

The effect of sandblasting on AISI 316L stainless steels

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Abstract

In this paper, the study of the sandblasting effect of AISI 316L stainless steel for medical implant is conducted to find out the mechanical properties of the implant after the treatment. Sandblasting is a method to change the surface quality by impacting the surface with the silica material. The impact time variables used in this experiment are 2, 6, 10, 16 and 22 minutes. The results show that the longer sandblasting time, the surface roughness becomes higher. The sandblasting creates change on the steel surface which correspond to increasing roughness from 0.67 μm to 1.46 μm . The variable of rotational speed during sandblasting at 45 rpm rotational speed produce poorer surface roughness (1.18 μm).

Keywords: Implant, Sandblasting, AISI 316L, and Surface Roughness.

1 INTRODUCTION

Some people activities such as exercising, driving, and riding sometime can get injuries or accidents that will result on bone fractures. Bone fractures can healed itself since it has a natural ability to heal. Its often called as immobilization. Developed nation has develope research on the manufacturing of bone implant using high quality materials, such as titanium. In Indonesia, some bone implant has been manufactured; however the quality is not as good as the imported one [1]. Technological development implants involved several many experts on manufacturing engineering, materials expert, and orthopedist that find solutions for suitable implants. There are several types of material that can be accepted by the human body, such as stainless steel, crome cobal, pure titanium and alloys titanium that have good quality on its properties such as easy to be formed, wear resistance and corosive that used for medical tools.

2 EXPERIMENTAL METHOD

2.1. Materials Specification

Medical special tools must make from the material that have a good property when inserted in the human body. It called a biocompatible implant which the implantation will not react to the body. The same biofilms were significantly retained by 316L stainless steel, borosicate glass, silicond borosilicate glass, poly (propylene) or poly (vinylidene fluoride) [2].

Manufacture of implants had been researched in Indonesia. Research was conducted by using material which is cheaper than Titanium. Its used AISI 316L stainless steel that has low carbon content. Several implants type made in Indonesia that competible with the dimension for human bone in Indonesia. The properties of stainless steel is not as strong as titanium so that it should be treated before used. Treatment have to increase the material properties at least almost same with the Titanium.

The AISI 316L stainless steel is a austenitic type stainless steel which can be heat treated, that is why the cold working operations are needed to increase the material property of

AISI 316L such as sandblasting, shot pening, and SMAT. Several process can increase the material property of AISI 316L closed to pure Titanium which more expensive than stainless steel after coldworking processes.

This research is conducted in order to manufacture the screws implant to be tightened on the implant plat to heal the bone fracture. The method used to increase the material property is sandblasting since the screw has unique contour which the sand can come on into the screw surface. The stainless steel were chosen, because they often exhibit a poor tribological behaviour, which can be improved when they are hardened by incorporating N₂, TiN and Zr and forming a hardened surface zone [3].

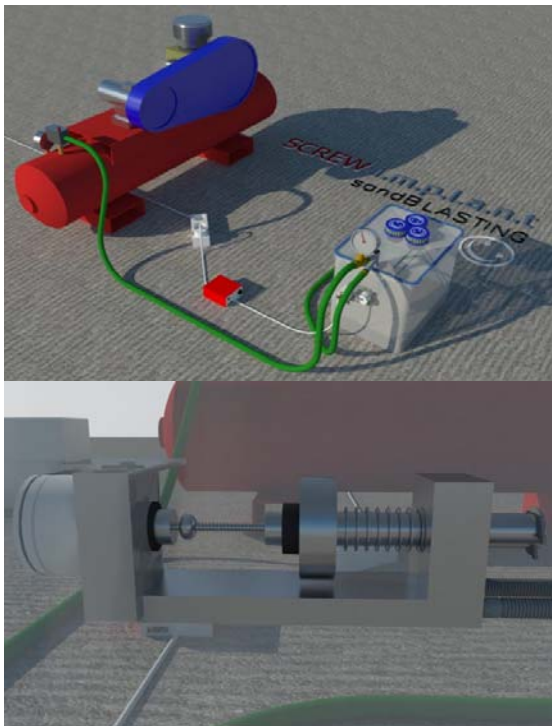


Figure 1. Sandblasting process.

