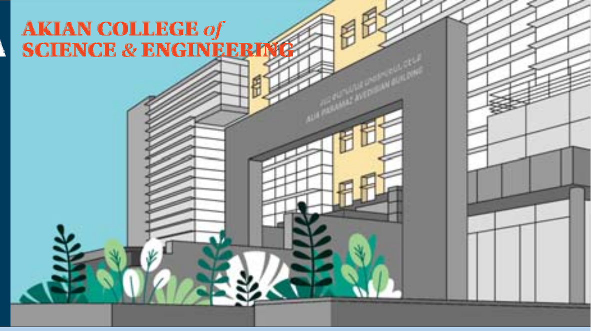
AUA American University of Armenia

AUA AKIAN COLLEGE of SCIENCE & ENGINEERING



Short Intramedullary Nail: Design, Analysis, and Prototyping

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Software:Creo Parametric Year: 2016 - 2017

Introduction

By way of background, orthopaedic and trauma care in Armenia are in a rather challenging state at the moment. Hardware and equipment are at the core of patient care in these fields, as surgeons need them to help patients and increase their volume of work to become proficient in delivery of care. Unfortunately, the high cost and limited availability of orthopaedic and trauma hardware adversely affect both of these components in Armenia.

Our first initiative has been the modified intramedullary (IM) nail, a mainstay of trauma care for elderly fractures. We have been able to design a system that reduces the complication of the surgical kit from over 60 to less than 10, to reduce cost and inventory and streamline care delivery. Over two years, we have undertaken the design and revision work for this IM nail at the AUA, where we have been able to implement the first prototype.

Problem Definition

What is used currently?

Screw fixation

Dynamic hip screw fixation

Hemiarthroplasty

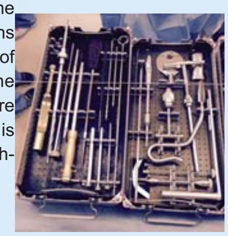
What is proposed, and what are its advantages?

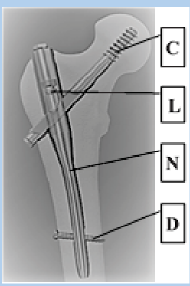
1. Less invasive approach
2. Short surgery time
3. Early weight bearing
4. Minor blood loss

Short intramedullary nail

What are the limitations?

It is too expensive because of the variety of implant configurations (sizes) and the large number of surgical accessories (see the photo on the right). The mere cost of the implant ($6,000) is unaffordable even for a high-income Armenian patient.





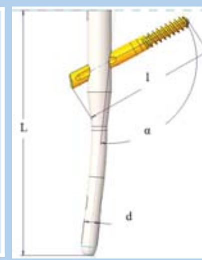
How It Works

Short intramedullary nail N is inserted into the proximal femur to connect the fractured parts, align them together, and provide proper position during the healing process. The proper position of the nail is achieved by fixing it to the bone with large lag cephalic screw C or blade at its proximal end (into the femoral head) and one or more shorter screws S into the distal end. Locking mechanism L, deployed within the body of the nail, engages the proximal cephalic screw within the nail, prevents the femoral head from rotating around the axis of the nail, and controls its sliding along the long axis.

Our Task

While identifying our design approach, we rested on the statistical data, according to which by pairing combinations of two configurations of nails and three configurations of cephalic proximal screws, a physician will be able to treat approximately 80% of all proximal femur fractures. The parameters for configurations are shown on the drawing on the right, and the configurations are shown in the table below.

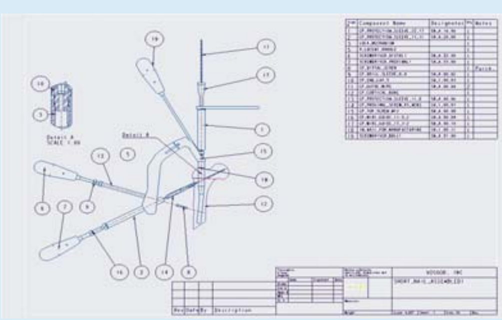
Configurations	α, °	d, mm	L, mm	l, mm
Nail_1	130	10	230	-
Nail_2	130	11	230	-
Cephalic Screw_1	-	-	-	75
Cephalic Screw_2	-	-	-	85
Cephalic Screw_3	-	-	-	95



L - length of the nail
l - lenght of the cephalic screw
α - femoral neck angle
d - distal diameter of the nail

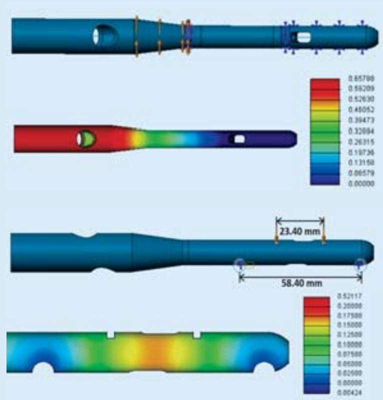
Three Parts of The Project

Design



The Intramedullary nail with the set of insertion accessories: The drawing with the Bill of Materials.

Analysis



Finite Element Analysis to check the model for correspondence to the requirements of the ASTM 1264-16 standard: Static Torsion (upper pic) and Bending Fatigue (lower pic).

Production of Prototypes

The prototypes produced and sent to the Beth Israel Deaconess Medical Center where they should undergo cadaveric bone tests, to assess the fatigue performance of the designed system.