  - need NDA agreement completed...can set up a meeting with them
- Electrical discharge machining
- possibly coat stainless steel with titanium
  - can purchase online
  - look into how they're made
- can do electro plating upstairs in ECB
- Compare the 3D printing one to coated one?
- Nondisclosure agreement on design resources website

Conclusions/action items:

We will purchase a steel lock washer and look into companies that could coat it with titanium. We'll also purchase one of the 3D printed ones or laser cut ones, and can compare them.

2023/11/10 - Advisor Meeting

JACKI SZELAGOWSKI - Dec 12, 2023, 7:07 PM CST

Title: 11/10 Advisor Meeting

Date: 11/10/23

Content by: Jacki

Present: Group

Goals: Meet with Dr. P and Tyler to discuss our meeting with our client this past week and the feedback we received.

Content:

- internal and external combined lock washer

- can use stereomicroscope

- washer interaction

- waterjet to cut internal/external washer

- use a scale model for testing

- brainstorm some sort of custom washer

- Order McMaster-Carr screw that is similar to our screw

2023/9/25 - Team Meeting - Design Matrix Discussion

Maggie MCDEVITT - Sep 25, 2023, 8:44 PM CDT

Title: Design Matrix Discussion

Date: 9/25/23

Content by: Maggie McDevitt

Present: Whole Team

Goals: To create our design matrix and rank the various criteria that we decide on.

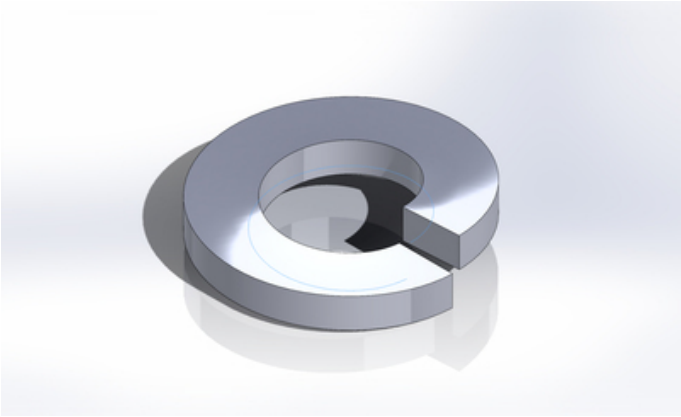
Content:

- Decided to make 2 design matrices:
  - one for the final material
  - one for the actual shape/type of lock washer
- For the material, strength, longevity/durability, and biocompatibility are our top 3 criteria
- For the actual lock washer, resistance to torque, versatility, and ease of fabrication are the most important to us
- Safety and cost are important, but are not major factors in this project
- We divided up the sections, so each of us are researching, ranking, and writing about 2 criteria and which design option won for that section
- Material considerations: pure titanium, titanium alloy, and zirconium
- Washer designs: split lock washer, external tooth lock washer, and conical washer

Conclusions/action items:

We will each research based on our assigned sections, and make sure this is completed earlier in the week so that we can edit as needed.

Maggie MCDEVITT - Oct 09, 2023, 8:29 PM CDT



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Lock_Washer.JPG (260 kB)

2023/10/18 - Meeting with Jesse Darley and Jay Bowe

Maggie MCDEVITT - Oct 20, 2023, 1:57 PM CDT

Title: Meeting with Jesse Darley

Date: 10/18/23

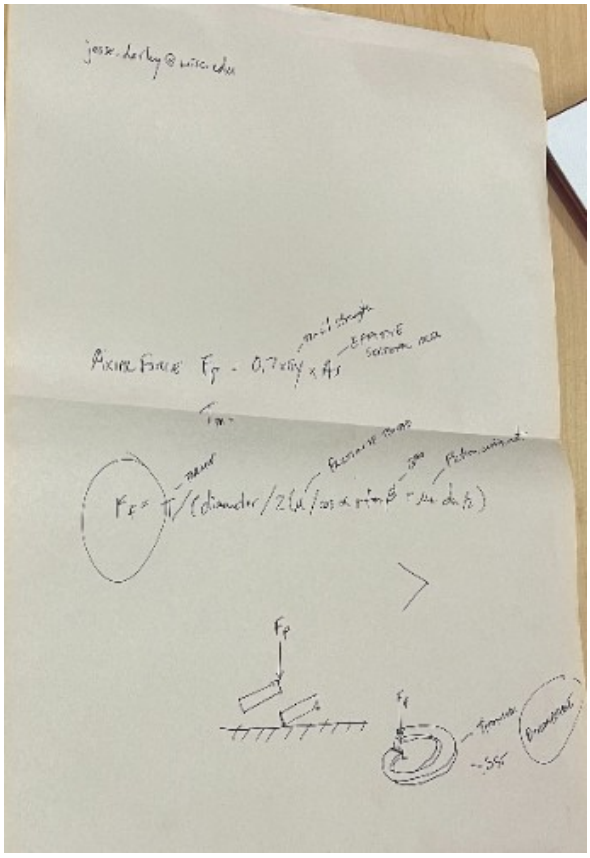
Content by: Maggie McDevitt

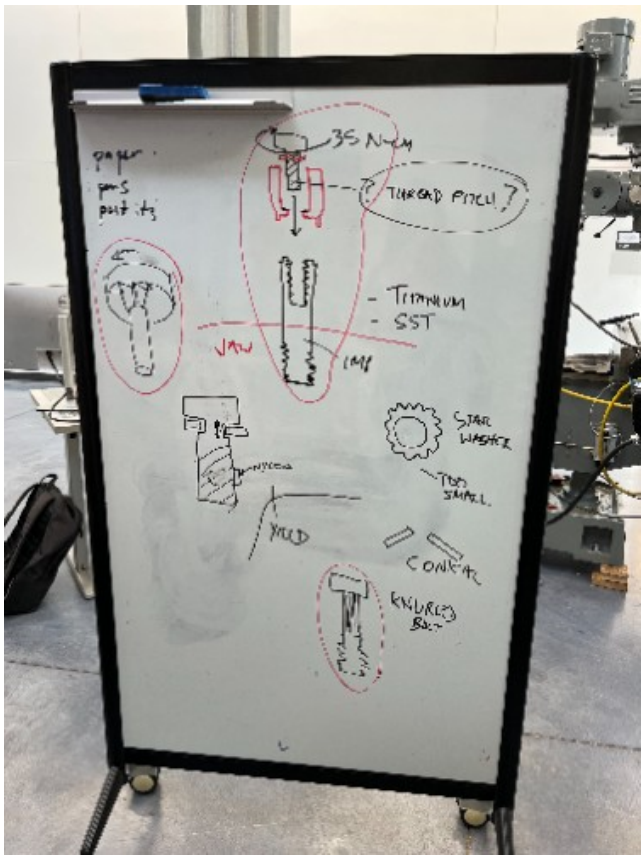
Present: Izzy and Maggie

Goals: To do some calculations, SolidWorks designs, and FEA.

Content:

- Through FEA: fixed one side of the split washer, and put a compressive force of 1 Newton on the top of other side of the washer
    - Deformation is roughly .22 mm (same as the pitch - so both sides are at the same height)
    - Stress was less than the yield strength...so this application is possible.
- Discussed potentially changing the screw by making a small hole on the side of the screw and adding Nylok in it.
- Also discussed continuing to consider our other lock washer options, as well as stainless steel...however: not biocompatible
- Need to figure out the thread pitch in order to complete more calculations





Conclusions/action items:

In this meeting, we went in-depth regarding multiple aspects of our project, which was slightly overwhelming. We decided that our primary focus for now will be changing dimensions on our SolidWorks design and doing FEA, to determine what the best dimensions, shapes, and materials are.

2023/11/1 - Team Meeting

Maggie MCDEVITT - Nov 01, 2023, 1:56 PM CDT

Title: Team Meeting 11/1

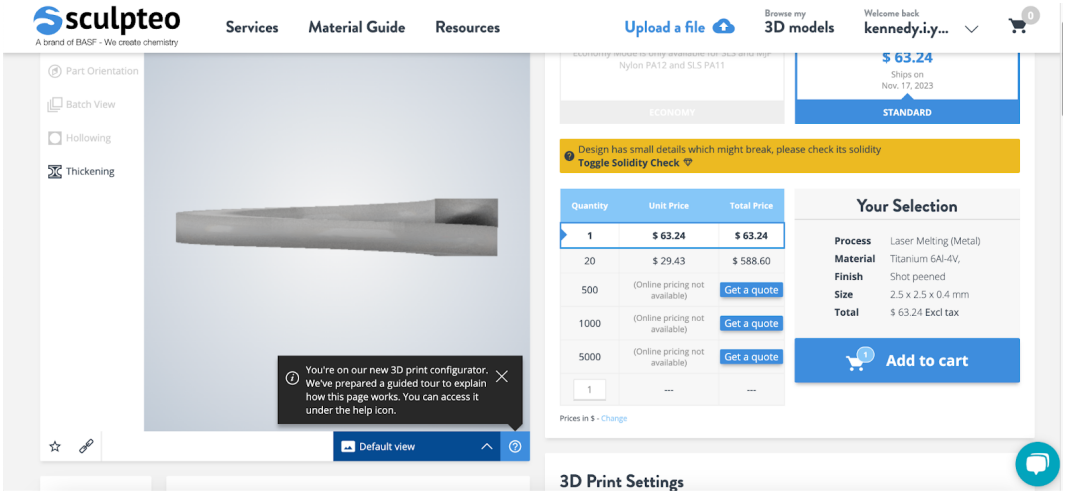
Date: 11/1/2023

Content by: Maggie McDevitt

Present: Whole Team

Goals: To discuss our next steps in terms of ordering a prototype.

Content:

- All signed NDA, waiting for company to get back to us in regard to if our design is feasible.
- Emailing Dr. Tipple to set up a virtual meeting and get his input on ordering the design.
  - Want to figure out how many he has the budget for
  - 

  - This company gave a non-automated response, and said that our design would work if printed.
  - Made of titanium alloy, which would provide more elasticity.
- Continuing to look into titanium plating for our 1.6 mm inner diameter steel lock washers from the Makerspace.

Conclusions/action items:

After contacting Dr. Tipple, we will be waiting on his response to determine how we should proceed with purchasing.

2023/11/3 - Show and Tell

Maggie MCDEVITT - Nov 03, 2023, 1:57 PM CDT

Title: Show and Tell

Date: 11/3/23

Content by: Maggie McDevitt

Present: Whole class

Goals: To get feedback from other design groups and practice presenting our project in an informal setting.

Content:

- Suggestions from other groups:
  - Metal to metal interactions if we electroplate steel?
    - We should look into electroplating with gold
  - Be able to quantify the forces that it should withstand
  - 3D printing may make the design non isotropic
  - Water cutting precision method for our scale

Conclusions/action items:

We need to look into electroplating in ECB, and decide after speaking with our client whether that would be necessary and see what he thinks. We also should focus on testing with our stainless steel washers, and create a testing protocol to follow.

2023/12/13 - Final Expenses

Title: Final Expenses Table

Date: 12/13/23

Content by: Maggie McDevitt

Present: Whole team

Goals: To document our expenses so that we are able to get properly reimbursed.

Content:

LabArchives Notebook	For Documentation purposes	LabArchives	N/A	9/8/23	1	$15	$15	BME Design-Fall 2023 - Maggie MCDEVITT - LabArchives, Your Electronic Lab Notebook
Steel Split Lock Washer	One with an inner diameter of 2.8 mm, and the other with a much larger diameter for presentation purposes	N/A - purchased from Makerspace	N/A	10/5/23	2	$0.10	$0.20	N/A
3D Printed PLA Split Lock Washer	Inner diameter of 5 mm, made of plastic and on a small support	Makerspace 3D printer	N/A	10/5/23	1	Free	Free	N/A
Split Lock Washers	18-8 Stainless Steel Split Lock Washer for Number 0 Screw Size, 0.062"	McMaster-Carr	92146A510	11/13/23	1 pack of 100	$4.02	$4.02	18-8 Stainless Steel Split Lock Washer, for Number 0 Screw Size, 0.062" ID, 0.137" OD | McMaster-Carr
Lock Washers	Internal-/External-Tooth Lock Washers, 410 Stainless Steel, for Number 10 Screw Size	McMaster-Carr	90588A114	11/13/23	1 pack of 100	$7.64	$7.64	Internal-/External-Tooth Lock Washers, 410 Stainless Steel, for Number 10 Screw Size | McMaster-Carr
Screws	Same-Size Thread 18-8 Stainless Steel Shoulder Screw, 3/16" Shoulder Diameter, 1/4" Shoulder Length, 10-32 Thread Size	McMaster-Carr	91273A139	11/13/23	5	$3.93	$19.65	Same-Size Thread 18-8 Stainless Steel Shoulder Screw, 3/16" Shoulder Diameter, 1/4" Shoulder Length, 10-32 Thread Size | McMaster-Carr

Conclusions/action items:

We were able to get properly refunded due to keeping track of all of our purchases.

2023/10/11 - Preliminary Testing Plans

Maggie MCDEVITT - Oct 11, 2023, 3:05 PM CDT

Title: Preliminary Testing Plans

Date: 10/11/2023

Content by: Maggie McDevitt

Present: N/A

Goals: To determine the method by which we will test how well the washer method works to keep the screw from loosening.

Content:

- BME lab already has FSB2 torque testing device
  - however - only can test samples with a minimum inner diameter of 1.5 mm
  - May have to order samples with a slightly larger inner diameter (1.5 - 2 mm)
    - Would also have to determine if these results are still applicable for our washer as it is a different size
  - Test torque needed to remove the screw from the implant without a washer
    - Use this as a control
  - Test the torque needed to remove the screw with a washer.
  - Continue to apply increasingly larger amounts of torque in the opposite direction
    - do at least 3/5 samples for each control and test group
    - Identify at which torque values each screw began to loosen, and at what point they were able to fully come off.

[1] "FSB2 - Torque Gauges - 17lbf.in x 0.01lbf.in - Torbal Torbal Force Gauges." Accessed: Oct. 11, 2023. [Online]. Available: https://www.qualityforcegauges.com/torque-gauges/fsb-chuck-clamp/fsb2

Conclusions/action items:

Our team needs to finish looking into companies to 3D print titanium split lock washers, and get on top of ordering multiple. We also need to determine if we also need to purchase screws and implants, or if we will be able to get the ones that Dr. Tipple uses.

2023/12/13 - Final Testing Protocol

Isabelle Peters - Dec 13, 2023, 2:57 PM CST

Title: Final Testing Protocol

Date: 2023/12/13

Content by: Isabelle Peters

Present: Maggie and Izzy

Goals: To describe the testing protocol done

Content:

To test the implementation of a split lock washer in a dental implant, a test was conducted on a larger scale. A screw, split lock washer, and flat washer 8.865x larger were used to simulate the design and provide clear results. A control was first obtained by using a flat washer around the screw and tightening the screw in at around 200 N-cm, recording the exact torque used to tighten the screw. After five minutes has passed, the screw is unscrewed, and the torque required to remove the screw is recorded. This process is repeated a minimum of 3 times. The same experiment is then replicated with a split lock washer. The split lock washer is placed beneath the flat washer to simulate the split lock washer making contact with the abutment (the flat lock washer replacing the contact with the abutment) as opposed to the screw head. The screw is once again tightened at around 200 N-cm, and the precise torque is recorded. The screw sits for five minutes and then is removed. The torque required to remove is recorded and the process is repeated a minimum of 3 times, replacing the split lock washer for each new run.

Conclusions/action items:

Record data, and inteperet

2023/10/26 - SolidWorks Preliminary Testing

Maggie MCDEVITT - Oct 26, 2023, 5:53 PM CDT

Title: SolidWorks Normal Force - Testing

Date: 10/26/23

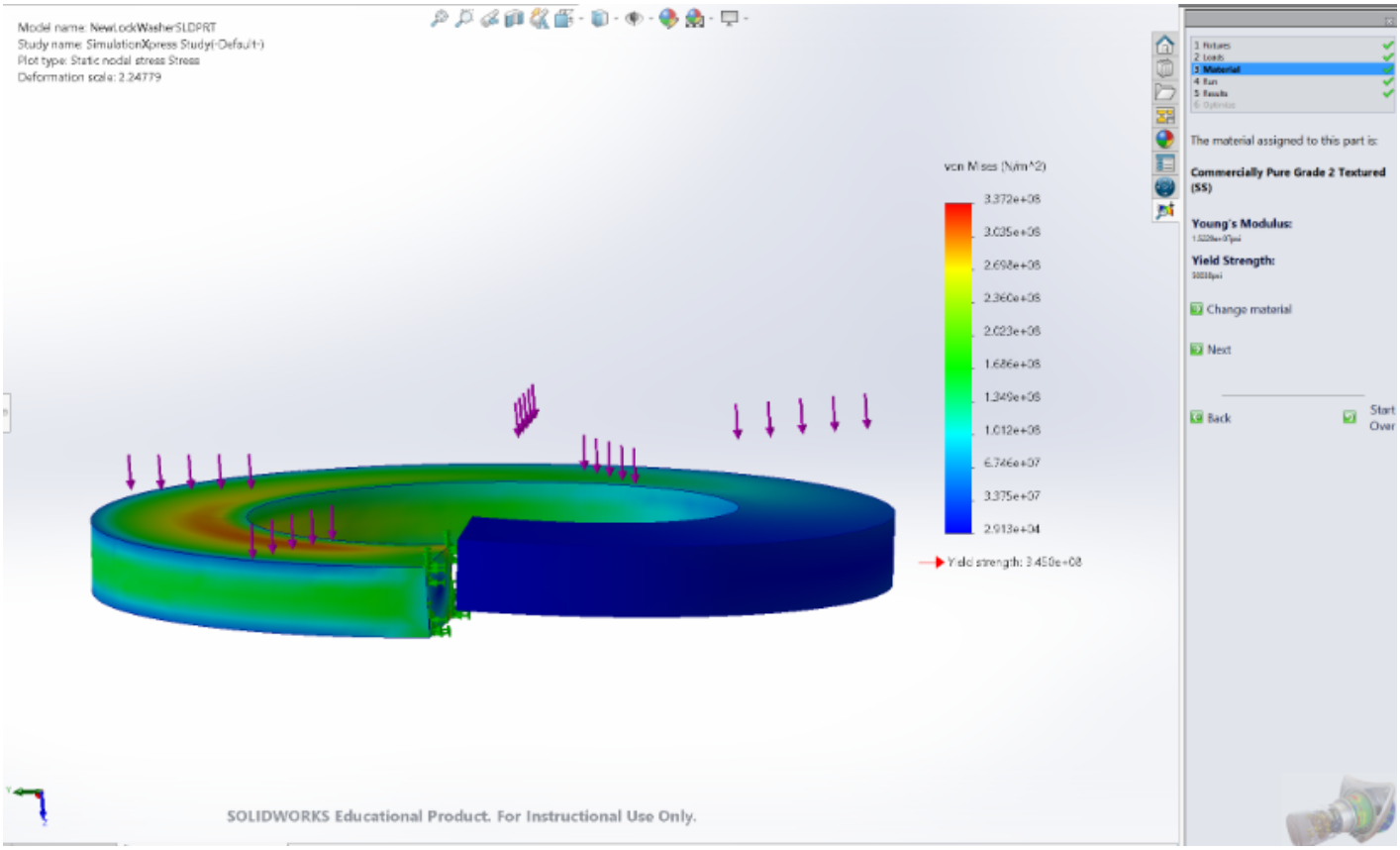
Content by: Maggie McDevitt

Present: N/A

Goals: To test how much normal force the washer is able to withstand before yielding.

