International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

Research and Development Research on Patella Lock Bone Plate Based on Finite Element Analysis

Chuntao Hou

Tianjin Jingdu Beisida Biotechnology Co., Ltd., Xiditou Town, Beichen District, Tianjin 300222, China

Abstract: ***The patella fracture is a common joint fracture in the clinical joint, which has a variety of surgical methods for the internal fixation of the patella fracture, and is currently the main method for the treatment of reset in the reset. According to the anatomical characteristics of the Patella, the novel patella locking bone plate is designed by constructing a human Patella fracture model, and the ANSYSWORKBENCH finite element analysis is used to verify the biomechanical characteristics of new Patella locking bone plates. Improve the new product development cycle, and provide new fixation methods and test basis for clinical fixation Patella fractures.***

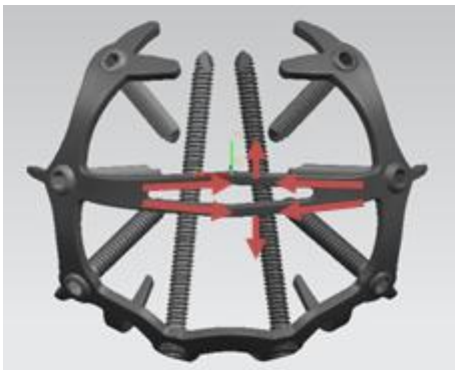
Keywords: ANSYS Workbench, Patella lock bone plate

1. Introduction

With the development of fixed technology in orthopedics, in-depth research is carried out according to each fracture site of the human body. Folding around the Patella, many orthopedic companies are actively carrying out the development of new Patella locking bone boards. Under this pressure, how we can quickly develop new products, shorten the R & D cycle, seize the market, and look particularly important.

2. Product Description

As shown in Figure 1, the novel Patella locking bone sheet has a form of a Patella anatomical curve design, and tightening structure is added. By opening the intermediate opening tank and engages in the outside of 10 crochet claws into the gathered effect, the locking screw is re-locked, and the patella can be combined with each other. The internal fixation structure is in line with the treatment of the patella fracture tension belt fixation principle, maintaining the integrity of the Patella and the stability of the knee joint, reducing the occurrence of complications, and improves the excellent treatment.



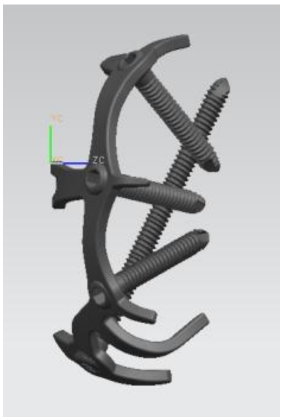
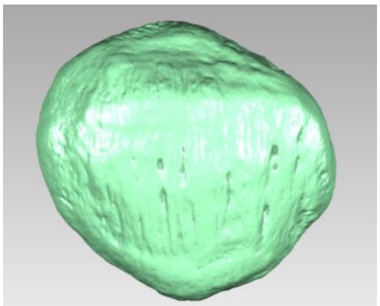


Figure 1: Novel Patella locking bone plate structure

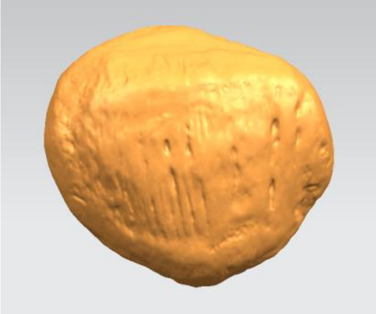
3. Analytical method

3.1 Model establishment and grid division

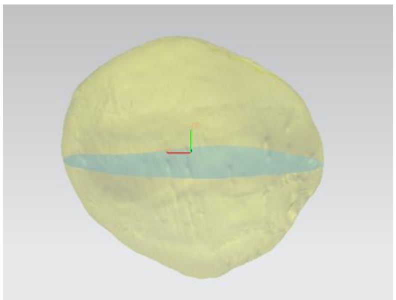
The three-dimensional model is used to simulate. According to the adult Patella model, it is used to convert the Patella data model scanned by the scanner to the three-dimensional data model. According to the landscape of the Patella, it is divided into two parts, as shown in Figure 2.Show, and with a 3D data model with 2.7 lock screws on the drawing software UG design 8 holes, 10 hook claws, thick-plate thickness 1.4mm new Patella locking bone plates, as shown in Figure 3 (a).



