

Contents

ACKNOWLEDGEMENTS.....	5
1. AIM.....	11
2. INTRODUCTION.....	12
3. REVIEW OF LITERATURE.....	14
4. CONCEPT EVOLUTION.....	16
4.1. Pauwel's Theory.....	16
4.2. Ilizarov Tension Stress Theory.....	18
4.3. Biomechanics.....	21
4.4. Mechanical Factors.....	22
4.4.1. Basic Load.....	22
4.4.2. Stress And Strain.....	23
4.4.3. Column and Shaft.....	24
5. ILIZAROV RING FIXATOR.....	25
5.1. Components.....	25
5.1.1. WIRES.....	27
5.2. Construction.....	29
5.3. Biomechanics of Ilizarov Ring fixator.....	36
6. 'APPARATUS LIMB'.....	40
7. OSSIFICATION STUDY.....	41
7.1. Experimental study:.....	41
7.2. Results of experimental study.....	44
8. FINITE ELEMENT ANALYSIS.....	52
8.1. Introduction.....	52
8.2. Finite element study.....	53
8.3. Results of finite element study.....	61
9. CLINICAL MATERIAL.....	62
9.1. Materials and Methods.....	62
9.2. Observations.....	66
9.6. Results.....	80
10. DISCUSSION.....	81
11. CONCLUSION.....	91
APPENDIX – A.....	92
Mechanical Properties of Human Compact Bone[78].....	92
Callus.....	92
Bone as a Material.....	92
Standard Units.....	93
REFERENCES.....	94

Illustrations

Figure 4.1 From Pauwels: histogenesis in the locomotor apparatus as a result of mechanical stresses. (As illustrated by Kummer in Pauwels)	16
Figure 4.2 Elastic micro motion	19
Figure 4.3 Basic load	22
Figure 4.4 - Stress and strain	23
Figure 4.5 - Three types of load bearing structures	24
Figure 5.1 - A complete set of the apparatus	26
Figure 5.2 - Wires: Points and stoppers	27
Figure 5.3 - ideal construct 4 rings connected to each other and wires crossing at 90° and transfixed to the tubular cortical bone	29
Figure 5.4 - 5/8 ring used to have access to raw area. To use 5/8 ring in this configuration a high degree of frame stability must be assured by attaching to the proximal and distal full rings at a minimum of three connection sites	29
Figure 5.5 - Ring Construct on a model for Distraction Osteogenesis	30
Figure 5.6 - Measurement of ring size. - Preoperative. A. Measurer at the widest part and add 6 cm, B. Proper ring size, C. Templates	30
Figure 5.7 - On table ring adjustment. A two fingers breath space between skin and ring	31
Figure 5.8 - Russian 'manual technique' of wire tensioning. A, firm wire tensioning is achieved by simultaneously turning a wire fixation bolt and nut with two wrenches approximately one-half turn. B, turning of the wire fixation bolt tightens the wire by bending it off the 90-degree axis with the ring shown schematically above. This varies with the density of bone	32
Figure 5.9 - Schematic of the axial loading distribution in the Ilizarov apparatus and in the unipolar dynamic axial external fixator during a tibia-fibula bifocal distraction. A. Balanced forces mimic the dynamic loading and biomechanical function of the bone. B, uniplanar forces place stress at right angles at two sites	37
Figure 7.1	42
Figure 7.2	43
Figure 8.1 - Finite Element Analysis	51
Figure 8.2	53
Figure 8.3 - External forces in Group 1 construct	54
Figure 8.4 - Stress variation in Group 1 construct	55
Figure 8.5 - Displacement variation in Group 1 construct	55
Figure 8.6 - External forces in Group 2 construct	56
Figure 8.7 - Stress variations in Group 2 construct	57
Figure 8.8 - Displacement variations in Group 2 construct	57
Figure 8.9 - External forces in Group 3	58

Figure 8.10 - Stress variation in Group 3	59
Figure 8.11 - Displacement variation in Group 3.....	59
Figure 8.12 - Displacement variation in Group 1, Group2, Group 3.	60
Chart 9.1 - Age Distribution	62
Chart 9.2 - Sex distribution	63
Table 9.1 - Case distribution.	64
Chart. 9.3 - AO Classification.	65
Chart 9.4 - Gustilo Classification	65
Chart 9.5 - Ring construct	65
Chart 9.6 - Healing time	66
Chart 9.7 – Results	80