Content:

- Using Commercially Pure Grade 2 Textured SS
- Yield Strength of material: 50038 psi
- Applied a 1 Newton force
- yield strength experienced: 3.45E8
    - failed, but did not deform too much



Conclusions/action items:

2023/11/26 - Testing Split Lock Washer

Maggie MCDEVITT - Nov 26, 2023, 2:53 PM CST

Title: Testing Split Lock Washer

Date: 11/26/23

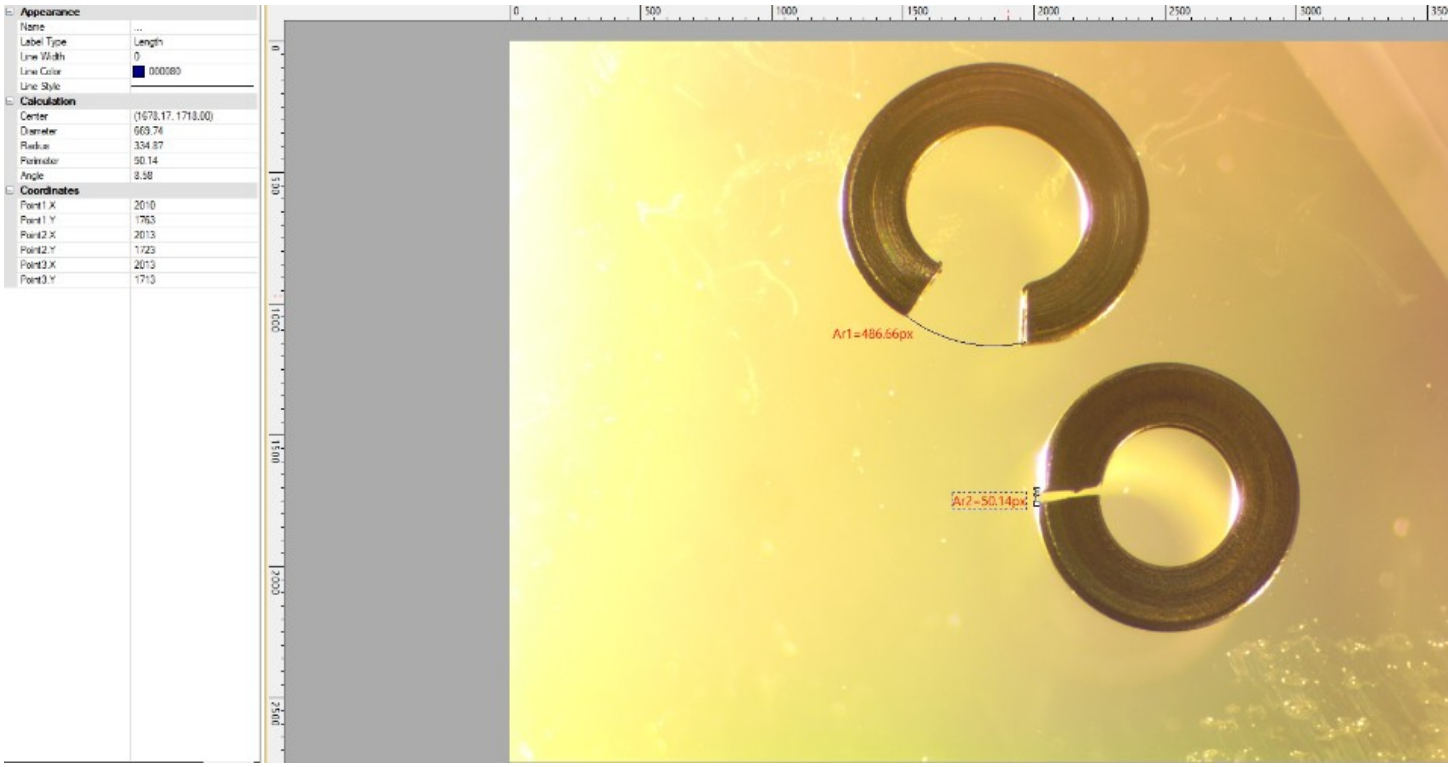
Content by: Maggie McDevitt

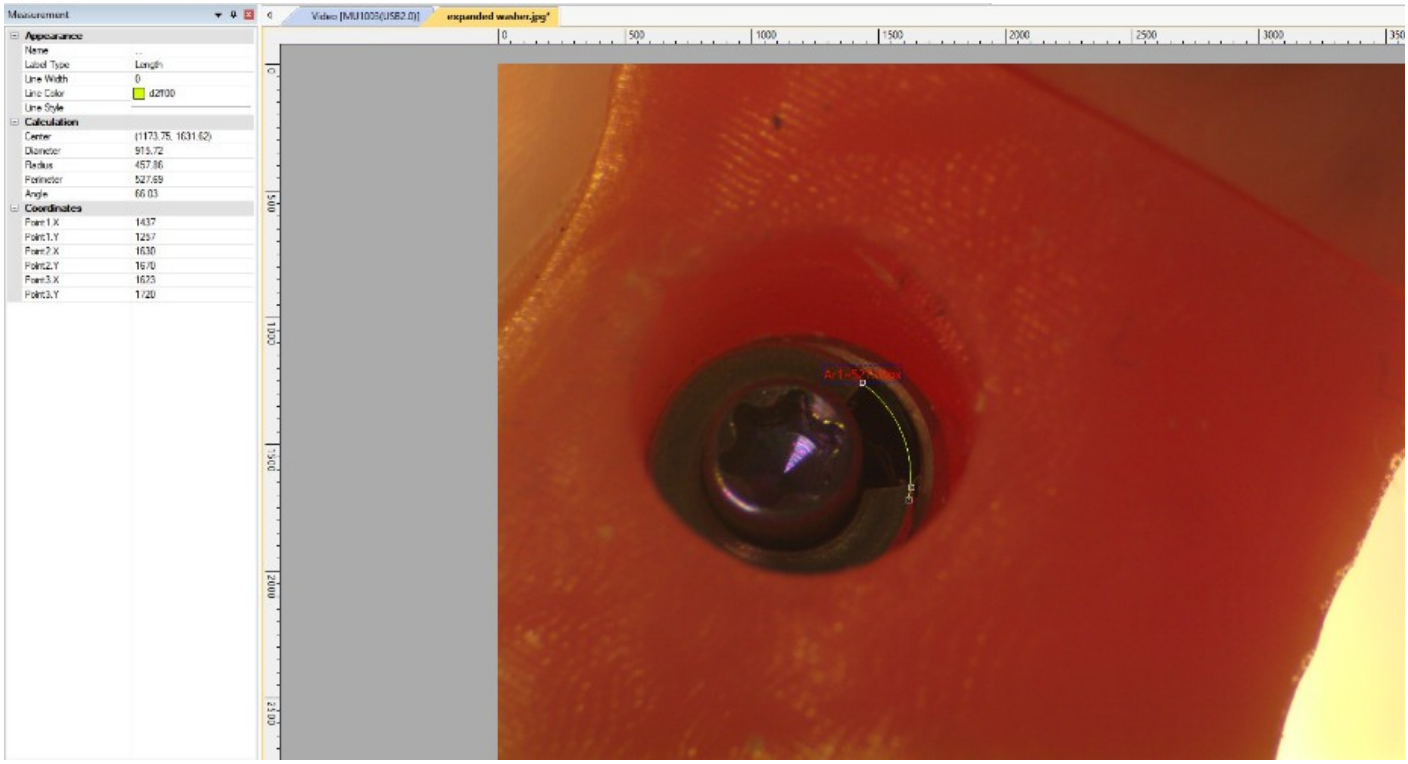
Present: Maggie, Izzy, Jacki

Goals: To determine whether or not a split lock washer can be incorporated into the current implant design and to get more familiar with the whole set-up.

Content:

- Upon screwing in the split lock washer into the threaded implant without the abutment/crown, the split lock washer significantly expanded, as shown in the second image
- We examined this difference under the microscope, and the circumference of the split increased by almost tenfold.





Conclusions/action items:

We have come to the conclusion that a split lock washer is not a good fit. However, we were not able to try to use it with the abutment, in which case it may actually work better. If we are able to find a longer screwdriver, we would be able to test it with the whole set-up.

2023/12/11 - Torque Testing with Split Washer

Maggie MCDEVITT - Dec 13, 2023, 9:23 PM CST

Title: Torque Testing Protocol

Date: Completed 12/4/23

Content by: Maggie McDevitt

Present: Maggie and Izzy

Goals: To simulate the abutment above the washer, we completed three trials of torque tests to determine if the split lock washer works well.

Content:

1. First, create a few taps in a thick piece of plastic using a 10-32 tap and drill bit. Using a drill press, make sure that the drill bit makes a straight 90 degree angle with the material. Slowly lower it down until it makes contact with the material. Slowly push the drill bit into the material, back out after a couple pieces of material get caught in the bit, and repeat, but push the bit slightly further this time. Using a tap, create threads by using a tap and turning it 3 half-turns to the right followed by a half-turn to the left, and repeating until the rest of the hole is threaded.

2. Screw in a no. 10 internal hex screw with a no. 10 flat normal washer underneath the head of the screw. Using the torque testing device with the handles attached, continue twisting in the screw with the bit attached to the torque testing device until the torque reaches around 200 Ncm. Make sure a timer is set so that the maximum torque is recorded every 10 seconds. Record the value, and let the screw sit for five minutes. Firmly twist the handles of the torque tester to the left to record the amount of torque necessary to remove the screw. Record the absolute value of the minimum value and completely remove the screw. Repeat two more times.

3. Screw in a no. 10 internal hex screw with a no. 10 flat normal washer directly underneath the head of the screw and a split lock washer beneath the flat washer. Use the torque testing device again to measure the torque required to screw in (~200 Ncm) and remove the screw, and wait five minutes similarly to in step 2. Repeat 2 more times.

Conclusions/action items:

The amount of torque required to remove the screw with the split lock washer incorporated as in step 3 was greater than the amount of torque recorded to tighten the screw. In step 2, less torque was required in each trial to remove the screw.

2023/12/13 - Final Testing Results

Isabelle Peters - Dec 13, 2023, 2:54 PM CST

Title: Final Testing Results

Date: 12/13/2023

Content by: Isabelle Peters

Present: Izzy and Maggie

Goals: To obtain results to prove that the split lock washer provides constructive strength to the mechanism.

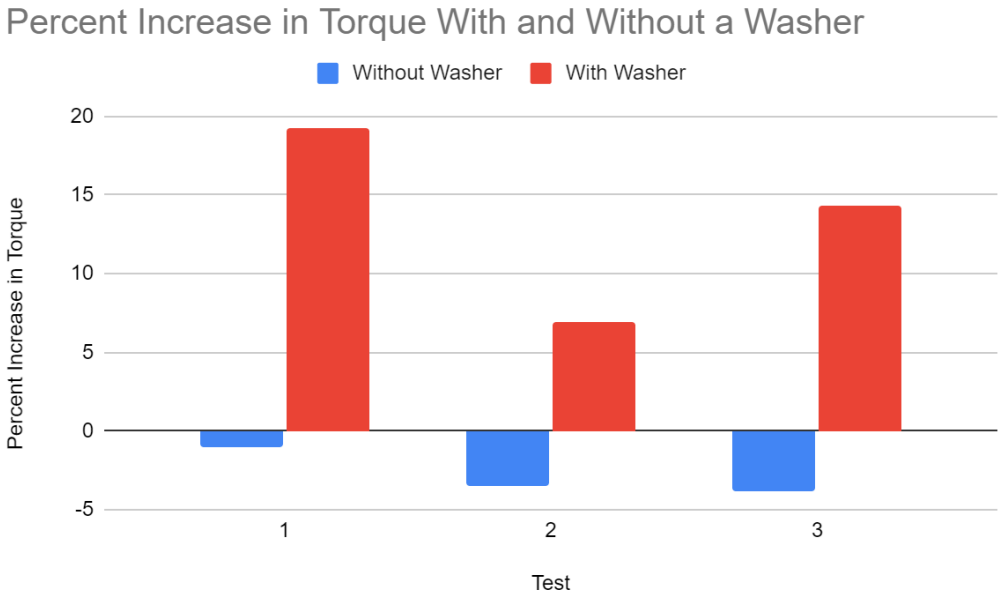
Content:

Without split lock washer: Average of 2.79% loss in torque

Torqued In (N-cm)	Torqued Out (N-cm)	Percent Increase (%)
292.6	289.6	-1.03%
278.4	268.7	-3.48%
336.5	323.5	-3.86%

With a split lock washer: An average of 13.5% increase in torque

Torqued In (N-cm)	Torqued Out (N-cm)	Percent Increase (%)
211.1	251.8	19.28%
226.4	242.1	6.93%
205.3	234.6	14.3%



The average percent change for the group without a split lock washer was -2.79%. The average percent change for the group with the split lock washer was 13.5%. Running a paired T-test returns a value of 5.4195. Additionally, this T-test returned a p-value of 0.0324 which is less than 0.05, showing that the means are significantly different from one another. Therefore the split lock washer provided a significant increase in torque.

Conclusions/action items:

Spend more time interpreting results.

2023/9/13 - Screw Loosening Statistics and Recommendations for Prevention

Maggie MCDEVITT - Sep 15, 2023, 11:04 AM CDT

Title: Abutment Screw Loosening in Implants

Date: 9/13/23

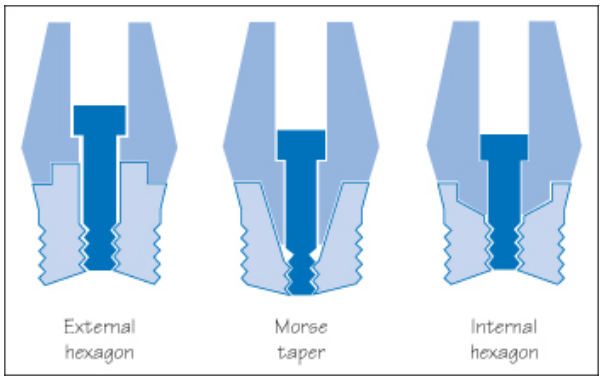
Content by: Maggie McDevitt

Present: Myself

Goals: To learn more about the most common mechanical and biological failures when restoring the mouth after dental implants.

Content:

- most commonly occurring mechanical complication: abutment screw loosening
  - occurs in 8% of cases, up to 45% with single crowns
  - less common in wider diameter implants
  - cause other complications: patient discomfort, screw fracture, peri-implantitis, marginal gap, microbial leakage, crown loosening, etc.
- Studies have conflicting arguments when it comes to screw length and thread count
  - one study: no significant effect on torque when minimum length screw is used
- Treatment process
  - Screw joint stability is affected by contamination by blood and saliva
  - chlorohexidine application: preferred in a study for stability
  - Gold coated screws are better, as well as a conical spring washer
  - Area should be dry during insertion
- Microleakage: gaps at the margin of restoration...fluid and bacteria can contaminate the tooth
  - more common when using internal hex type of abutment (titanium, zirconium)
  - increases the incidence of screw loosening
  - another type of abutment (less incidents of microleakage): Morse tapered titanium



- Increase in abutment collar length --> increased screw loosening
- Anti-rotation resistance features
  - notches or micro-stops
    - prevent abutment rotation and reduces screw loosening

[1] E. F. Alsubaiy, “Abutment screw loosening in implants: A literature review,” *J Family Med Prim Care*, vol. 9, no. 11, pp. 5490–5494, Nov. 2020, doi: 10.4103/jfmpc.jfmpc_1343_20.

[2] U. F. O. Themes, “7 Implant macrostructure: implant/abutment connection,” *Pocket Dentistry*, Jan. 07, 2015. https://pocketdentistry.com/7-implant-macrostructure-implantabutment-connection/ (accessed Sep. 14, 2023).

Conclusions/action items:

There are many small fixes that studies have shown to reduce the rate of occurrence of screws becoming loose. I want to look more into the actual structure of the screws and lock washers and the current competition.

Review Article

Abutment screw loosening in implants: A literature review

Ebrahim F Alsubaiy

Assistant Professor, Department of Prosthodontics, King Khalid University, Abha, Saudi Arabia

Abstract

This review was intended on major factors contributing to abutment screw loosening. A search of Pubmed and Google Scholar, as well as a manual search, was conducted. Publications and articles accepted for publication up to February 2020 were included. Out of 150 studies retrieved, a total of 37 were selected for this review. Dental implants are associated with a complication of abutment screw loosening. Implantologists and prosthodontists should be aware of factors that contribute to this problem. In the current review previously identified factors were collected, the consideration of which can help to reduce the frequency of abutment screw loosening.