a) Temple bone point cloud data



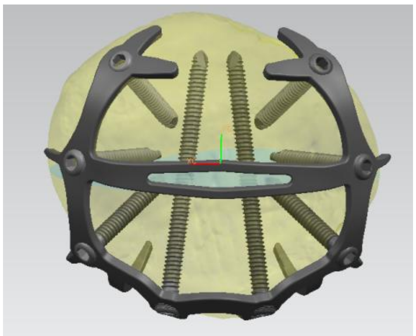
b) Tibetan 3D model



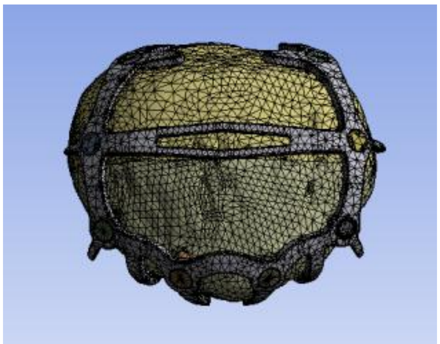
c) Tiblastine horizontal fracture model

Figure 2: Tiblastia model

Since the locking bone plate and the Patella are "lock" fixed by locking screws when finite element analysis. Considering that the impact of the threaded factors on the mechanical analysis is not much, the thread shape on the lock bone plate and screw is canceled, which is conducive to subsequent grid division, while reducing the amount of calculation, ensuring the analysis of the analysis simulation. Tetracene or hexahedral mesh is divided into tetrahedral or hexahedral mesh, and the mesh unit is 1.0 mm. The grid is divided into Fig. 3 (b), and Table 1 shows.



a) Assembly model



b) The grid unit size is 1.0mm

Figure 3: Novel Patella lock bone plate and Patella horizontal fracture model assembly graph and mesh

Table 1 Model node number and grid

Model	Number of nodes	Number of grids
Locking screw	7366	3440
Novel patella locking bone plate	44327	23392
Bone	66364	39591

3.2 Finite element analysis material assignment

Import the 3D composite model constructed in UG into ANSYS Workbench. The material property assignment is shown in Table 2. The patella locking bone plate is made of titanium alloy material, and the 2.7 locking screw is made of titanium alloy material. The analysis program uses the Static Structural analysis model.

Table 2 Material parameters

Material	Elastic Modulus (MPa)	Poisson's ratio
bone	24100	0.20
Titanium alloy	110000	0.30

3.3 Loading plan and constraints

To establish a new type of patella locking bone plate internal fixation to treat transverse patella fractures with finite element analysis. Studies have shown that when the knee joint is flexed at 90°, the upper 1/3 of the patella is in contact with the cartilage of the lower part of the trochlear, and the stress is up to (4.4±1.0) MPa. The general shape of the patella model used in this study is almond-shaped. The height of the patella is about 45.32mm, the width is about 48.95mm, the thickness is about 20.44mm, the horizontal arc length is 45.05mm, and the longitudinal arc length is 40.36mm. According to the size of the patella model, we selected a new medium-sized patella locking bone plate, which was fixed with 6 16mm long and 2 36mm long 2.7mm locking screws. When the knee joint is flexed at 90°, the compressive stress at the 1/3 position perpendicular to the articular surface of the patella is 5.4 MPa. Set the patellar base and the patellar tip in front of the patella as fixed constraints, the bone pieces at both ends of the fracture line are set to surface-to-surface contact, the friction coefficient of the interface is set to 0.04, and the rest of the relationship is set to not separate. In this simulation mechanical analysis, there is no relative movement between the patella and the new patella locking bone plate and locking screw. Limit the degree of freedom between them to 0 in all directions, as shown in Figure 4.