Silica sand was used as the material of the sandblasting processes to be shoot into the screws. The size of the silica sand used is 0.5 – 0.8 mm, the silica is transferred to the bone screw using a compressor. The filter is attached to the compressor in order to collect the duct of the silica. The special tool was made in order to make the silica hit the bone screw in all direction of the bone screw, as shown in Figure 1.

2.2. Experimental Tools

The experimental tools used in this research consist of sand box, wind screws, 3 units of compressors, and sandblasting unit. Sand box used to circulate the silica sand when the sandblasting proses is performing. Wind screws used to roll the screws. Three units compressor blows air to shoot the bone

screw which is tighten to the bone screw spindle. Sandblasting unit consist of spreycun and rubber tube, for circulation sand in the box.

Sandblasting processes is started by using the air from compressor that flowing in pressure gauge to nozzle. Nozzle has two channels; one channel is from box to suck the sand and the other channel is from compressor as shown in **Fig. 1**. The air and the sand that have high pressure are then will punch the bone screw which is rotate. Screw can rotate because it coupled with transmission with electric motor which can control speed motor by adapter.

The adapter was set according to the motor speed as desired. The tachometer was used to measure the amount of rotation per minute. The air was collected in the compressor tank until the pressure reach 7 bar, then the nozzle can be opened. The sandblasting processes can be stopped according to the time variable specified.

The longer sandblasting duration will result on the decreasing of the diameter of bone screw. The bone screw diameter was used to measure its diameter, before and after sandblasting processes.

2.3. Scanning Electron Microscope (SEM)

The surface characteristics analysis was performed by using SEM, in order to see the detailed crater after the sandblasting processes used ESEM Philips.

2.4. Surface roughness

The surface roughness profile was measured by surface roughness tester, Surfcom 120A. The measurement taken in 13-25 locations depend on the shape of the screw.

3 RESULT AND DISCUSSION

3.1. Shape deformation

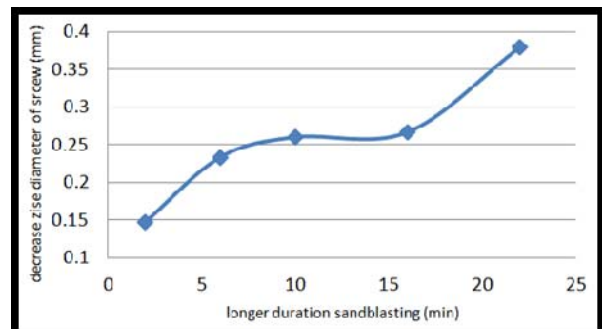


Figure 2. Average value decrease diameter screw.

The screw diameter was measured and it shows that the deformation is occurred, caused by the effect of blasting the

sand into screw. The results show that the diameter of the bone screw decreased after the sandblasting processes. Various diameter of the bone screw versus the sandblasting duration are depicted in **Fig.2**. From Figure 2 we can see that when the sandblasting duration is 22 min, the diameter of the bone screw decrease up to 0.38 mm. In average, it is about 9.31 % from the original diameter before the sandblasting processes.

3.2. Surface roughness

The surface roughness of the bone screw after sandblasting processes can be seen on **Figs. 3-4**. **Fig. 3**. shows the effect of sandblasting duration on surface roughness and **Fig. 4**. shows the effect of rotational speed of the bone screw on surface roughness. On the duration of 2 min, the surface roughness increase significantly, as follow: The Ra value of 1.46 μm is achieved when the screw rotation is 67 rpm, Ra 1.43 μm is achieved when the screw rotation is 45 rpm, and Ra 1.4 μm is achieved when the screw rotation is 30 rpm, after that the Ra value is decrease at next duration but it is not significant. **Fig.4**. show the results of the effect of rotational speed to Ra value. It shows that the Ra value relatively constant in each sandblasting duration on different rotational speed of the bone screw.

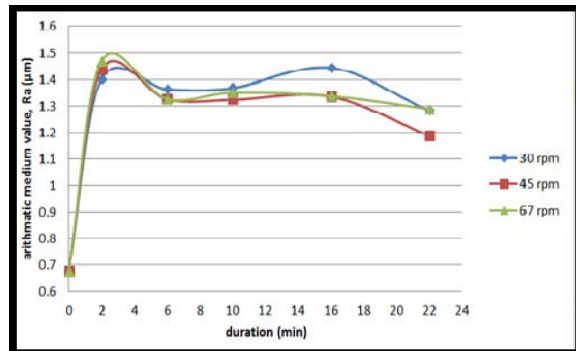


Figure 3. Effect duration on the surface roughness.