Keywords: Abutment, implants, screw loosening, torque value

Introduction

Factors Affecting Abutment Screw Loosening

Address for correspondence: Dr. Ebrahim F. Alsubaiy, Assistant Professor, Department of Prosthodontics, King Khalid University, Abha, Saudi Arabia. E-mail: ebrahim.f@hotmail.com

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Accepted: 28-09-2020 Published: 30-11-2020

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How to cite this article: Alsubaiy EF. Abutment screw loosening in implants: A literature review. J Family Med Prim Care 2020;9:5402-4.

Screwloosening.pdf (501 kB)

2023/9/21 - Titanium in Dentistry

Maggie MCDEVITT - Sep 21, 2023, 7:45 PM CDT

Title: Titanium and Alloys in Dentistry

Date: 9/21/23

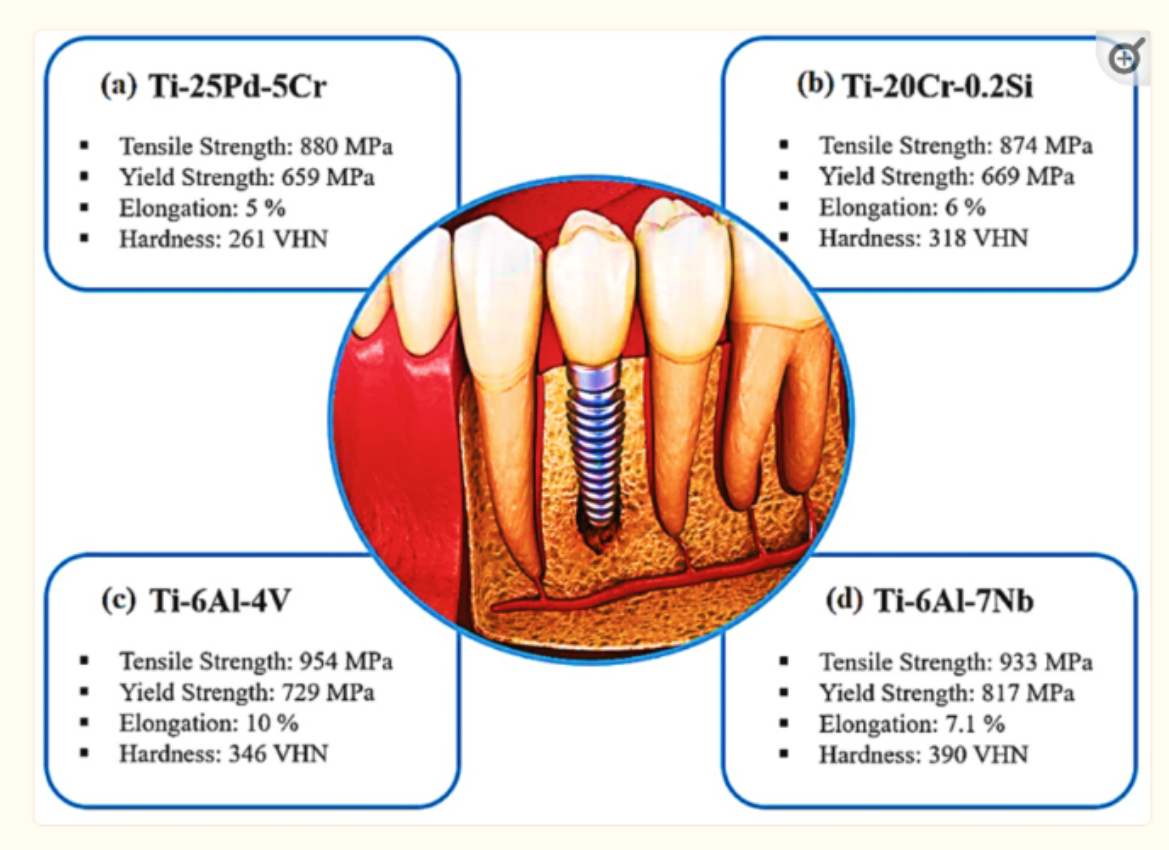
Content by: Maggie McDevitt

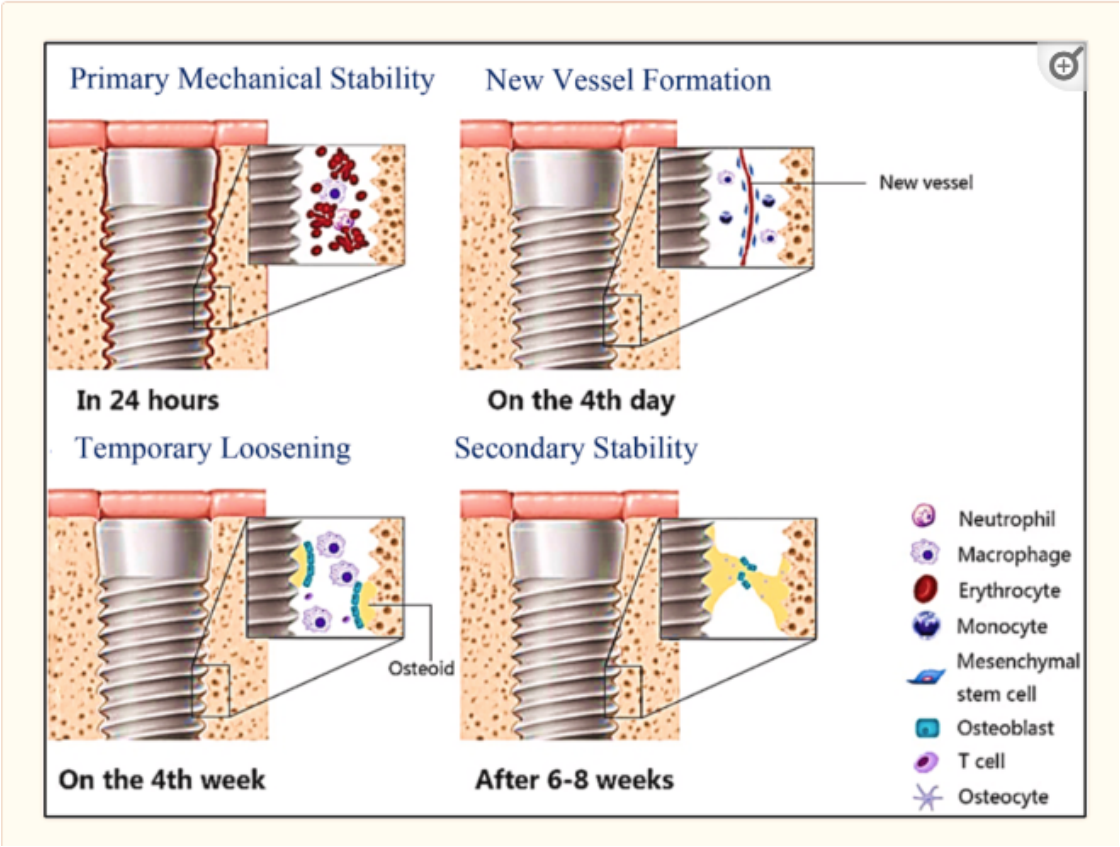
Present: N/A

Goals: To look into why Titanium and Titanium alloys are consistently used in many dental applications.

Content:

- Great information provided regarding the different types of Titanium alloys and their mechanical properties. It will be helpful to look at these when determining which final materials to use.





Conclusions/action items:

Titanium is biocompatible, has osseointegration properties, and great biomechanical and biochemical properties. It would be interesting to look into the ultimate torques of different alloys.

2023/9/21 - Washers on the Market

Title: Stainless Steel Washers

Date: 9/21/23

Content by: Maggie McDevitt

Present: N/A

Goals: To learn more about the washers that are currently available and sold.

Content:

- **Smallest inner diameter offered by this company is 3.4 mm, which is likely too big.**

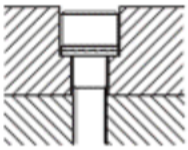
Principle of Lock Washers
A pair of washers with wedge cams on one side and radial ribs on the other side each to compose a self-locking arrangement. Cam angle (α) is set to be larger than the thread lead angle (β). When the screw attempts to rotate loose, a force is generated by a cam member to push up and separate from the opposite cam member. The rotation is blocked by the wedge effect and the cams will not be separate by more than one thread pitch.

Proper Installation
Set up correctly as shown in the image to the right.
Do not use together with other washers.

Cautions on Repeated Use
NLDF can be used repeatedly with a lubricant.

Allowable Temperature
Temperature limit for NLDF is 500°C. Do not use in an environment when it exceeds the temperature limit.

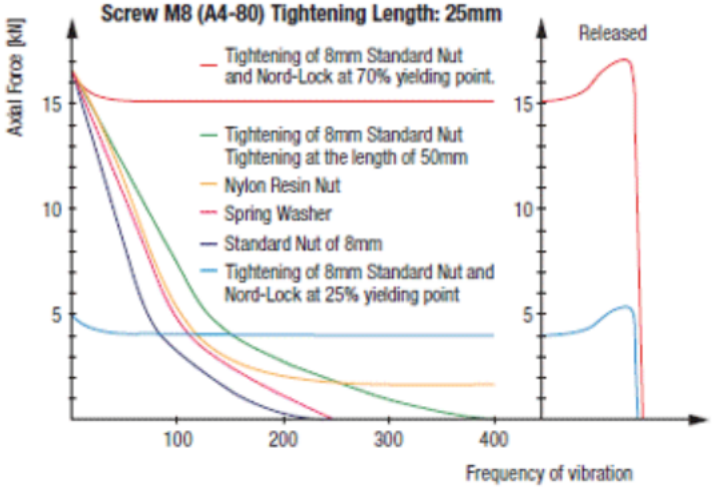
Application Example
Counterbore dia. does not need to be increased.



About Mating Materials
On the surface of mating materials, there will be impress of the washers. The hardness of the mating surfaces sho Nord-Lock Washers.

Recommended Tightening Torque and Tightening For
Please refer to the values listed below as guidelines whe washer. There is no self-locking effect when the values a If the tightened torque exceeds the recommended values impossible or Nord-Lock may be broken.

Junker Test Result
Screw M8 (A4-80) Tightening Length: 25mm



Screw Tightening Torque and Recommended Tightenin
(Lubricant GTP600)

NLDF	Applicable Screws M x P	Screw Strength Class A2-70, A4-70 G_F=0.65 μ_G=0.14, μ_W=0.14	
		Torque N•m	Tightening kN
3	3 x 0.5	0.9	1.5
4	4 x 0.7	2	2.6
5	5 x 0.8	3.9	4.1
6	6 x 1.0	6.9	5.9
8	8 x 1.25	17	11
10	10 x 1.5	33	17
12	12 x 1.75	56	25

① G_F: Coefficient at the Yield Point μ_G: Coefficient of Friction at Screw Thread μ_W: Coefficient of Friction in Washer

[1] "Lock Washers - Small Outer Diameter | MISUMI | MISUMI." https://us.misumi-ec.com/vona2/detail/110301997560/?curSearch=%7b%22field%22%3a%22%40search%22%2c%22seriesCode%22%3a%22110301997560%22%2c%22innerCode%22%3a%22%22%2c% (accessed Sep. 21, 2023).

Conclusions/action items:

While this type of washer probably won't be our final design, it is still helpful to see how the torque needed varies based on the type of screw. It is also helpf

2023/9/21 - Titanium Washer Effect on Removal Torque

Maggie MCDEVITT - Oct 04, 2023, 10:31 AM CDT

Title: Titanium Washer Usage in Dental Implant

Date: 9/21/23

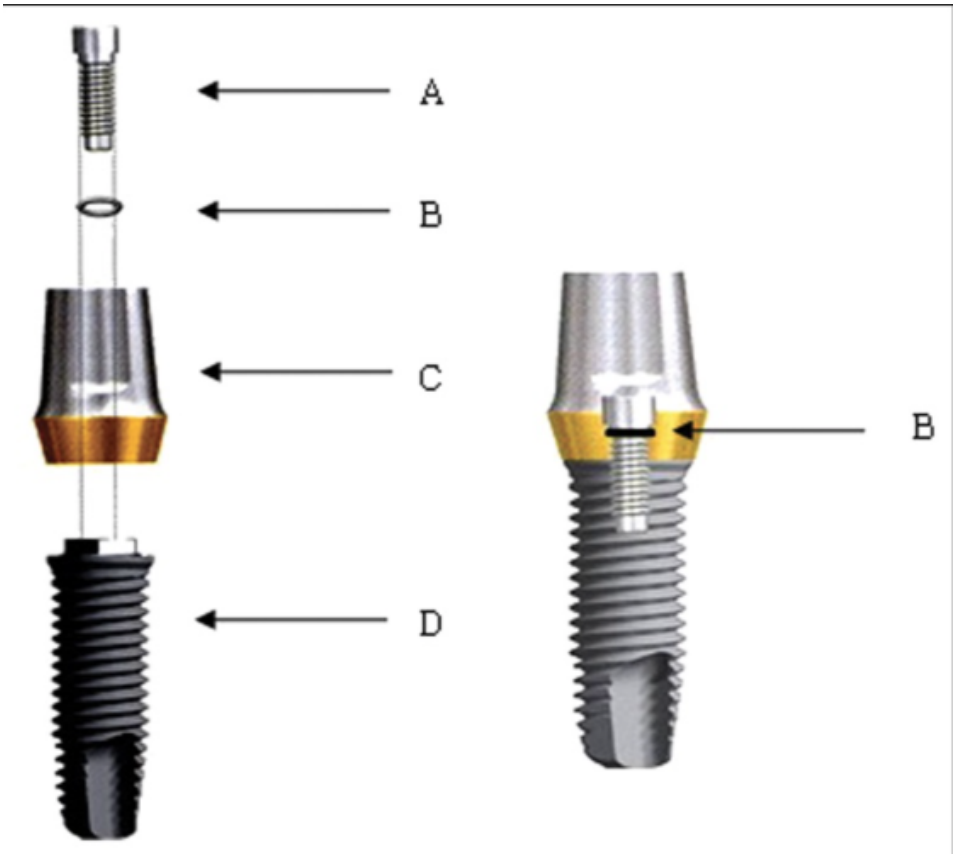
Content by: Maggie McDevitt

Present: N/A

Goals: To understand more about the usage of titanium washers as it applies to dentistry, as there are not many academic articles pertaining to that specific application.

Content:

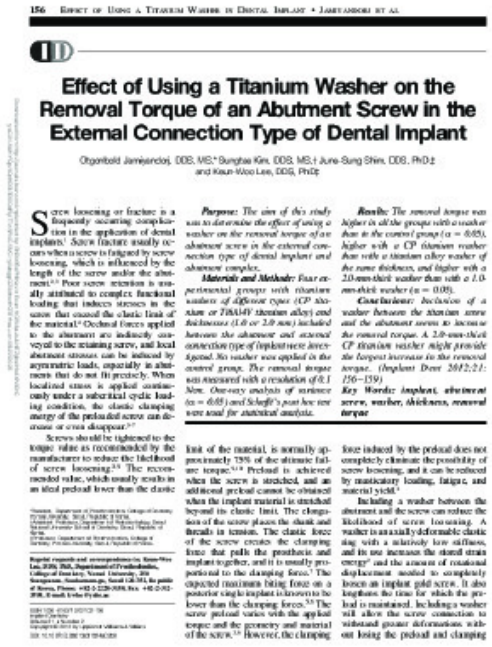
- Used washer made of pure titanium and an alloy of titanium (Ti6Al4V)
- 4 experiments were done, and both of these materials were used to make washers of 1 mm and 2 mm thickness
- Unscrewing: elastic clamping energy of the screw can decrease/disappear
- typically- recommended torque amount is 75% of ultimate failure torque
- ***Placing washer between abutment and screw reduces likelihood of screw loosening
    - increases stored strain energy & the amount of rotational displacement needed to completely loosen a screw
    - can withstand greater deformations
    - friction btwn washer and screw head is important
- Testing:
    - Used a digital torque gauge to measure removal torque
    - higher removal torque in screws with washer compared to without
    - pure titanium better than alloy
    - rougher washer surface = higher performance



[1] O. Jamiyandorj, S. Kim, J.-S. Shim, and K.-W. Lee, “Effect of Using a Titanium Washer on the Removal Torque of an Abutment Screw in the External Connection Type of Dental Implant,” *Implant Dentistry*, vol. 21, no. 2, p. 156, Apr. 2012, doi: 10.1097/ID.0b013e31824a02b9.

Conclusions/action items: Our client came up with the idea to try a lock washer as he wondered why no one had ever tried it in dentistry. This is the first academic study in which any type of washer was used in dentistry, and it has promising results. It seems that titanium is a better bet as a material than an alloy, and a thicker washer would work better. It will be interesting to see how all of this applies to lock washers.