Figure 4: Schematic diagram of load loading

3.4 Authentication method

Since the fineness of the mesh and the selection of elements have a considerable influence on the accuracy of the solution, the Convergence tool of the ANSYS workbench software is used to conduct a mesh refinement and convergence analysis on the analyzed new patella locking bone plate to determine the limit. The real and effective meta-analysis. Set the Max Refinement Loops loop value to 6, to determine convergence, and the Allowable Change determination amount to converge within 2%.

4. Result

Results Figures 5, 6, 7, 8, and Tables 3 and 4 show that when the new patella locking bone plate is flexed at 90°, the maximum principal stress appears near the top of the fracture line.The maximum displacement value of the entire model appears at the proximal end of the patella.The maximum principal stress and principal strain of the initial mesh of the new patella locking bone plate As the number of nodes and elements increase, the stress and strain values gradually stabilize, and the stress concentration point and strain concentration point are both at the proximal hook claw of the locking bone plate, The consistency is better to get a convergent stable solution.

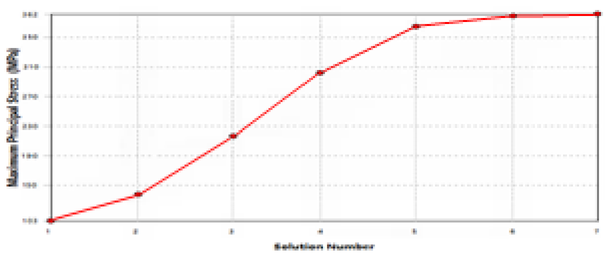


Figure 5 The maximum principal stress curve of the patella locking bone plate convergence verification

Table 3 Verification of the maximum principal stress and the percentage change of the patella locking bone plate convergence

No.	Maximum Principal Stress (MPa)	Change (%)	Nodes	Elements
1	102.52	-	44327	23392
2	139.34	34.472	75654	58183
3	215.82	52.209	108914	81511
4	305.74	40.236	131354	118885
5	356.12	15.4756	189997	148253
6	359.02	0.81433	221756	185775
7	362.11	0.86067	264536	227863

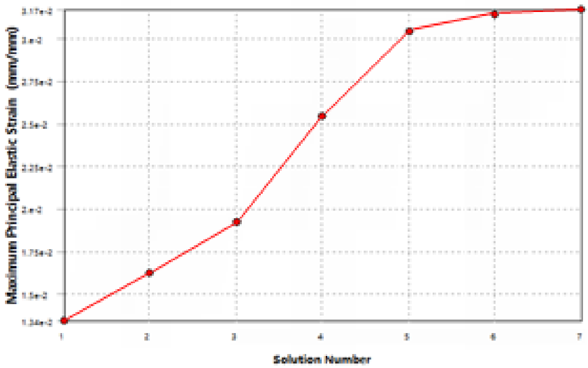
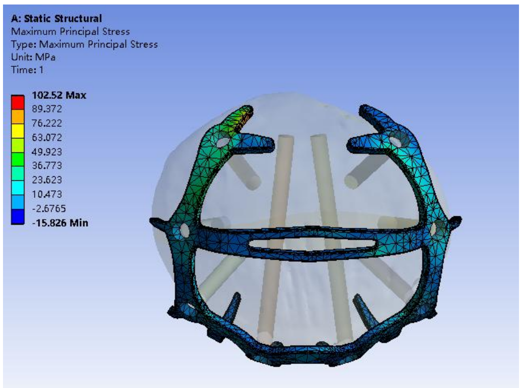


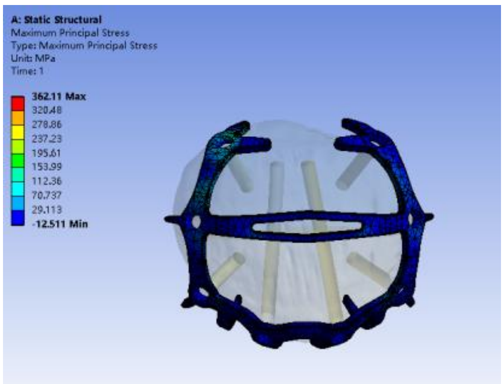
Figure 6: The maximum principal strain curve of the patella locking bone plate convergence verification