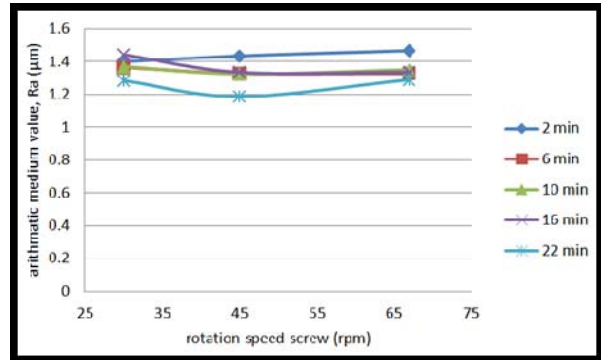
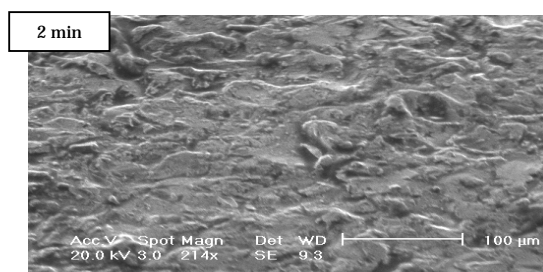
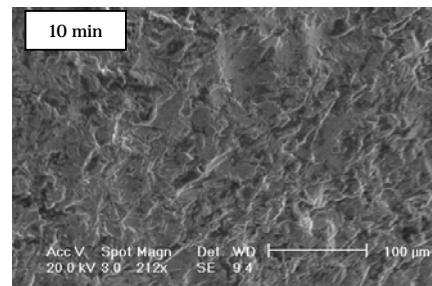
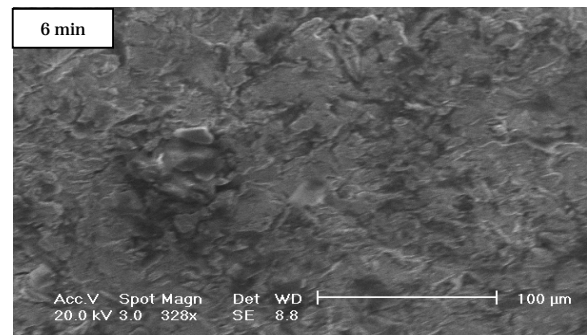


Figure 4. Effect rotation speed on the surface roughness.

3.3. SEM

Figure 5 shows the SEM photo. It can be seen that the longer sandblasting duration, the surface roughness become smoother. It might be happen because the roughness of the bone screw will be hit over and over resulting on smoother roughness. Relatively, the short duration of sandblasting processes to the specimen will result on rougher surface because the first collision caused defects in materials. The longer duration of sandblasting process will made surface material to be smoother which proportion to sandblasting duration.



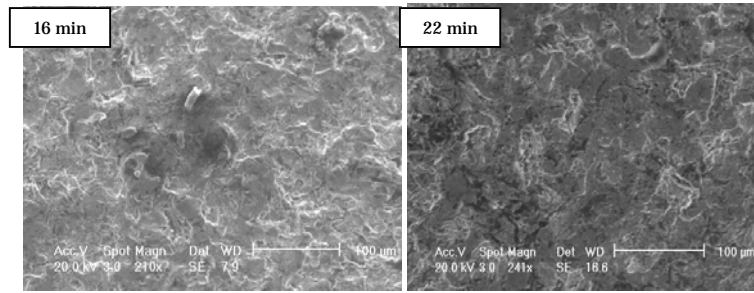


Figure 5. Effect of duration on photo SEM

4 CONCLUSION

AISI 316L stainless steel can be used as bio-implantation after receiving sandblasting treatment. Selected sandblasting method for surface treatment to bone screws made from AISI 316L stainless steel can produce dense material in order to increase its hardness. Longer duration of sandblasting process will make surface become denser, however it make the surface become rougher. The solution of this problem is doing electropolishing treatment after sandblasting process.

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