Maggie MCDEVITT - Sep 21, 2023, 7:37 PM CDT



156 EFFECT OF USING A TITANIUM WASHER IN DENTAL IMPLANT • JAMJOODIRI ET AL

Effect of Using a Titanium Washer on the Removal Torque of an Abutment Screw in the External Connection Type of Dental Implant

Otgonbold Jamjoodiri, DDS, MS,* Sunghae Kim, DDS, MS,† June-Sung Shim, DDS, PhD,‡ and Keun-Woo Lee, DDS, PhD§

Purpose: *The aim of this study was to determine the effect of using a washer on the removal torque of an abutment screw in the external connection type of dental implant and abutment complex.*

Materials and Methods: *Four experimental groups with titanium washers of different types (CP titanium or Ti6Al4V titanium alloy) and thicknesses (1.0 or 2.0 mm) included between the abutment and external connection type of implant were investigated. No washer was applied in the control group. The removal torque was measured with a resolution of 0.1 Ncm. One-way analysis of variance (α = 0.05) and Scheffé's post hoc test were used for statistical analysis.*

Results: *The removal torque was higher in all the groups with a washer than in the control group (α = 0.05), higher with a CP titanium washer than with a titanium alloy washer of the same thickness, and higher with a 2.0-mm-thick washer than with a 1.0-mm-thick washer (α = 0.05).*

Conclusions: *Inclusion of a washer between the titanium screw and the abutment seems to increase the removal torque. A 2.0-mm-thick CP titanium washer might provide the largest increase in the removal torque. (Implant Dent 2012;21: 156–159)*

Key Words: *implant, abutment screw, washer, thickness, removal torque*

Screw loosening or fracture is a frequently occurring complication in the application of dental implants.[1] Screw fracture usually occurs when a screw is fatigued by screw loosening, which is influenced by the length of the screw and/or the abutment.[2,3] Poor screw retention is usually attributed to complex functional loading that induces stresses in the screw that exceed the elastic limit of the material.[4] Occlusal forces applied to the abutment are indirectly conveyed to the retaining screw, and local abutment stresses can be induced by asymmetric loads, especially in abutments that do not fit precisely. When localized stress is applied continuously under a subcritical cyclic loading condition, the elastic clamping energy of the preloaded screw can decrease or even disappear.[5–7]

Screws should be tightened to the torque value as recommended by the manufacturer to reduce the likelihood of screw loosening.[2,3] The recommended value, which usually results in an ideal preload lower than the elastic limit of the material, is normally approximately 75% of the ultimate failure torque.[8,9] Preload is achieved when the screw is stretched, and an additional preload cannot be obtained when the implant material is stretched beyond its elastic limit. The elongation of the screw places the shank and threads in tension. The elastic force of the screw creates the clamping force that pulls the prosthetic and implant together, and it is usually proportional to the clamping force.[7] The expected maximum biting force on a posterior single implant is known to be lower than the clamping forces.[3,5] The screw preload varies with the applied torque and the geometry and material of the screw.[10] However, the clamping force induced by the preload does not completely eliminate the possibility of screw loosening, and it can be reduced by masticatory loading, fatigue, and material yield.[5]

Including a washer between the abutment and the screw can reduce the likelihood of screw loosening. A washer is an axially deformable elastic ring with a relatively low stiffness, and its use increases the stored strain energy[6] and the amount of rotational displacement needed to completely loosen an implant gold screw. It also lengthens the time for which the preload is maintained. Including a washer will allow the screw connection to withstand greater deformations without losing the preload and clamping

Download

effect_of_using_a_titanium_washer_on_the_removal.15.pdf (608 kB)

2023/9/28 - CeraRoot Ceramic Implants

Maggie MCDEVITT - Sep 28, 2023, 12:04 PM CDT

Title: CeraRoot Ceramic Implants

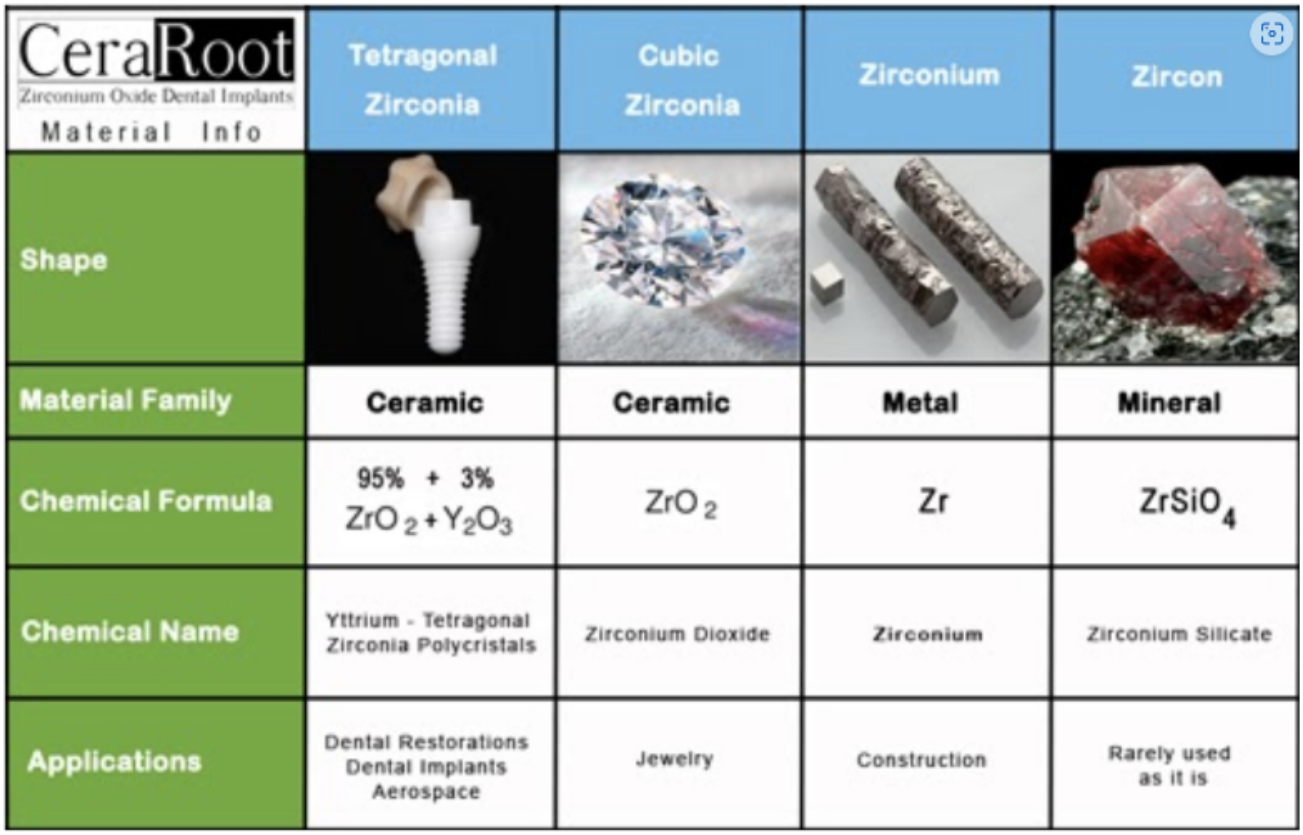
Date: 9/28/2023

Content by: Maggie McDevitt

Present: N/A

Goals: To learn more about implants on the market that are made of Zirconia.

Content:

- High biocompatibility when purified of radioactive contents
- ceramics- inert materials: no adverse local or general tissue reactions
- 

  - Great visual to see the chemical make-up of zirconia that is used by this company

[1] "ceramic implants - Composition of CeraRoot Implants." Accessed: Sep. 28, 2023. [Online]. Available: https://www.ceraroot.com/patients/composition-of-ceraroot-implants

Conclusions/action items:

Previously, I did not know the difference between zirconia and zirconium, and would use the two words interchangeably. Now, I will go back in some of our documents and edit this.

2023/10/9 - Ethical Considerations Research

Maggie MCDEVITT - Oct 09, 2023, 8:25 PM CDT

Title: Dental Ethics

Date: 10/9/2023

Content by: Maggie McDevitt

Present: N/A

Goals: To look into the ethical dilemmas that come up in dentistry, especially surrounding implants.

Content:

- While our project/adding a lock washer into the current implant method doesn't directly relate to dental/implant ethics, it is definitely related and helpful to consider them.
- In the 1970's --> crowns and endodontics were $300 and crowns were $1500
    - now: crowns, endodontics, and crowns are all $1500
    - implants then: lasted over a 5-year period with a success rate of 75%
        - now: last more than ten years with an upwards success rate of 90%
- Can't just consider the fastest, easiest, and cheapest solution
    - usually the cheapest option: partial or complete dentures...not implants
- paper slightly confusing if he is comparing implants to dentures (instead of doing a bone graft)

[1] C. E. Misch, “A Current Dental Ethics Dilemma,” *Implant Dentistry*, vol. 21, no. 3, p. 161, Jun. 2012, doi: 10.1097/ID.0b013e318258ec5d.

Conclusions/action items:

This dentist seems to have a controversial opinion on dental implants; he believes that they are a faster/easier solution that is not as good as a bone graft. Some other ethical considerations to consider are how expensive implants are and if they are accessible for everyone. While we strive to make healthcare more equitable, we must consider that not everyone may have access to dental implants and dental insurance. However, our project will not significantly impact the price of a dental implant.

Maggie MCDEVITT - Oct 09, 2023, 8:26 PM CDT

Editorial

A Current Dental Ethics Dilemma

Carl E. Misch, BS, DDS, MDS, PhD

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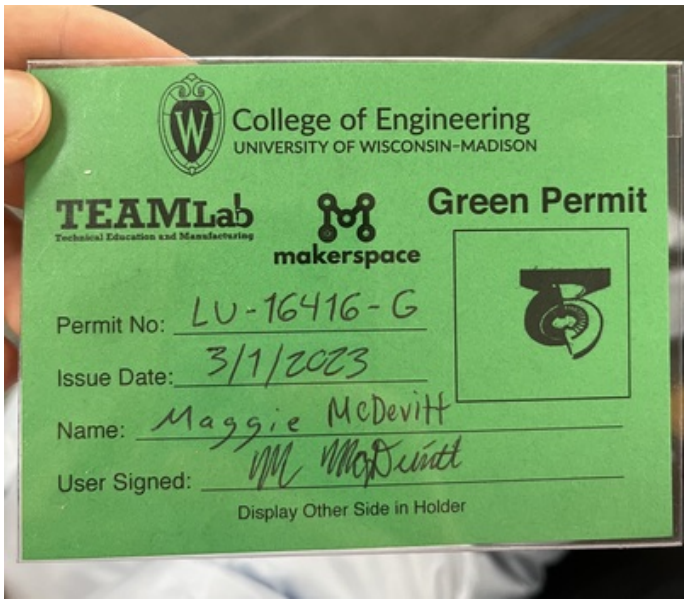
a_current_dental_ethics_dilemma.1.pdf (72.1 kB)

Green Permit

Maggie MCDEVITT - Sep 21, 2023, 11:12 AM CDT



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Greenpermit.jpg (2.18 MB)

Torque Test Research

Isabelle Peters - Sep 10, 2023, 7:58 PM CDT

Title: Torque Test Research

Date: 9/10/2023

Content by: Isabelle Peters

Present: Work done individually

Goals: Research what a lock washer is and where problems arise with it.

Content:

This article gives good insight on how a lock washer can come undone, and just how much torque it takes for a lock washer to come undone.

[1] K. T. A. A;, “Effect of washers on reverse torque displacement of dental implant gold retaining screws,” The Journal of prosthetic dentistry, https://pubmed.ncbi.nlm.nih.gov/10479258/ (accessed Sep. 10, 2023).

https://pubmed.ncbi.nlm.nih.gov/10479258/

Conclusions/action items:

Understand more about what a lock washer is and how it works.

Material Research

Isabelle Peters - Sep 10, 2023, 8:10 PM CDT

Title: Material Research

Date: 9/10/2023

Content by: Isabelle Peters

Present: Work done individually

Goals: Understand flaws with the current design of a lock washer and how to improve them.

Content:

This article has some good information about what material would work best for a lock washer. This will go well with the previous article I researched as it talks about the specific materials and can refer to the torque in the previous article

https://www.researchgate.net/publication/259272589_Analysis_of_Loss_of_Torque_in_Dental_Implants_Containing_Gold_Washers_between_Implant_and_Screw_Head

[1] S. Cicero, D. Fernández, R. Lacalle, and R. Cicero, “Analysis of loss of torque in dental implants containing gold washers between implant and screw head,” Journal of Testing and Evaluation, https://www.astm.org/jte103346.html (accessed Sep. 10, 2023).

Conclusions/action items:

Learn more about what current different designs look like for a lock washer.

Current Designs

Isabelle Peters - Sep 10, 2023, 8:19 PM CDT

Title: Current Lock Washer Designs

Date: 9/10/2023

Content by: Isabelle Peters

Present: Work done individually

Goals: To learn more about what designs of lock washers look like currently.

Content:

This explains the current types of lock washers, what they look like, and the benefits of the different designs.

[1] Palak KariaA passionate metal industry expert and blogger. With over 5 years of experience in the field, “5 types of lock washer and their uses,” ThePipingMart Blog, https://blog.thepipingmart.com/fasteners/5-types-of-lock-washer-and-their-uses/ (accessed Sep. 10, 2023).

https://blog.thepipingmart.com/fasteners/5-types-of-lock-washer-and-their-uses/

Conclusions/action items:

Continue to do research on which are used specifically in dentistry,

Lock Washer used in Dentistry

Isabelle Peters - Sep 10, 2023, 8:27 PM CDT

Title: Lock washer used in dental implants

Date: 9/10/2023

Content by: Isabelle Peters

Present: Work done individually

Goals: Understand how lock washers are currently used in dental implants.

Content:

This shows what lock washers currently look like and the patents that are in place for lock washers.

https://patents.google.com/patent/US7300283B2/en

[1] “US7300283B2 - abutment screw with Spring-Washer,” Google Patents, https://patents.google.com/patent/US7300283B2/en (accessed Sep. 10, 2023).

Conclusions/action items:

Try to find more information on the process of implanting these lock washers to understand what the lock washers need to withstand.

Conical and Cylindrical Screw Parts

Isabelle Peters - Sep 28, 2023, 12:54 PM CDT

Title: Conical and Cylindrical Screw parts

Date: 9/28/23

Content by: Isabelle Peters

Present: Work done individually

Goals: To find current patents

Content:

Describes a current design for dental implants that uses both conical and cylindrical screw parts in order to minimize the stress put on the screw.

[15] M. HILDMANN and S. Nagele, “Dental implant having a first conical screw part and a second cylindrical screw part,” CA2831021C, Aug. 30, 2016 Accessed: Sep. 21, 2023. [Online]. Available: https://patents.google.com/patent/CA2831021C/en?q=(dental%2bimplant%2bscrew)&oq=dental%2bimplant%2bscrew

Conclusions/action items: Find more patents

Current Dental Patent

Isabelle Peters - Sep 28, 2023, 12:57 PM CDT

Title: Current Dental Patent

Date: 9/28/23

Content by: Isabelle Peters

Present: Work done individually

Goals: To find Current patents and designs of dental implants.

Content:

This source has some really great images of dental implants as well as some good ideas about how to minimize the force on the screw in a dental implant.

[1] バーナード・ウエイズマン, “歯科用インプラント用の係止用キャップ,” JP5149792B2, Feb. 20, 2013 Accessed: Sep. 21, 2023. [Online]. Available: https://patents.google.com/patent/JP5149792B2/en?q=(dental%2bimplant%2bscrew)&oq=dental%2bimplant%2bscrew

Conclusions/action items:

Continue to research more current designs.

Anchored dental implant

Isabelle Peters - Oct 11, 2023, 9:14 PM CDT

Title: Anchored Dental Implant

Date: 9/28/23

Content by: Isabelle Peters

Present: Work done individually

Goals: To find more information about current designs that are used to minimize forces on the screw in dental implants.

Content:

This specific design shows an anchor used to plant the screw into place better in order to avoid the screws coming loose. This specific design is not ideal for our project as it involves adding new parts, however it is good to see ideas of other angles to take to solve this problem.

[17] D. Kennard, “Immediate provisional implant,” US8608473B2, Dec. 17, 2013 Accessed: Sep. 21, 2023. [Online]. Available: https://patents.google.com/patent/US8608473B2/en?q=(dental%2bimplant%2bscrew)&oq=dental%2bimplant%2bscrew&page=4

Conclusions/action items:

Find more current designs

Multiple Part Dental Implant

Isabelle Peters - Sep 28, 2023, 1:03 PM CDT

Title: Multiple Part Dental Implant

Date: 9/28/23

Content by: Isabelle Peters

Present: Work done individually

Goals: To find more research on current designs

Content:

This design has a similar problem to the last source where it involves adding a lot more pieces which creates more work for the dentist. This still gives us some insight into how to stabilize the screw in dental implants.

[1] M. A. M. NAVARRO, “System for securing a dental prosthesis,” EP3017785A1, May 11, 2016 Accessed: Sep. 21, 2023. [Online]. Available: https://patents.google.com/patent/EP3017785A1/en?q=(dental%2bimplant%2bscrew)&oq=dental%2bimplant%2bscrew&page=4

Conclusions/action items:

Research Materials to use for our project.

Dental Implant Problems

JACKI SZELAGOWSKI - Sep 23, 2023, 5:57 PM CDT

Title: The Problem with Dental Implants Loosening

Date: 9/10/23

Content by: Jacki

Goals: To learn how dental implants work and why they become loose.

Content:

Below is a diagram of the different parts of a dental implant. We are designing a lock washer mechanism to go between the abutment and implant screw. The dental restoration is what sits on top of the implant. The dental restoration could be a crown for a single tooth, or a bridge or full denture for more. A crown can be screwed into the abutment or cemented to it.

Screw loosening can cause complications that may contribute to crestal bone loss, screw fracture, implant fracture, or implant failure.

Etiology: cause of condition

When a screw is torqued it creates preload or tension with the screw joint. The preload force leaves the screw joint in compression and promotes a spring-like effect. The preload also acts as elastic recovery that is transferred to the abutment and implant, pulling them together and creating a clamping force. **If the screw is overtightened the screw will actually loosen.** In order for the screw to stay tight the clamping force must be greater than the separating force.

Conclusions/action items:

[ ] "How to Fix Loose Dental Implants," *Smile Design Dentistry*, Aug. 05, 2020. https://www.smiledesigndentistry.com/fix-loose-dental-implants/ (accessed Sep. 23, 2023)

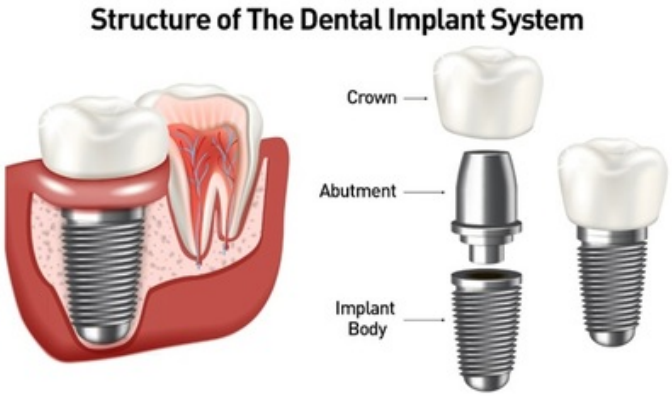
[ ] D. Today, "The Dreaded Loose Abutment Screw: Etiology, Management, and Prevention," *Dentistry Today*, Feb. 01, 2018. https://www.dentistrytoday.com/the-dreaded-loose-abutment-screw-etiology-management-and-prevention/ (accessed Sep. 23, 2023).