Table 4: Verification of the maximum principal strain and the percentage change of the patella locking bone plate convergence

No.	Maximum Principal Elastic Strain(mm/mm)	Change (%)	Nodes	Elements
1	1.3425e-002	-	44327	23392
2	1.6419e-002	16.921	75654	58183
3	1.9205e-002	16.674	108914	81511
4	2.541e-002	27.813	131354	118885
5	3.0291e-002	18.209	189997	148253
6	3.1192e-002	0.2789	221756	185775
7	3.1685e-002	0.1556	264536	227863

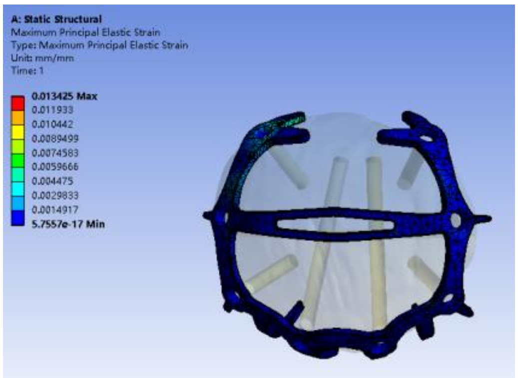


a) Initial grid

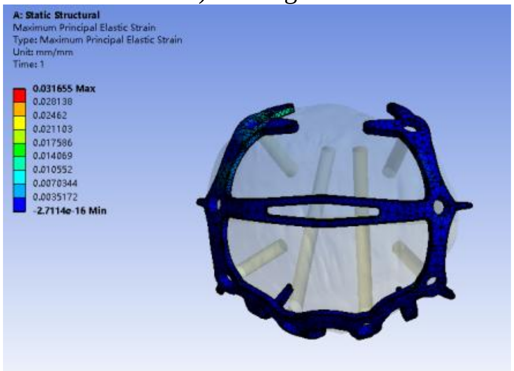


b) Grid after convergence

Figure 7: Grid and stress distribution diagram before and after the patella locking bone plate convergence verification



a) Initial grid



b) Grid after convergence

Figure 8: Grid and strain distribution diagram before and after the patella locking bone plate convergence verification

5. Analysis

The transverse fracture of the patella is the most common form of patella fracture. In this study, a new type of patella locking bone plate was designed to fix the three-dimensional finite element model of the patella transverse fracture. Through mechanical analysis of the knee flexion at 90°, it was found that when the strength of the quadriceps muscle increases during the flexion and extension of the knee joint, the articular surface of the patella is increased. The reduced contact area results in a maximum principal stress of 102.52 MPa, which is much smaller than the tensile strength of the new patella locking bone plate of 351 to 429 MPa. The maximum displacement of the fracture piece is 0.013425 mm, which is much smaller than the clinical requirement that the articular surface step is less than 2 mm. And using the Convergence tool for automatic convergence verification, the maximum principal stress and principal strain of the patella locking bone plate gradually stabilize with the increase of the number of meshes. The maximum principal stress value of the locking bone plate ranges from 102.52Mpa to 362.11 Mpa, and the final change rate is 0.86067%. The maximum principal strain value of the locking bone plate ranges from 1.3425e-003 to 3.1685e-002, and the final change rate is 0.1556%. Their final rate of change is less than the set 2% judgment amount. Moreover, the force distribution diagrams of stress and strain have not changed due to the increase in the number of meshes. After comparison, the results are found to be more consistent and the results are credible. This can provide a theoretical basis for clinical application, greatly reducing the cycle and cost of new product development.

6. Experience Sharing

Through the introduction of advanced R&D design concepts and methods, the patella locking bone plate designed in this study has a very good centripetal cohesion, better maintains the integrity of the patella and the stability of the knee joint, and proposes a new approach to the internal fixation of patella fractures. The fixing method. Only by constantly learning and thinking about how to apply these new technologies to enterprises can we develop high-quality new products and occupy the rapidly developing orthopedics market.