Table 1. Factors That Increase Screw Loosening
1. Cantilevers
2. Increased crown-height space
3. Parafunction
4. Abutment not fully seated
5. Inadequate or excessive torque
6. Non-passive prosthesis
7. Poor implant position

Table 2. Prosthetic Parameters That Reduce Screw Loosening
1. Narrow occlusal table
2. No lateral forces
3. Decreased cusp height
4. Occlusal contact in central fossa, not marginal ridges
5. Minimized cantilevers
6. Occlusal guards, if parafunction is present
7. Increased abutment diameter
8. Evaluating/adjusting occlusion during recall exams
9. Mutually protected occlusion

Table 3. Ideal Torque Technique
1. Lightly finger tighten screw with an implant driver (~10 N/cm)
2. Maximally finger tighten screw with a driver (~20 N/cm)
3. Implant screw should be torqued to the manufacturer's specifications
4. After 5 to 10 minutes, the screw should be re-torqued to the manufacturer's specifications

JACKI SZELAGOWSKI - Sep 10, 2023, 4:53 PM CDT



Download

dental-implant-system.jpg (44.7 kB)

Lock Washer Research

JACKI SZELAGOWSKI - Sep 23, 2023, 6:24 PM CDT

Title: Types of lock washers

Date: 9/10/23

Content by: Jacki

Goals: To understand how lock washers are used in a traditional setting and the different types.

Content:

Types of Lock Washers

Lock washers are designed to secure fasteners that have a tendency to rotate or lose friction.

Helical lock washers, also known as split lock washers, have a single coil of non-continuous flat wire filament. Each end of the coil is bent outwards . When secured, the lock washer flattens while each end of the coil bites into the mating surfaces.

External tooth lock washers have a cylindrical inner diameter with several teeth along the outside diameter. They are designed for use with wide headed fasteners. When secured, the teeth bite into a mating surface while they resist the compressional force.

Internal tooth lock washers have a cylindrical outer diameter with several teeth along the inside diameter. They are designed for use with shallow headed fasteners. The internal tooth fastener also bites into a mating surface while resisting the compressive force.

Second article showed that more rotational displacement was needed to loosed a screw when a lock washer was used in dental implants

Conclusions/action items:

[1] "Washers Selection Guide: Types, Features, Applications | GlobalSpec." https://www.globalspec.com/learnmore/mechanical_components/mechanical_fasteners/washers (accessed Sep. 23, 2023).

[1] T. W. Korioth, A. C. Cardoso, and A. Versluis, "Effect of washers on reverse torque displacement of dental implant gold retaining screws," *J Prosthet Dent*, vol. 82, no. 3, pp. 312–316, Sep. 1999, doi: 10.1016/s0022-3913(99)70086-7.

JACKI SZELAGOWSKI - Sep 10, 2023, 4:51 PM CDT

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Types_of_Lock_Washers (8.41 kB)

Dental Implant Standards

JACKI SZELAGOWSKI - Sep 23, 2023, 5:45 PM CDT

Title: Dental Implant Standards

Date: 9/19/23

Content by: Jacki

Goals: To be informed on standards that must be met in the dental industry for new products

Content:

Standard was found for testing on screw loosening for dental implants.

https://www.iso.org/obp/ui/en/#iso:std:iso:tr:18130:ed-1:v1:en

Conclusions/action items:

Find out how we could do this sort of testing

[1] 14:00-17:00, “ISO/TR 18130:2016,” *ISO*. https://www.iso.org/standard/61530.html (accessed Sep. 22, 2023).

JACKI SZELAGOWSKI - Sep 23, 2023, 5:45 PM CDT

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ISO/TR 18130:2016

Dentistry — Screw loosening test using cyclic torsional loading for implant body/implant abutment connection of endosseous dental implants

Abstract

Preview

ISO/TR 18130:2016 provides guidelines for a method to determine the extent of screw loosening of the metallic implant body/implant abutment joint of endosseous dental implants, such as two-part implants or multi-part implants under cyclic torsional loading. This test is most appropriate for evaluating new types of joints fixed using screw(s) and metallic connecting parts. This Technical Report provides a protocol for torsional cyclic torque on an implant body/implant abutment joint, but its intended use is for prefabricated implant bodies, implant abutments and, if appropriate, implant connecting parts that are made of metallic materials.

It is not applicable to ensure the in vivo performance of endosseous dental implants and is not derived from observations of clinical failures.

NOTE This Technical Report is not intended for use with temporary abutments.

Download

ISO_TR_18130_2016_-_Dentistry_Screw_loosening_test_using_cyclic_torsional_loading_for_implant_body_implant_abutment_connection_of_endosseous_dental_implants.html (101 kB)

FDA Regulation Dentistry

JACKI SZELAGOWSKI - Sep 23, 2023, 5:47 PM CDT

Title: FDA Regulations for Dental Implant Parts

Date: 9/20/23

Content by: Jacki

Goals: To see how the FDA classifies dental parts.

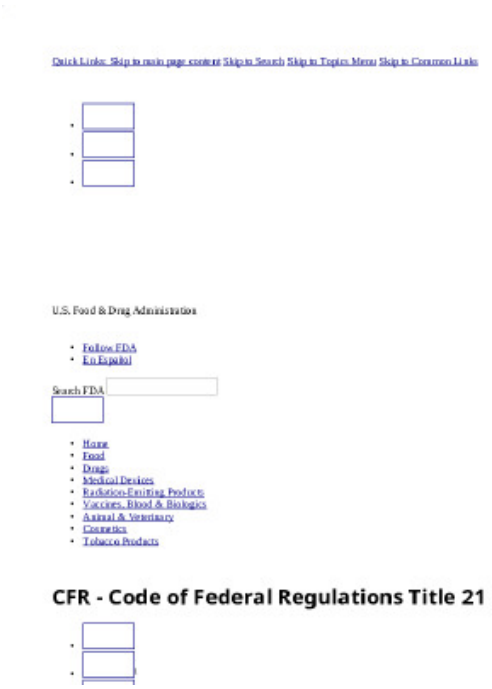
Content:

Dental screws are considered as Class II.

Conclusions/action items:

[ ] "CFR - Code of Federal Regulations Title 21." https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=872.3640 (accessed Sep. 22, 2023).

JACKI SZELAGOWSKI - Sep 23, 2023, 5:45 PM CDT



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CFR_-_Code_of_Federal_Regulations_Title_21.html (144 kB)

Screwmentable

JACKI SZELAGOWSKI - Sep 23, 2023, 5:52 PM CDT

Title: Screwmentable Research

Date: 9/20/23

Content by: Jacki

Goals:

To learn more about what a screwmentable implant is and how it differs from other types of implants.

Content:

After meeting with Dr. Tipple, he told us he uses a screwmentable implant. I was able to research this a little more to get a better understanding of the process he uses. The abutment and crown are together and is screwed directly into the implant. The screw going into the implant is the screw that we are trying to prevent from loosening.

https://decisionsindentistry.com/article/screwmentable-implant-crowns/

Conclusions/action items:

[ ] “Screwmentable Implant Crowns,” *Decisions in Dentistry*, Apr. 20, 2023. https://decisionsindentistry.com/article/screwmentable-implant-crowns/ (accessed Sep. 22, 2023).

Locker washer design ideas

JACKI SZELAGOWSKI - Sep 27, 2023, 7:57 PM CDT

Title: Locker Washer Options

Date: 9/25/23

Content by: Jacki

Goals: To get an idea of what type of lock washer to use in our final product.

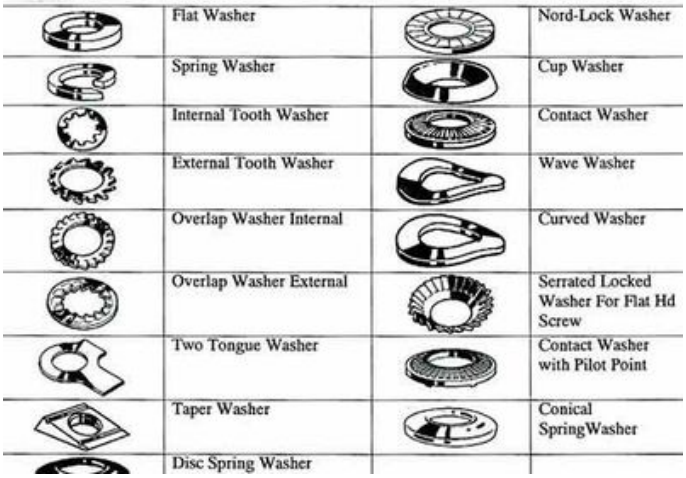
Content:

Below is an image of all the different types of lock washers used in settings outside of dentistry. I believe the split washer or the internal tooth washer would be the best for our project. The split/spring washer seems like it would be the easiest to fabricate. The internal tooth washer may be the easiest to 3d print. I think that any washer used will be difficult to work with based on how small we need to make it to fit our screw.

Conclusions/action items:

Testing is going to need to be done with the different types of lock washers in order to see which one would work best with our screw and be the best at keeping the screw from loosening.

JACKI SZELAGOWSKI - Sep 27, 2023, 7:54 PM CDT



Download

locker_washer_types.jpg (41.1 kB)

Titanium alloy design research/idea

JACKI SZELAGOWSKI - Oct 11, 2023, 5:47 PM CDT

Title: Titanium Alloy Research

Date: 10/10/23

Content by: Jacki

Goals: To understand what titanium alloy is made up of.

Content:

Titanium Alloy: An alloy that contains mostly titanium metal along with other chemical elements. In dentistry, beta titanium alloy is used most commonly. Other possible elements used in this alloy are zirconium, niobium, vanadium, iron, aluminum and manganese. This beta alloy is used in dentistry primarily because of its strength and elasticity ratios being much higher than those of some sort of steel or other metal.

The current titanium alloy screw Dr. Tipple uses is called Titanium-6aluminum-7niobium alloy (TAN). It contains 6.50-7.50 % mass niobium, 5.50-6.50 % mass aluminum, less than 1.09 % mass of other residuals (Ta, Fe, O, C, N, H) and the rest of the mass in titanium.

Conclusions/action items:

We are looking into doing 3D printing so we would have to see if the titanium alloy they print with is a beta titanium alloy and hopefully the percent of the other metals used are close to that the current screw is made out of.

[1] “Titanium alloys,” *Wikipedia*. Sep. 05, 2023. Accessed: Oct. 10, 2023. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Titanium_alloys&oldid=1173923043

9/15/23 BSAC Meeting

CAROLINE DAVIS - Dec 01, 2023, 10:12 AM CST

BSAC Meeting 9/15/23
Caroline Davis

2003:

- What questions do you have about BME Design?

Does it ever happen that a group finds that they cannot solve their project?

- Have you received enough guidance in terms of the syllabus, requirements, and schedule?

I have found it to be a little difficult to find rubrics; for example, I could not find a rubric for filling out the research template and was unsure if I was completing it to the correct standards.

- In general, how are things going so far? Where are you in the process? Are others in your group in a similar position?

The project has been going well so far. I am still in the early stages of the process and am getting an understanding of the project and the components involved. Others in my group seem to be at a similar spot to me; we are all starting our research and gaining background knowledge about our project.

- What are you excited to learn this semester?

I am excited to learn more about a completely new topic to me, which is dentistry! I think it will be super interesting and helpful for me to see if I ever want to do more work in the dental field in the future.

Download

BSAC_Meeting_9_15_23.docx (7.2 kB)

CAROLINE DAVIS - Dec 01, 2023, 10:12 AM CST

BSAC Meeting 9/15/23
Caroline Davis

200s:

- What questions do you have about BME Design?

Does it ever happen that a group finds that they cannot solve their project?

- Have you received enough guidance in terms of the syllabus, requirements, and schedule?

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9/28/23 BSAC Meeting

CAROLINE DAVIS - Dec 01, 2023, 10:13 AM CST

BSAC Meeting 9/28/23
Caroline Davis

Presentation Outline

● Discuss any problems your team is facing with the other students and faculty members. (Consider current progress, deadlines, expectations, clarifications, problems, communication, etc.)

- One problem that my team is facing is making sure everyone is on the same page with deadlines. I think that this may be a result of not everyone checking the schedule online because we are used to checking Canvas for deadlines. I also personally need to get more comfortable with navigating the BME Website.

● Small group discussion - introductions (Students: Name, year, track)

- My name is Caroline Davis. I am a sophomore. I am undecided on my track, but I am currently thinking bioinstrumentation and medical devices.

● Small group discussion - design process

○ How was the process of drafting and submitting the PDS?

- The process of drafting and submitting the PDS went well, except for having to take out a section because our group concluded it was not applicable to our project. Personally, I found it difficult to do some of the PDS since we do not know what our design will be for sure.

○ How is your design matrix coming along?

- It is going well! We are doing two design matrices: one for the geometry of our design and one for the material it will be made out of. This way, we can isolate the two main variables we are choosing between to weigh the pros and cons of each.

○ How is your team planning for the preliminary presentations next Friday (October 6th)?

- My team is planning for the preliminary presentation next Friday by starting to make our presentation now, meeting several times the week leading up to the presentation (the last meeting will be a practice run-through), and each team member adding to the presentation and practicing.

○ Have you started working on your preliminary deliverables?

- My team has not started working on our preliminary deliverables.

○ How have your advisor meetings been?

- We have only had one advisor meeting, but it was really effective. We went over our research, talked about what we found, talked about our assignment overall/ the task at hand, discussed our team goals, and prepared questions for our first client meeting.

● Mentor/Mentee

○ Have you established communication with your mentee?

- Yes, I have established communication with my mentee.

○ Did you have a chance to meet your mentee?

- I have not had a chance to meet with my mentee.

10/13/23 BSAC Meeting

CAROLINE DAVIS - Dec 01, 2023, 10:14 AM CST

BSAC Meeting 10/13/23
Caroline Davis

Small Group Discussion (~35 min)

Preliminary presentations (~10 min)

- How was the experience?

The Preliminary Presentation experience was slightly stressful, but I think that it was a good experience for my group and I and forced us to organize all of our research and progress on this project from the whole year. Personally, I am not very comfortable with presenting in front of large groups of people, so it was scary in the moment but was definitely a good experience to get more practice with public speaking.

- Did you and your team have enough time to get acquainted with the various parts of the project to prepare for the Presentation?

My team and I all had a very busy week with difficult exams, so it was hard to find time to prepare as a group for the presentation, but we made time and pulled it all together for the presentation.

Preliminary report and PDS (~15 min)

- Did you receive enough feedback from your advisor to write your preliminary report and update your PDS?

We did receive enough feedback from our advisor to write our preliminary report and update our PDS.

- How are you dividing the work amongst your team members?

For the Preliminary Report, each of our team members signed up for a section to focus on, but we all plan to edit each others' sections and help in areas where others need help.

- Have you checked in with all/some of the other members in your team to make sure everyone has an appropriate workload?

Yes we have all checked in with each other to make sure everyone has an appropriate workload. Our group leaders do a good job of making sure everyone does their sufficient part.

    - If so, are there any good strategies that you have implemented to make sure this interaction is constructive?

A good strategy I have implemented to make sure the interaction is constructive is check in by asking, "How is [what they are working on]? Do you need help anywhere or are you feeling ready to move on to a new task?".

- Especially for those of you who have not written a preliminary report, were instructions/expectations clear? If not, was the design website helpful? What further questions do you have?

The instructions for the Preliminary Report were somewhat clear. Since there is no set classroom time with instruction, sometimes it is difficult to know exact expectations from our instructor.

Preliminary notebook (~10 min)

- Are your advisors checking your notebooks every week? Do they ask each team member to share their entries from the past week?

Our advisors check our notebooks every week at our advising meetings.

- Do you like your advisor's system? Why or why not?

I like our advisor's system; he is very flexible and willing to help.

- Do you feel like you have a good grasp on what makes a great notebook entry?

For the most part, but a question I have is that do we need to have in-text citations as well as the full IEEE citation at the end of the "content" section. Since we haven't gotten graded on our notebook yet, we do not know for sure yet if everyones' entries are meeting the expectations.

10/27/23 BSAC Meeting

CAROLINE DAVIS - Dec 01, 2023, 10:15 AM CST

BSAC Meeting 10/27/23
Caroline Davis

Small Group Discussion

- Design Process
    - Progress on projects
    - Questions about Show and Tell (Friday, Oct. 3rd)?

How will the Show and Tell work if our team will not have a prototype?

    - Testing progress
        - Physical, simulations, trial and error, math/physics calculations help
    - What has worked for your team during the brainstorming/iterative process?

Something that has worked for our team during the brainstorming/iterative process is talking to many different qualified people, such as material science professors, makerspace workers, our advisors, other BME students, and multiple dentists. These people have helped guide us through our design process, making us consider things we would not have thought of otherwise.

    - What resources have you used within and outside of BME advisors?

Talking to material science professors, makerspace workers, other BME students, and multiple dentists.

- General
    - Course planning for next semester
        - Difficulties? Course not offered in preferred/necessary semester?

I have not had any difficulties yet with course planning for next semester.

Mentor/Mentee

- Have you reached out to your mentee with another email?

I have not.

11/10/23 BSAC Meeting

CAROLINE DAVIS - Dec 01, 2023, 10:15 AM CST

Caroline Davis
BSAC Meeting 11/10/23

Small Group Discussion
Design Process

- How was Show and Tell?

The Show and Tell went well and smoothly; it provided an opportunity at a great point in the semester for our group to step back and reflect on our work so far and receive some feedback and suggestions.

  - What did you like/dislike?

Something that I liked about the Show and Tell was that it was a low-stakes and low-pressure environment for each group to do a mini presentation of their project and get some constructive guidance and feedback. One thing that I disliked about the Show and Tell was how long it was; I had an exam right after so I was stressed with time.

- What is your team's game plan for the rest of the semester?

Our team's game plan for the reset of the semester is to plan our testing, perform our testing, draw conclusions from our testing, tweak our design, and complete the final deliverables.

- What are some roadblocks you are facing?

A roadblock we are currently facing is figuring out how to replicate the environment our final product would be in for our testing; specifically, our project is a lock washer that goes on a dental implant screw inside the mouth.

- Have you been updating your lab notebook regularly?

I have started to stop updating my lab notebook as often; how much research are we expected to be adding each week?
General

- Course planning for next semester
  - Difficulties?

Deciding on engineering electives is slightly overwhelming.

  - Course not offered in preferred/necessary semester?

Not that I have experienced yet.

12/1/23 BSAC Meeting

CAROLINE DAVIS - Dec 01, 2023, 10:16 AM CST

Presentation Outline
12/1/23

Small Group Discussion

- Design Process
    - How was Show and Tell?

Show and Tell went super well and was helpful; we got new ideas and considerations from the other groups, which we would have not thought of otherwise.

    - What did you like/dislike?

I liked how we got fresh new ideas from our peers, and it was interesting to see where the other groups have come from the preliminary presentations. Something that I disliked was how long it was; at the end of each rotation, people ran out of things to talk about.

    - What is your team’s game plan for the rest of the semester?

Our team’s game plan for the rest of the semester is to conduct final testing, draw conclusions accordingly, create and present our final poster at the poster session, and then write the final report.

    - What are some roadblocks you are facing?

A roadblock we are facing is that our testing has not gone as planned and now we have to try something new.

    - Have you been updating your lab notebook regularly?

I haven't been updating my lab notebook regularly; is there a location on the website that shows what we should be including besides research?

    - Do you feel ready for the final presentation?

Not yet; we need to finish our testing and then go from there to complete our final poster.

- General
    - Did you have any remaining course selection problems?

I could not get into ema 303, which was what I was planning on taking; so instead I am taking physics 202 first.

- Mentor/Mentee
    - Have you reached out to your mentee with another email?

No I have not; are these the mentors that reached out to us freshman year?

9/14/23 - Abutment Screw with Spring-Washer

CAROLINE DAVIS - Sep 14, 2023, 3:30 PM CDT

Title: Abutment Screw with Spring-Washer

Date: 9/14/23

Content by: Caroline Davis

Present: Myself

Goals: To understand what retaining screws are, why they come loose, and previous and possible solutions to fixing this issue of them coming loose.

Content:

- Retaining screws in dentistry are crucial, but they come loose over-time so research and time is continuously being put into solving this issue.
- Dental retaining screws are made of titanium, which is a strong, lightweight metal but its high friction coefficient makes it come loose overtime.
    - The friction comes from the "... contact between the screw threads and threaded bore of the implant and between the screw head and seating surface of the abutment"
- Come loose also due to large loads and heavy vibrations
- Solutions proposed over the years:
    - Increase applied torque on screw
    - Reduce friction coefficient between screw head and mating surface
    - Reduce friction coefficient between screw thread and threaded bore of implant
        - In the past, gold-alloy is used to lower friction coefficient, but the material is soft
- The invention in this patent has the goal of securing dental retaining screws used to secure dental components
    - Has a proximal end with a head portion with a locking mechanism

[1]I. Aravena and A. Kumar, "Abutment screw with spring-washer." https://patents.google.com/patent/US7300283B2/en (accessed Sep. 14, 2023).

Conclusions/action items: Now that I know a little more about dental retaining screws, why they loosen, and possible solutions, I now plan on researching lock washers, what they are, how they work, and how they can hold dental implant-supported restoration screws in place.

9/14/23 - Effect of washers on reverse torque displacement

CAROLINE DAVIS - Sep 14, 2023, 3:49 PM CDT

Title: Effect of washers on reverse torque displacement of dental implant gold retaining screws

Date: 9/14/23

Content by: Caroline Davis

Present: Myself

Goals: To understand the purpose/effect that washers have and their effectiveness in preventing gold retaining screws from coming loose.

Content:

- A series of tests revealed that gold screws without spring washers had about 35% more rotational displacement than the screws with spring washers.

[2] T. W. P. Korioth, A. C. Cardoso, and A. Versluis, “Effect of washers on reverse torque displacement of dental implant gold retaining screws,” The Journal of Prosthetic Dentistry, vol. 82, no. 3, pp. 312–316, Sep. 1999, doi: https://doi.org/10.1016/s0022-3913(99)70086-7.

Conclusions/action items: In conclusion, I now understand the importance of washers in keeping dental implant-restoration screws in place, as the research above showed how without a washer, the screws were displaced up to 35% more. Now, I plan on researching how a lock washer works and its different components.

9/14/23 - Fatigue Design of Dental Implant

CAROLINE DAVIS - Sep 14, 2023, 4:21 PM CDT

Title: Fatigue Design of Dental Implant Assemblies: A Nominal Stress Approach

Date: 9/14/23

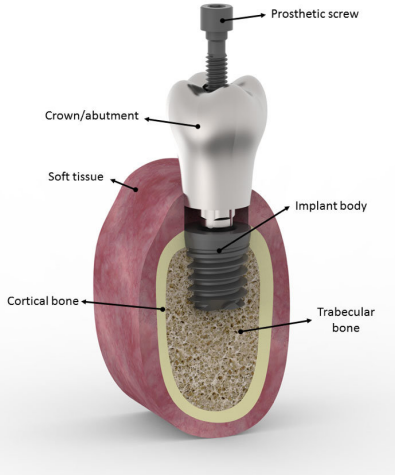
Content by: Caroline Davis

Present: Myself

Goals: To understand visually how dental screws are used

Content:

The image (below) depicts the system of how a dental screw can be used to hold a crown/abutment in place on the tooth.



[1] Fatigue Design of Dental Implant Assemblies: A Nominal Stress Approach - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Assembly-of-a-single-dental-implant-restoration_fig1_341905444 [accessed 14 Sep, 2023]

Conclusions/action items: Examining the image aided my understanding of and helped me visualize how dental screws can be placed on the tooth. Now, I am going to do some research on lock washers and how they work.

12/3/23 - Biocompatibility

CAROLINE DAVIS - Dec 12, 2023, 1:34 PM CST

Title: Why Biocompatibility in Dental Implants Matters for Tooth Replacement

Date: 12/3/23

Content by: Caroline Davis

Present: Myself

Goals: To learn why it's important for a dental implant to be biocompatible

Content:

- "Dental implants made from biocompatible materials, such as titanium or zirconia, are well-tolerated by the body, reducing the risk of rejection or allergic reactions."
- "Biocompatible materials, like titanium or zirconia used in dental implants, have a minimal chance of triggering an immune response, ensuring a higher success rate and long-term stability of the implant."
- "Biocompatible materials, such as titanium, have the unique ability to bond directly with the bone, promoting a strong connection. This integration allows the implant to mimic the function and feel of a natural tooth, providing excellent chewing capability and preventing bone loss in the jaw."
- "Biocompatible dental implants offer stability, functionality, and aesthetics similar to natural teeth, allowing patients to regain their smiles, confidence, and oral health."

https://toothimplantsydney.com.au/why-biocompatibility-in-dental-implants-matters-for-tooth-replacement/

Conclusions/action items:

Biocompatibility is an important factor to consider when designing a dental implant because it reduces the risk of implant rejection and allergic reactions, ensures a better chance of success and implant stability, and allows the implant to integrate into the bone more smoothly.

9/27/23 - Material Research

CAROLINE DAVIS - Sep 29, 2023, 10:15 AM CDT

Title: Material Research

Date: 09/27/23

Content by: Caroline Davis

Present: Myself

Goals: To compare the properties of different metals for our design.

Content:

Pure titanium received the lowest score in the strength category as its tensile strength is 220 MPa [1]. The tensile strength of zirconia is slightly higher at 330 MPa , and titanium alloys typically range from 860 to 895 MPa, depending on which metals the mixture is made from [2], [3].

Pure titanium is the cheapest material at $30 per pound, while titanium alloys range from $25 to $40 per pound [4], [5]. Zirconia received the lowest score, as dental implants made of zirconia typically range between $500 and $600, compared to titanium dental implants which range between $300 and $500 [6].

References:

[1] “Titanium, Ti.” Accessed: Sep. 28, 2023. [Online]. Available: https://www.matweb.com/search/DataSheet.aspx?MatGUID=66a15d609a3f4c829cb6ad08f0dafc01&ckck=1
[2] J. R. says, “Zirconium - Mechanical Properties And Material Applications,” AZoM.com. Accessed: Sep. 28, 2023. [Online]. Available: https://www.azom.com/article.aspx?ArticleID=7645
[3] “Titanium. What Alloys Tooth Implants Are Made Of.” Accessed: Sep. 28, 2023. [Online]. Available: https://uniqa.dental/articles/titanium-what-alloys-tooth-implants-are-made-of/
[4] J. Palmer, “What Is the Price of Titanium per Ounce? (2022 Guide).” Accessed: Sep. 28, 2023. [Online]. Available: https://jewelsadvisor.com/what-is-the-price-of-titanium-per-ounce/
[5] “How Much Is Titanium Worth Per Pound In 2023? - Own Your Own Future.” Accessed: Sep. 28, 2023. [Online]. Available: https://www.ownyourownfuture.com/how-much-is-titanium-worth-per-pound/
[6] D. H. M. D. D. Michael *et al.*, “Zirconia Dental Implants vs Titanium Implants - Which is the Best? Zirconia Implants Cost, Titanium Tooth Implant Cost,” Sarasota Dentistry. Accessed: Sep. 28, 2023. [Online]. Available: https://www.sarasotadentistry.com/dental-blog/zircona-dental-implants-vs-titanium-implants/

Conclusions/action items: The titanium alloy had the highest strength, based on tensile strength values. Pure titanium has the lowest price point. Since our client does not have a strict budget for our team, we weighted the price category lower on our design matrix. As a result, based on the two factors of tensile strength and price, tensile strength is more important, and thus, the titanium alloy would be a better fit for our project.

9/29/23 - Types of Lock Washers

CAROLINE DAVIS - Sep 29, 2023, 11:01 AM CDT

Title: Types of Lock Washers

Date: 9/29/23

Content by: Caroline Davis

Present: Myself

Goals: To gather basic information on a few of the different types of lock washers.

Content:

Lock washers have a purpose of "... prevent[ing] the fastener from rotating or losing friction due to vibration or torque". They hold the nut and bolt in place.

Three types of lock washers (from top to bottom): External Tooth Lock Washer, Retaining Washer, Sealing Washer.

External Tooth Lock Washer: Tooth-like serrations prevent screws from loosening through friction. Used when high mechanical-strength needed.

Retaining Washer: Internal teeth hold screw. Made out of nylon to insulate for electrical uses.

Sealing Washer (or Tap Washer): Creates tight seal between screwhead and surface it is fastened to. Prevents movement of dust or liquid. Used for plumbing,

Two types of Spring Washers (from top to bottom): Single Wave Spring Washer, Cup Washer.

Spring washers are a type of lock washer. They provide axial load to fasteners to prevent movement in case of vibration or thermal expansion. They provide a degree of flexibility.

Single Wave Spring Washer: Deflects in application, creating more friction with the assembly, reducing the risk of the bolt or nut coming loose. Absorbs shock. Use: pre-load shafts or bearings

Cup Washer: Provides insulation by protecting the head of metal screws from electrical contact. Provides an aesthetic finish. Uses: Isolate screws used as stand-offs on PCBs and bolts that secure electrical components

[1]“The complete guide to washers,” www.essentracomponents.com. https://www.essentracomponents.com/en-us/news/solutions/fastening-components/the-complete-guide-to-washers

Conclusions/action items: I now have a better overall understanding of different types of lock washers and can brainstorm more design ideas for my team.

10/26/23- Potential Laser Cutting and 3D Printing Companies

CAROLINE DAVIS - Oct 27, 2023, 1:01 PM CDT

Title: Potential Laser Cutting and 3D Printing Companies

Date: 10/26/23

Content by: Caroline Davis

Present: Myself

Goals: To find potential laser cutting and 3D printing companies to work with to fabricate our split lock washer.

Content:

Laser Cutting:

- https://www.protolabs.com/
    - Said the prototype would be too small to make.
- https://sendcutsend.com
    - Available materials: Grade 2 Titanium, Grade 5 Titanium
- https://www.williewasher.com/laser-cut-parts.html
    - Steel, stainless steel
- https://www.micronlaser.com/laser-applications/gaskets-and-washers/
    - Grade 2 Titanium (Highly CR Ti), Grade 5 Titanium (High-Strength Ti), Grade 7 Titanium

3D Printing:

- https://craftcloud3d.com/cart?utm_source=gads&utm_medium=max&utm_campaign=ad&gclid=CjwKCAjwnOipBhBQEiwACyGLugiOnPZr2sjX4G12fGQ9WJIfl2Wk41Mk1JumE5F5IzyDk-kL2DynZRoCI6QQAvD_BwE
- https://i.materialise.com/en
- https://www.sculpteo.com/en/

Conclusions/action items:

Kennedy and I sent in requests to all of the laser cutting and 3D printing quotes, and the companies should get back to us shortly (since our design is so small, they cannot provide an instant quote). After we receive the quotes back, our team will decide as a group which company to work with to create our product.

9/14/2023 Implant Research

Aaron Marattil - Sep 25, 2023, 5:37 PM CDT

Title: Implant Research

Date: 9/14/2023

Content by: Aaron

Present: Aaron

Goals: Learn more about our project and dental implants

Content:

https://pubmed.ncbi.nlm.nih.gov/10479258/ - [1] study finding that conical spring washers could increase the amount of force needed to unscrew the dental screws.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4295219/#:~:text=Titanium%20(Ti)%20and%20its%20alloys,%2Dchromium%20alloys%5B3%5D. - article on properties of implant materials to help determine what material to use for washer.

[1] T. W. P. Korioth, A. C. Cardoso, and A. Versluis, “Effect of washers on reverse torque displacement of dental implant gold retaining screws,” *The Journal of Prosthetic Dentistry*, vol. 82, no. 3, pp. 312–316, Sep. 1999, doi: https://doi.org/10.1016/s0022-3913(99)70086-7. [2] M. Saini, “Implant biomaterials: A comprehensive review,” *World Journal of Clinical Cases*, vol. 3, no. 1, p. 52, 2015, doi: https://doi.org/10.12998/wjcc.v3.i1.52.

Conclusions/action items:

Research more and begin to brainstorm for solutions

9/14/2023 Competing designs research

Aaron Marattil - Sep 25, 2023, 6:56 PM CDT

Title: Competing designs research

Date: 9/14/2023

Content by: Aaron

Present: Aaron

Goals: Learn more about other designs seeking to solve the same problem

Content:

https://patents.google.com/patent/US7300283B2/en - [1] expired patent for a gold spring washer to be used on dental screws

https://www.lasak.com/products/implantology/bioniq-implant-system/advantages-of-bioniq-system - [2] BioniQ design from lasik with a unique dental implant system.

[1] I. Aravena and A. Kumar, “Abutment screw with spring-washer,” Nov. 27, 2007 Accessed: Sep. 14, 2023. [Online]. Available: https://patents.google.com/patent/US7300283B2/en [2] “Advantages of BioniQ system | LASAK,” *LASAK*, 2023. https://www.lasak.com/products/implantology/bioniq-implant-system/advantages-of-bioniq-system (accessed Sep. 14, 2023).

Conclusions/action items:

Research more and after preliminary brainstorming learn from these other designs.

9/25/2023 Washer research

Aaron Marattil - Sep 27, 2023, 11:30 PM CDT

Title: Washer research

Date: 9/25

Content by: Aaron

Present: Aaron

Goals: Find out more about the types of washers and their uses.

Content:

https://youtu.be/I59iO1XPTVw?si=k_OHeqkT3GDkVAhS : video describing different washers and their uses. Spring/Split lock washers prevent loosening caused by vibrations. Toothed lock washers prevent loosening caused by torque.

https://www.titaniumprocessingcenter.com/the-element-titanium/#:~:text=These%20applications%20range%20from%20jewelry,metal%20it%20is%20combined%20with. - Information on Titanium and Titanium Alloy properties

https://www.beverlyhillsladentist.com/blog/are-zirconia-implants-better-than-titanium/ - Information on Zirconia vs. Titanium Implants

Conclusions/action items:

Use information to generate preliminary designs.

10/11/2023 Design Matrix Research

Aaron Marattil - Oct 11, 2023, 12:16 PM CDT

Title: Research for design matrix

Date: 10/11/2023

Content by: Aaron

Present: Aaron

Goals: Complete Biocompatibility section on Design Matrix

Content:

https://www.titaniumprocessingcenter.com/the-element-titanium/

https://www.beverlyhillsladentist.com/blog/are-zirconia-implants-better-than-titanium/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9389932/

Found the following three resources which I will use to complete the Design Matrix.

Conclusions/action items:

Use research to complete Design Matrix

11/18/2023 electroplating research

Aaron Marattil - Dec 12, 2023, 9:13 PM CST

Title: Electroplating Research

Date: 11/18

Content by: Aaron

Present: Aaron

Goals: Research Possibility of electroplating stainless steel washer with titanium

Content:

After substantial it does not seem possible to electroplate Titanium on other metals.

However, there is a procedure known as Physical Vapor Deposition which can plate titanium on other metals. I found some companies which can do this process and reached out to them.

https://pvdtitanium.com/ - This company is based in Malaysia and I thought it may be difficult to send and receive product from them.

https://www.pvdamerica.com/ - This company is based in California. I reached out to them and asked if they would be able to help us with our project.

Conclusions/action items:

12/2/2023 Ext/Int. Tooth Washer

Aaron Marattil - Dec 12, 2023, 9:19 PM CST

Title: External Internal Tooth Washer

Date: 12/2

Content by: Aaron

Present: Aaron

Goals: Look into the potential use of Ext/Int washers for our project

Content:

Typically used to keep nuts tight on bolts. Ext and Int grab different parts of the nut. If used, we must limit what the teeth come into contact with as they should not interact with gums or other organic matter in the mouth. Additionally we will have to test if the teeth cut into the abutment, this could create metal shavings in the mouth/teeth cavity which could cause problems.

Source:

https://www.surajmetal.com/stainless-steel-star-washers.html#:~:text=The%20applications%20such%20as%20engine,to%20hold%20it%20in%20place.

Conclusions/action items:

Basic Information on Lock Washers - 09/14/2023

Title: Basic information on Lock Washers

Date: 09/14/2023

Content by: Kennedy Young

Present:

Goals:

To understand what lock washers are and how they are used

Content:

- Feature teeth that allow them to bite into the surface
- Internal lock washers
    - Characterized by the use of inward facing teeth
    - Have a ring-shaped pieces of metal
    - Inner walls aren't smooth and are serrated
- External lock washers
    - Outward facing teeth
    - Similar to internal washer but with reversed teeth
    - Serrated perimeter
        - Found on the outside of the external locking washers
- Differences between internal and external locking washers
    - Where the teeth are facing
    - Internal locking washers are able to bite into fasteners
        - Can bite into the head of a screw or bolt, holding the fastener in place
    - External locking washers are better suited for biting into surfaces
        - Create a stronger bite with the surrounding surface
        - Internal locking washers may bite into some of the surrounding surface of an object, but most of their force will be placed on the head of a fastener
    - Larger than internal locking washes
        - Cover more space
    - Internal locking washers are typically used for grounding applications

Conclusions/action items:

Lock Washers are used to prevent bolts and screws from loosening. The inward and outward facing teeth provide friction keeping the screws in place. There are internal and external lock washers, varying mostly by orientation of the teeth on the plate. External lock washers are better for biting into services and covering more space, whereas internal lock washers are mostly used for grounding applications.

References:

[1] "Internal vs external locking washers: What's the difference?," Blog Monroe Aerospace, https://monroeaerospace.com/blog/internal-vs-external-locking-washers-whats-the-difference/ (accessed Sep. 14, 2023).

Dental Screws Used in restorations - 09/14/2023

Title: Dental Screws

Date: 09/14/2023

Content by: Kennedy Young

Present:

Goals: To understand what type of dental screws are used in restorations

Content:

- Dental Screws, a.k.a Implant screws
    - Places in the jawbone and artificial teeth can be attached to them
    - Small stainless steel threaded pieced used to attach two or more teeth to the mouth
        - Used in dentures and bridges
        - Holds the attached pieces in place so they can fit securely into the jawbone
        - Also used in bone grafting procedures, where the jawbone has been removed
            - Aid in healing by providing support to the adjacent teeth and gums until new tissue grows back
- Material
    - Titanum
        - Strong metal that can resist corrosion from human tissue and bodily fluids
        - Biocompatible metal
        - Dome shaped
- Placement
    - Implanted into the jawbone at the site of the missing tooth or teeth
        - Stays there for the rest of their life
        - Placeholder for an artificial tooth to be placed after surgery

Conclusions/action items:

Dental screws are made of titanium because they can resist corrosion from human tissue and bodily fluids. They are implanted into the jawbone at the desired site, and once they are there they remain there for the rest of the patients life. Lock Washers can prevent these screws from loosening over time.

References:

Admin, “How dental screws are used in dental implants - dental design - buffalo grove dentist,” Dental Design, https://dentaldesignbg.com/blog/dental-implants-how-screws-are-used/ (accessed Sep. 14, 2023).

Dental Restorations - 09/14/2023

KENNEDY YOUNG - Sep 14, 2023, 10:06 AM CDT

Title: Dental Restorations

Date: 09/14/2023

Content by: Kennedy Young

Present:

Goals: To understand dental restorations, specifically dental implants

Content:

- Medical devices surgically implanted into the jaw to restore a person's ability to chew
- When a tooth is lost a person can experience complications such as rapid bone loss, defective speech or changes to chewing patterns that result in discomfort
- Dental implant
    - Consists of a dental implant body and dental implant abutment and may also include an abutment fixation screw
    - Surgically inserted in the jawbone in place of the tooth's root
    - Abutment is usually attached to the implant body by the abutment fixation screw
        - Extends through gums into the mouth to support the artificial teeth

Conclusions/action items:

Dental restorations are used to improve complications with rapid bone loss, defective speech, and discomfort. The project calls for a focus on dental implants, which contains an implant body, abutment and occasionally a fixation screw. The implant and screws are inserted into the jawbone in the tooth's root.

References:

Center for Devices and Radiological Health, "Dental implants: What you should know," U.S. Food and Drug Administration, https://www.fda.gov/medical-devices/dental-devices/dental-implants-what-you-should-know (accessed Sep. 14, 2023).

Biocompatibility of Materials - 9/21/2023

KENNEDY YOUNG - Sep 27, 2023, 11:02 PM CDT

Title: Biocompatibility of Materials

Date: 9/21/2023

Content by: Kennedy Young

Present:

Goals: To find which material is the most biocompatible

Content:

Biocompatibility - The ability of a material to perform in a specific application with an appropriate host response

- Pure Titanium
  - Has a low electrical conductivity which contributes to a thin passive oxide layer
    - The oxide layer has a high resistance to corrosion
  - Passive layer can be retained at the pH values of the human body
  - No noticeable difference between biocompatibility of titanium and titanium alloy
  - Superior osseointegration than zirconium
    - Necessary for the success of dental implant treatment

S. Furqan, M. Trobos, P. Thomen, and A. Palmquist, “Commercially pure titanium (CP-ti) versus Titanium Alloy (ti6al4v) materials as bone anchored implants - is one truly better than the other?,” C, https://www.sciencedirect.com/science/article/pii/S0928493116300315?via%3Dihub (accessed Sep. 27, 2023).

A. T. Sidambe, “Biocompatibility of advanced manufactured titanium implants-A Review,” Materials (Basel, Switzerland), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5456424/#:~:text=Furthermore%2C%20titanium%20is%20considered%20to,a%20high%20resistance%20to%20corrosion (accessed Sep. 27, 2023).

- Titanium Alloy
  - Most common titanium alloy used in dental implants is Ti-6Al-4V
    - 6% aluminum, 4% vanadium, 0.25% iron, and 0.2% oxygen - remaining percentage is titanium
    - Has excellent biocompatibility
    - Lighter in weight
    - Can tightly integrate into bone and other tissues
    - Rough surfaces of titanium alloy result in good osseointegration between the bone and implant
      - This results in good clinical outcome after implant

T. Hanawa, “Biocompatibility of titanium from the viewpoint of its surface,” Science and technology of advanced materials, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9389932/ (accessed Sep. 27, 2023).

X. Liu, S. Chen, J. K. H. Tsoi, and J. P. Matinlinna, “Binary titanium alloys as dental implant materials-a review,” Regenerative biomaterials, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5633690/#:~:text=The%20most%20commonly%20used%20Ti,of%20the%20alloy%20is%20titanium (accessed Sep. 27, 2023).

- Zirconium
  - Biocompatible in vitro and in vivo
  - Have the capacity to reduce plaque on implant and surrounding tissues
  - High fracture resistance and can be used in stress-bearing areas
  - Absence of micro gaps between fixtures discourages bacterial invasion
  - Is a promising alternative to titanium
  - Better to inhibit bacterial adhesion, but both titanium and zirconium have similar capability for soft tissue adhesion

H. Lin, C. Yin, and A. Mo, “Zirconia based dental biomaterials: Structure, mechanical properties, biocompatibility, surface modification, and applications as implant,” Frontiers, https://www.frontiersin.org/articles/10.3389/fdmed.2021.689198/full (accessed Sep. 27, 2023).

H. Takao, “Zirconia versus titanium in dentistry: A Review,” Dental materials journal, https://pubmed.ncbi.nlm.nih.gov/31666488/ (accessed Sep. 27, 2023).

Conclusions/action items:

Titanium, Titanium Alloy, and Zirconium are all very biocompatible and have similar properties that improve their biocompatibility. Titanium and Titanium Alloy have not noticeable difference in biocompatibility, whereas titanium and zirconium differ slightly. Zirconium is more resistant to bacteria but titanium has better osseointegration, which is better for dental implants. Because of the importance of osseointegration in dental implants, titanium is the better biocompatible material for the project.

Versatility of the designs - 9/28/2023

KENNEDY YOUNG - Sep 28, 2023, 7:26 AM CDT

Title: Versatility of the designs

Date: 9/28/2023

Content by: Kennedy Young

Present:

Goals: To find which design is the most versatile

Content:

Versatility - how well the design can accommodate different bold sizes and materials

- Split Lock Washer
  - Can penetrate the surface of softer materials, increasing friction that turn resists turning.
  - Not the best choice for applications that are exposed to extreme vibrations
  - Takes additional torque to flatten the split into the joint
    - Results in an additional axial force on the washer through the bearing contact surface of the washer and better secures the joing
  - Versatile because the design features that make them spring-like are scalable and can be incorporated into almost any washer size or metallic material
    - Can find a spring washer specific to your needs

  Huyett Marketing Department, “How to Use Lock Nuts and Lock Washers,” Huyett.com, https://www.huyett.com/blog/lock-nuts-lock-washers (accessed Sep. 28, 2023).

  C. Layosa, “Spring Washer vs. Flat Washer: How to choose correctly: Misumi Mech lab blog,” MISUMI Mech Lab Blog |, https://us.misumi-ec.com/blog/spring-washer-vs-flat-washer-how-to-choose-correctly/ (accessed Sep. 28, 2023).

- External tooth lock washer
  - Sizing has to be very specific
    - If its too big it may fit loosely around the fastener, renders it useless
    - Too small it might not fit at all
  - Works well with larger headed screws

  “How to choose Lock Washers,” Blog Monroe Aerospace, https://monroeaerospace.com/blog/how-to-choose-lock-washers/ (accessed Sep. 28, 2023).

  L. Melone, “Internal tooth lock washer vs external tooth lock washer,” Melfast, https://www.melfast.com/blog/2012/08/internal-tooth-lock-washer-vs-external-tooth-lock-washer#:~:text=As%20your%20fastener%20distributor%20will,heads%2C%20including%20fillister%20head%20fasteners (accessed Sep. 28, 2023).

- Conical Washer
  - Made to maintain tensions during assembly's thermal expansion and contraction
  - Support large weights while deflecting only slightly
  - Inner circle makes it more specific to size than split washers, but less specific than external tooth washers

  “Belleville Disc Washer Springs - learn about: Lee spring,” Belleville Disc Washer Springs - Learn About | Lee Spring, https://www.leespring.com/learn-about-belleville-washers#:~:text=High%20Loads%20in%20Small%20Spaces&text=Their%20conical%20configuration%20enables%20them,relaxation%20and%20bolt%20creep%20problems. (accessed Sep. 28, 2023).

Conclusions/action items:

The different types of washers all work well with the materials being considered. Split washers are the most versatile. They are the easiest to scale to size and can be incorporated into almost any washer size. External tooth lock washers are the least versatile, the sizing of the teeth have to be very specific; if it's too big or small it will not work well. Conical washers are similar to split washers, but the closed inner circle makes it more specific to sizing than split washers.

Fabrication Places - 10/19/2023

Title: Fabrication Places

Date: 10/19/2023

Content by: Kennedy Young

Present:

Goals: To find a place that can 3D print our design in Titanium

Content:

FIT AG

- Can 3D print titanium Alloys
- Won't be able to print something as small as the lock washer we need
- Mostly prints parts for cars

Fit, "Unverbindliche Anfrage: Fit Additive Manufacturing Group: Fit Additive Manufacturing Group," Unverbindliche Anfrage | FIT Additive Manufacturing Group | FIT Additive Manufacturing Group, https://fit.technology/request (accessed Oct. 19, 2023).

Craftcloud

- Titanium
- Printed by sintering titanium powder together with a laser to produce metal parts
- Tensile strength of 900 - 1370 MPa
- Tensile modulus 111000 MPa
- Tensile elongation of 4-12%
- Accuracy of ± 0.2%
- Minimum wall thickness of 1 mm

"Material guide," Craftcloud®, https://craftcloud3d.com/material-guide (accessed Oct. 19, 2023).

I.materialise

- Titanium
- Minimum Wall Thickness of 0.5 to 1 mm
- Minimum details of 0.25 mm
- Accuracy of ± 0.2%
- Matte gray finish

I.materialise, "Online titanium 3D printing service," i.materialise, https://i.materialise.com/en/3d-printing-materials/titanium (accessed Oct. 19, 2023).

Protolabs

- Titanium Alloy - not the same alloy used in dentistry
- High stiffness and strength relative to weight
- High temperature and corrosion resistance
- Yield Stress 138 ksi
- Hardness 35 HRC

“Manufacturing Materials Comparison Guide,” Protolabs, https://www.protolabs.com/materials/comparison-guide/?category=metal (accessed Oct. 19, 2023).

Sculpteo

- Titanium ingredients
    - Titanium: 88-100
    - Aluminum: 5.5 - 6.5
    - Vanadium: 3.5 - 4.5
- Standard layer thickness of 60 um
- Accuracy of ±0.2 mm
- Minimum wall thickness of 1 mm
- Minimum thickness particular design aspects of 1 mm
- Biocompatible

Carmel, “Titanium material for 3D printing: 3D Printing Metal,” Sculpteo, https://www.sculpteo.com/en/materials/dmls-material/dmls-titanium-material/ (accessed Oct. 19, 2023).

Conclusions/action items:

There are many places that can 3D print small sizes using titanium. The companies available will depend on the thickness of the lock washer. We will need to talk to professionals at UW for advice before deciding on a place for fabrication.

Anti-Slippage Mechanism for Dental Implant Components - 9/21/2023

KENNEDY YOUNG - Sep 21, 2023, 9:01 PM CDT

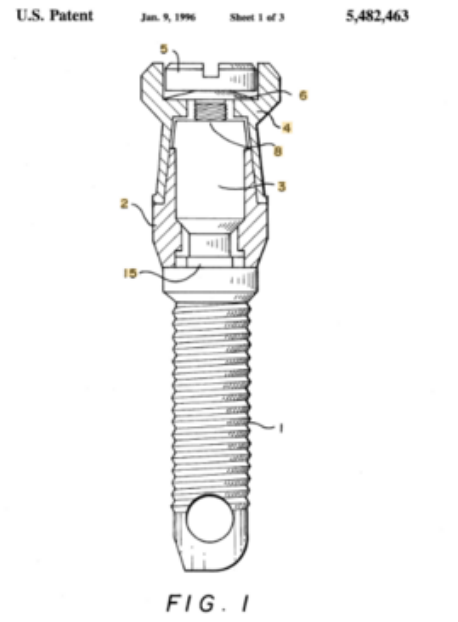


FIG. 1

Download

Screenshot_2023-09-21_at_8.52.14_PM.png (65.6 kB) Figure 1: Frontal view of the dental screw and abutment with the spring washer attached.

KENNEDY YOUNG - Sep 21, 2023, 9:01 PM CDT

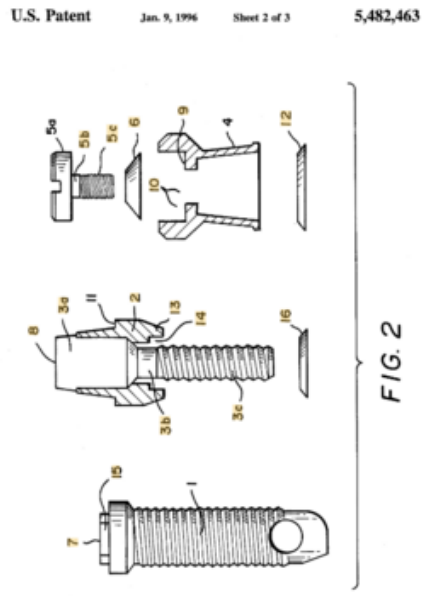
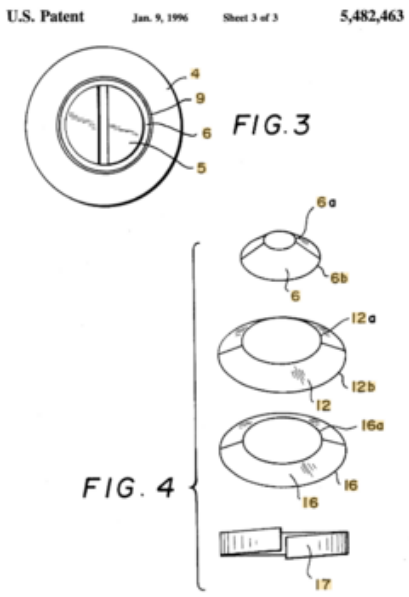


FIG. 2

Download

Screenshot_2023-09-21_at_8.52.37_PM.png (79.3 kB) Figure 2: View of the difference components

KENNEDY YOUNG - Sep 21, 2023, 9:01 PM CDT



Download

Screenshot_2023-09-21_at_8.52.52_PM.png (70.6 kB) Figure 3: The spring washer on its own

KENNEDY YOUNG - Sep 21, 2023, 8:59 PM CDT

Title: Anti-Slippage Mechanism for Dental Implant Components

Date: 9/21/2023

Content by: Kennedy Young

Present:

Goals: To find competing or similar designs

Content:

- A spring washer is placed directly below the head of the screw
- Prevents loosening of screw joints for dental implant component stacks
- Can also be put between the abutment and the fixture

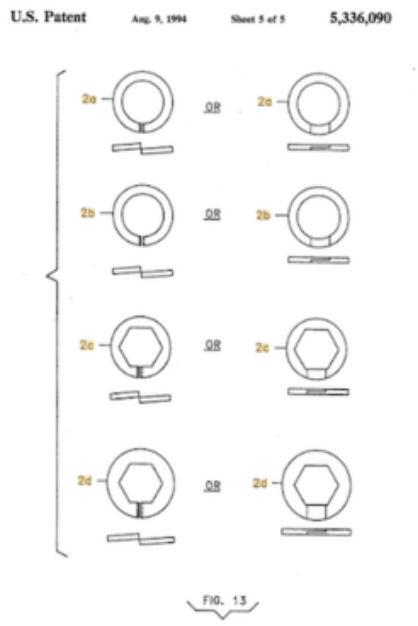
[1] R. S. Wilson, “US5482463A - Anti-slippage mechanism for dental implant components,” Google Patents, https://patents.google.com/patent/US5482463A/en (accessed Sep. 21, 2023).

Conclusions/action items:

The patent design is similar to a lock washer, as lock washers are a type of spring washer. In our design the lock washer would be attached to the screw head rather than below the head of the screw. This patent is meant for a gold plated screw.

Transmucosal healing cap and lock washer for dental implants - 9/21/2023

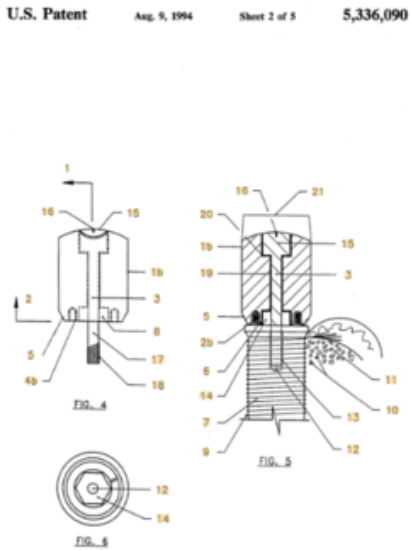
KENNEDY YOUNG - Sep 21, 2023, 9:11 PM CDT



Download

Screenshot_2023-09-21_at_9.10.32_PM.png (55.8 kB) Figure 2: Image of the of lock washer

KENNEDY YOUNG - Sep 21, 2023, 9:11 PM CDT



Download

Screenshot_2023-09-21_at_9.09.56_PM.png (63.2 kB) Figure 1: Image of the full design of the patent, with all the components put together

Title: Transmucosal healing cap and lock washer for dental implants

Date: 9/21/2023

Content by: Kennedy Young

Present:

Goals: To find competing or similar designs to the lock washer

Content:

- Healing caps with varied bottom services and difference shaped lock washers to prevent loosening of the healing cap
- Has a retaining screw separate from the cap body
- Lockwasher prevents breakage of the cap body or fissure from excessive torque

[1] W. S. Richard, “US5336090A - transmucosal healing cap and Lockwasher for dental implants,” Google Patents, https://patents.google.com/patent/US5336090A/en (accessed Sep. 21, 2023).

Conclusions/action items:

Lock washer is used to keep another part in place, the healing cap. The lock washer in this design is placed in between the abutment and the screw, with the healing cap placed on top. Use these designs to aid in brainstorming.

Conical Washer Drawing - 10/11/2023

KENNEDY YOUNG - Oct 11, 2023, 3:32 PM CDT

Title: Conical Washer Drawing

Date: 10/11/2023

Content by: Kennedy Young

Present:

Goals: To depict the design of the conical washer and its placement on the screw and implant

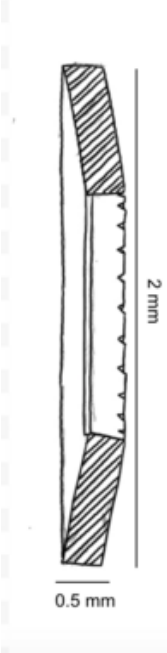
Content:

- Aerial profile of conical lock washer
- Side profile of conical lock washer
- Conical lock washer on the screw
- Conical lock washer in the implant

Conclusions/action items:

The conical washer would be more complicated to add to the screw because of the precision needed for the inner diameter measurements. The diameter must be 1.4 mm so it won't move around on the screw or fall off the threads. The outer diameter would need to be 2 mm, making this design hard to reproduce because of its size and the precision required.

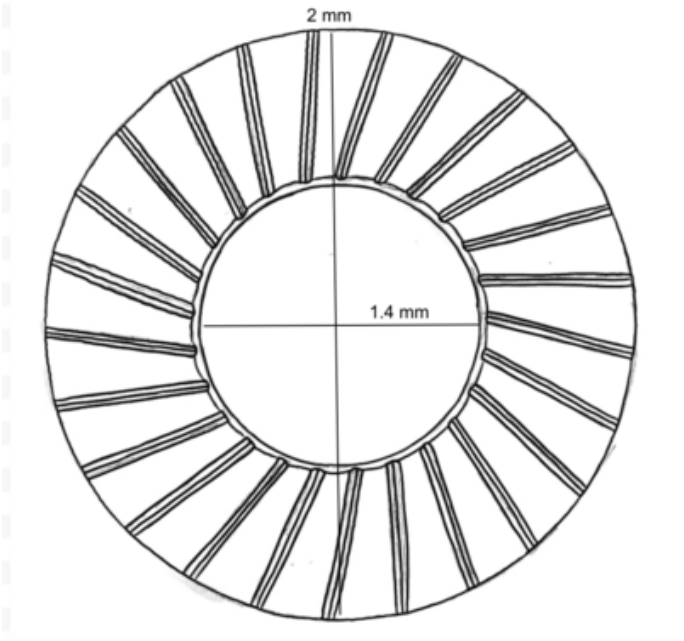
KENNEDY YOUNG - Oct 11, 2023, 3:31 PM CDT



Download

Screenshot_2023-10-11_at_3.29.06_PM.png (78.2 kB) Figure 2: Side profile of conical washer

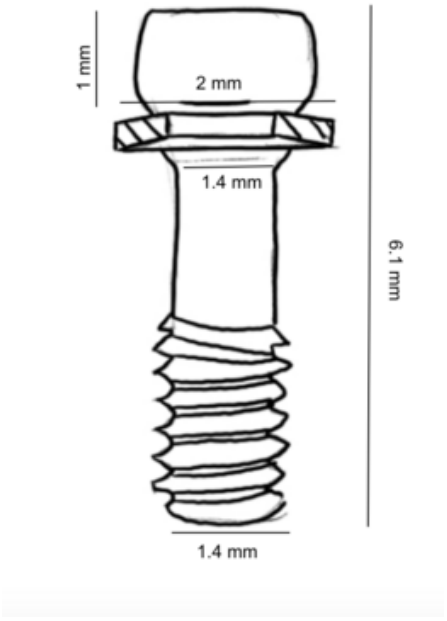
KENNEDY YOUNG - Oct 11, 2023, 3:30 PM CDT



Download

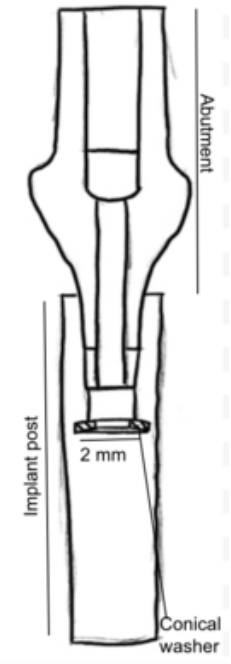
Screenshot_2023-10-11_at_3.29.28_PM.png (342 kB) Figure 1: Aerial profile of conical washer

KENNEDY YOUNG - Oct 11, 2023, 3:31 PM CDT



Download

Screenshot_2023-10-11_at_3.28.45_PM.png (117 kB) Figure 3: Conical washer on screw



Download

Screenshot_2023-10-11_at_3.28.07_PM.png (98.3 kB) Figure 4: Conical washer placement in implant

Split Washer Drawing - 10/11/2023

KENNEDY YOUNG - Oct 11, 2023, 3:36 PM CDT

Title: Split Washer Drawings

Date: 10/11/2023

Content by: Kennedy Young

Present:

Goals: To depict the design of the split washer and its placement on the screw and implant

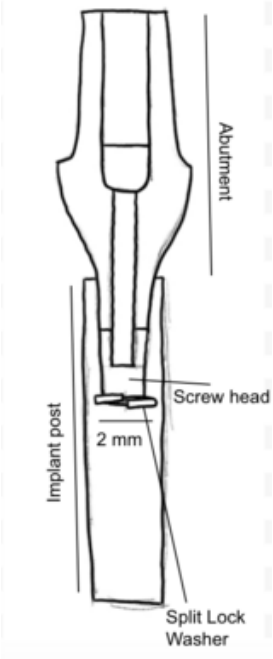
Content:

- Aerial profile of split washer
- Side profile of split washer
- Split washer on the screw
- Split washer in the implant

Conclusions/action items:

The split washer would be the easiest to add to the screw because of the split in the washer and uneven side. The split washer would need to have a 1.4 mm inner diameter and a 2 mm outer diameter.

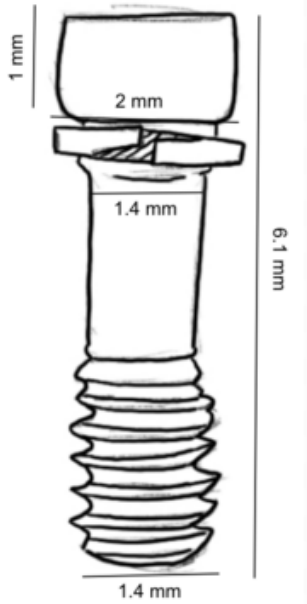
KENNEDY YOUNG - Oct 11, 2023, 3:39 PM CDT



Download

Screenshot_2023-10-11_at_3.37.34_PM.png (93.8 kB) Figure 4: Split washer on dental implant

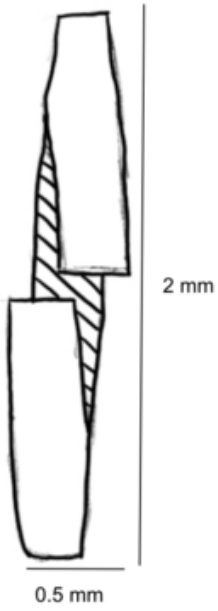
KENNEDY YOUNG - Oct 11, 2023, 3:39 PM CDT



Download

Screenshot_2023-10-11_at_3.37.13_PM.png (104 kB) Figure 3: Split washer on dental screw

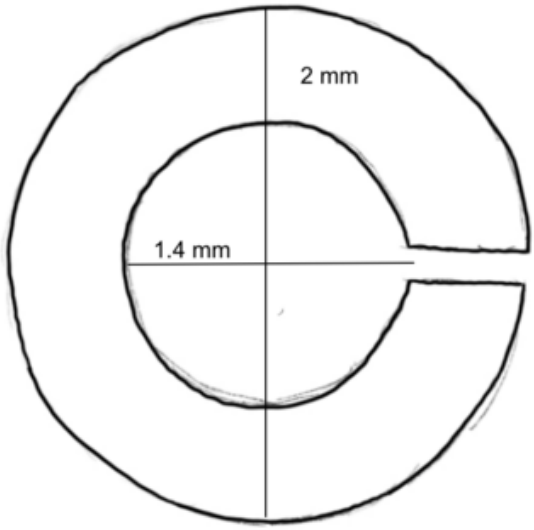
KENNEDY YOUNG - Oct 11, 2023, 3:38 PM CDT



Download

Screenshot_2023-10-11_at_3.36.55_PM.png (72.4 kB) Figure 2: Side profile of split washer

KENNEDY YOUNG - Oct 11, 2023, 3:38 PM CDT

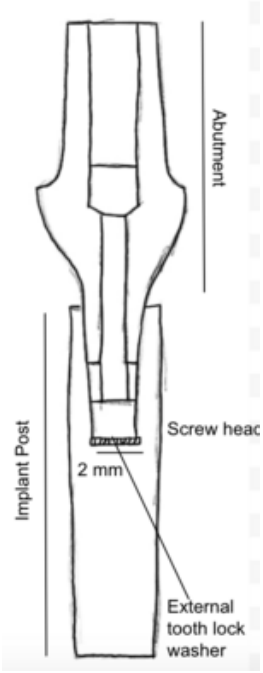


Download

Screenshot_2023-10-11_at_3.36.33_PM.png (103 kB) Figure 1: Aerial profile of split washer

External Tooth Lock Washer Drawings - 10/11/2023

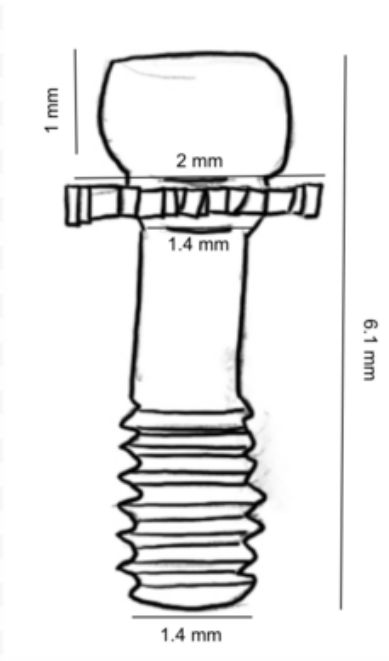
KENNEDY YOUNG - Oct 11, 2023, 3:47 PM CDT



Download

Screenshot_2023-10-11_at_3.44.07_PM.png (97.1 kB) Figure 4: External tooth lock washer in dental implant

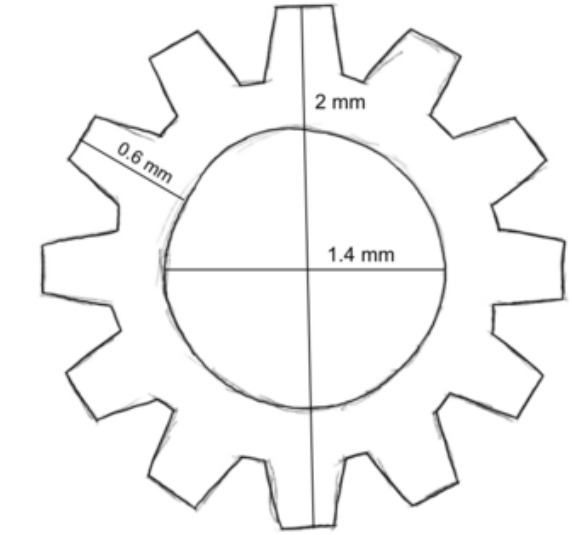
KENNEDY YOUNG - Oct 11, 2023, 3:46 PM CDT



Download

Screenshot_2023-10-11_at_3.43.48_PM.png (131 kB) Figure 3: External tooth lock washer on screw

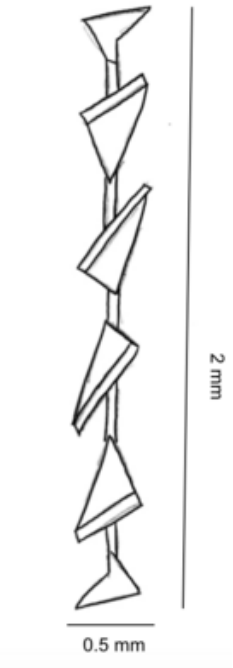
KENNEDY YOUNG - Oct 11, 2023, 3:45 PM CDT



Download

Screenshot_2023-10-11_at_3.42.50_PM.png (137 kB) Figure 2: Aerial profile of external tooth lock washer

KENNEDY YOUNG - Oct 11, 2023, 3:45 PM CDT



Download

Screenshot_2023-10-11_at_3.43.08_PM.png (71.7 kB) Figure 1: Side profile of external tooth lock washer

Title: External Tooth Lock Washer Drawings

Date: 10/11/2023

Content by: Kennedy Young

Present:

Goals: To depict the design of the external tooth lock washer and its placement on the screw and implant

Content:

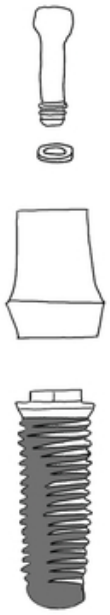
- Aerial profile of external tooth lock washer
- Side profile of external tooth lock washer
- External tooth lock washer on the screw
- External tooth lock washer on the implant

Conclusions/action items:

The external tooth lock washer would be the most difficult to fabricate because of its complex design. Additionally, the external teeth pose a risk to the patient due to the risk of the external teeth chipping off. The external lock washer would need to have an inner diameter of 1.4 mm and an outer diameter of 2 mm.

Final Design Drawings - 12/12/2023

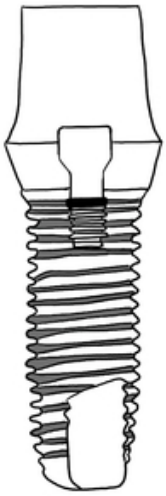
KENNEDY YOUNG - Dec 12, 2023, 4:05 PM CST



Download

IMG_0402.jpg (77.3 kB) Figure 3: Drawings of the different components of the implant with the washer

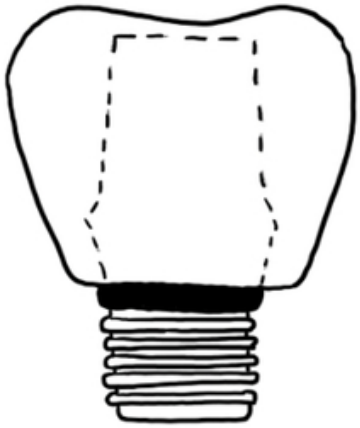
KENNEDY YOUNG - Dec 12, 2023, 4:04 PM CST



Download

IMG_0400.jpg (110 kB) Figure 2: Drawing of all the components assembled

KENNEDY YOUNG - Dec 12, 2023, 4:04 PM CST



Download

IMG_0399.jpg (34.8 kB) Figure 1: Drawing of abutment with crown, washer, and dental screw

KENNEDY YOUNG - Dec 12, 2023, 4:03 PM CST

Title: Final Design Drawings

Date: 12/12/2023

Content by: Kennedy Young

Present:

Goals: To accurately depict the final design idea of the project

Content:

- Images Attached
  - Drawing of each of the different components of the dental implant with the lock washer
  - Drawing of all of the components assembled with the washer
  - Drawing of the abutment with the crown, dental screw, and washer

Conclusions/action items: The three different drawings show the different angles of the proposed final design. The drawing of the abutment with crown around it, allows people to visualize how the abutment is set up, as well as how the screw and washer will sit against the abutment. The drawing with each of the different components shows how each piece looks individually. Finally, the drawing with all of the components assembled shows where the lock washer will sit in the dental implant.

Fabrication Quotes - 10/27/2023

KENNEDY YOUNG - Dec 12, 2023, 4:07 PM CST

Title: Fabrication Quotes

Date: 10/26/2023

Content by: Kennedy Young

Present: Caroline Davis

Goals: To gather quotes from companies to gauge the cost of the produce

Content:

3D printing Companies

- Craft Cloud
  - Ranges from $94.35 - $148.35
  - Orders from another company
  - Titanium material
- I.materialise
  - $63.83 for one product
  - Titanium material with a Matte Finish
- Sculpteo
  - $63.24 for one
  - Titanium 6Al-4V with a short peened finish

Laser Printing Companies

- Proto Labs
  - No Quote
  - Part is far too small for their tooling, equipment, and processes
  - Can not modify or supply off the shelf components
- Micron Laser Technology
  - Still haven't received a quote
- Xometry
  - Outside of their capabilities at this time
- SendCutSend

Conclusions/action items: The team decided to go with Sculpteo since the other companies used an automatic quote, meaning there is still a chance that the size might not work. Whereas we were able to receive a manual quote from Sculpteo, given to us by an employee. With Sculpteo, there is less of a risk of not receiving the right sized product. Also, sculpteo is one of the cheaper options.

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: