Lifelong Learning

IBV
INSTITUTO DE BIOMECÁNICA

ORTHOBIOMED: PRESENTATION OF OSTEOFORM PROJECT

C.Atienza

Kick off meeting 12/11/13

SUMMARY

DESCRIPTION OF THE ACTION

The aim of **Leonardo da Vinci Multilateral Projects 'Transfer of Innovation'** is to improve the quality and attractiveness of the European vocational education and training system **by adapting and integrating innovative content or results from previous Leonardo da Vinci Projects, or from other innovative projects** into public and/or private vocational training systems and companies at the national, local, regional, or sectorial level.

The process for transferring innovative training content or results includes the following actions:

- Identifying and analyzing targeted user requirements.
- Selecting innovative content to meet these requirements and analyzing the feasibility of transfer.
- Integrating or certifying it in European, national, regional, local and/or sectorial training systems and practices.

OBJECTIVE AND CONTENTS OF THE PROJECT

OBJECTIVE OF THIS PROJECT: *to ensure the access to a continuous learning in the fields of osteosynthesis and fracture management for surgeons and engineers who focus their attention to the design of implants for surgery.*

Training contents are related with medicine and engineering disciplines, and deal with both clinical and biomechanical aspects of the osteosynthesis and fracture management.

Training material has been implemented in a **telematic training tool** which comprise both theoretical modules about surgery and biomechanics, and practice contents for the students to make exercises to train their learning.

OSTEOSYNTHESIS

Definition of Osteosynthesis: A surgical procedure with an open or percutaneous approach that stabilizes and joins the ends of fractured (broken) bones using mechanical devices such as metal plates, pins, rods, wires or screws. Osteosynthesis aim to bring the fractured bone ends together and immobilize the fracture site while healing takes place.

PROJECT OVERVIEW

MOTIVATION TO CARRY OUT THE PROJECT

- Europe is currently the oldest region in the world and its life expectancy is increasing.
- The number of bone fractures and the number of osteosynthesis surgeries are increasing.
- There is a constant innovation of the surgical techniques.

Osteosynthesis procedures: high demanding activities

- From other projects, we know that orthopedic surgeons and professionals working in orthopaedic surgery and traumatology fields are interested in telematic training-learning tools to update their knowledge.
- Partners of the project have a wide experience in OST fields, and have complementary knowledge about osteosynthesis.

Leonardo da Vinci Project 'Transfer of Innovation'

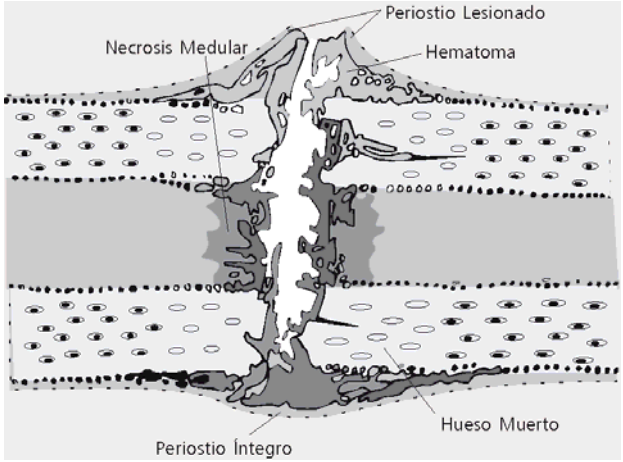
TARGET GROUPS

This project is addressed to the following groups:

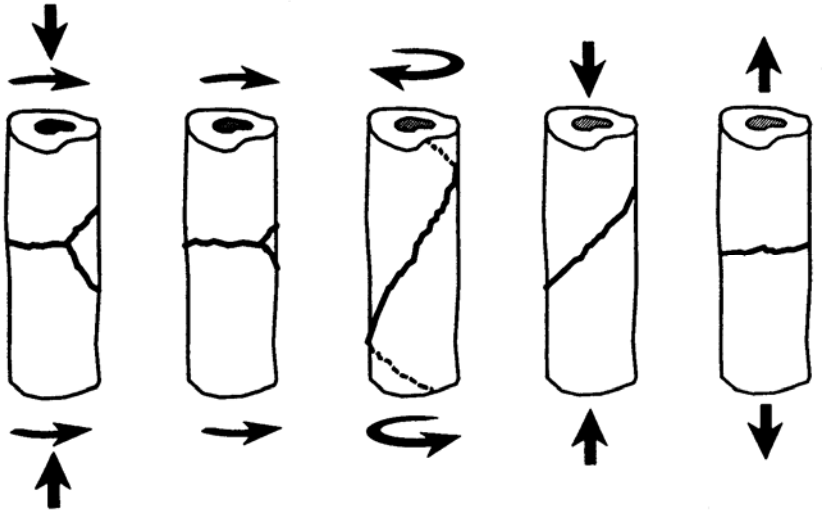
- **Orthopaedic surgery departments of Schools of Medicine**.
- **Departments of biomedical engineering in technical universities and postgraduate degrees in biomedical engineering**.
- **Public hospitals with doctors in training**.
- **Public or private hospitals with doctors who want extent or renew their knowledge on new technologies linked to spine surgery**.
- **R+D and sales departments of orthopaedic implant manufacturers that want to offer continued training to their employees**.

TRANSFER OF INNOVATION

• **Theory documentation** consists in transferring previous training materials (books and courses) developed by the consortium partners, to transform them in telematic content which will be accessible for any European student.



Fracture healing process



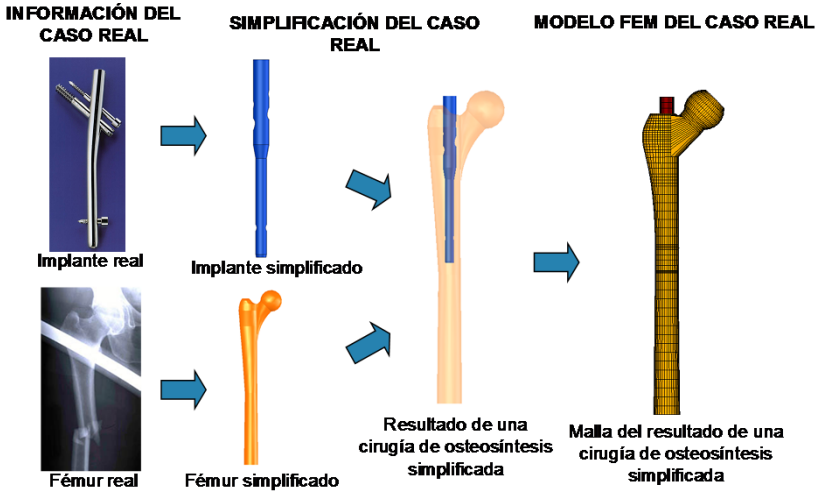
Fracture mechanisms

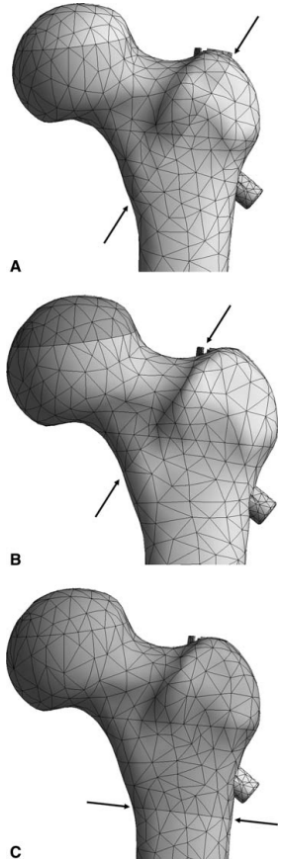
PROJECT OVERVIEW

TRANSFER OF INNOVATION

- **Practical contents** consists of two parts:

1. **Simulations developed with Finite Element Models**. These models allow comparing different osteosynthesis procedures by calculating the mechanical stability of the assembly, and therefore can theoretically provide assistance for the decision making for orthopaedic surgeons.



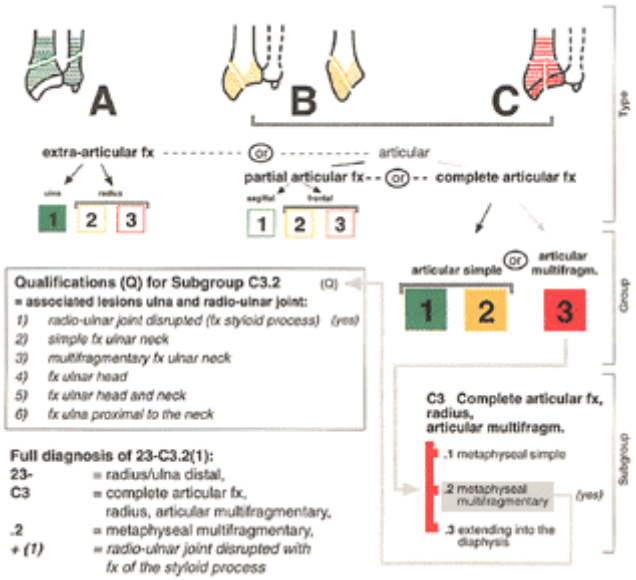


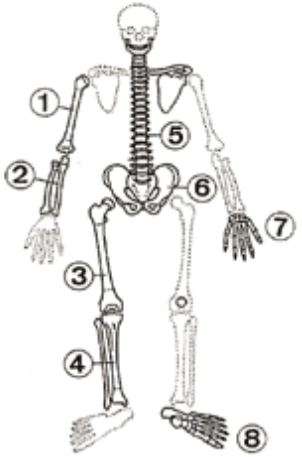
Simulation of different fractures

PROJECT OVERVIEW

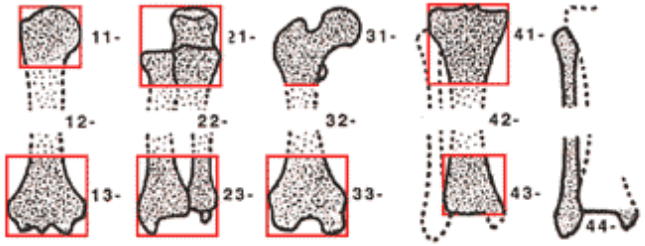
TRANSFER OF INNOVATION

2. **A telematic training tool for fractures diagnosis**. This training tool provide several cases to help students improve their **fracture diagnosing skills**.





Each bone or group of bones is designated by a number from 1 to 8: Humerus (1), Radius/Ulna (2), Femur (3), Tibia/Fibula (4), Spine (5), Pelvis (6), Hand (7), Foot (8). All the remaining bones are classified under 9: Patella (91.1), Clavicle (91.2), Scapula (91.3), Mandible (92), Facial Bones and Skull (93).



Segments of long bones.
Each long bone has 3 segments: the proximal, the diaphyseal, and the distal segment. The malleolar segment is an exception and is classified as the 4th segment of the tibia/fibula (44-).

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COURSE DEVELOPMENT METHODOLOGY

1. **Learning needs analysis and contents definition**
2. **Integration and adaptation of learning contents**
3. **Online course development**
4. **Pilot course. Validation**

1.- Learning needs analysis and contents definition

- Objectives:
  - Identify the learning needs of the target collectives:
    - Medical residents in training process
    - Biomedical engineers working in osteosynthesis implants development and manufacturing
    - Senior surgeons updating their knowledge in osteosynthesis
  - Define the learning objectives to fit the needs detected and to develop the course modules

1.- Learning needs analysis and contents definition

- Activities:
  - A specific questionnaire was developed and sent to the target users, in order to identify the learning necessities, taking into account thematic fields, target groups and the training application context
  - 64 questionnaires were collected that allowed acquiring the information to define the main characteristics of the course and its contents.
  - Definition of the training modules, based on previously developed contents

1.- Learning needs analysis and contents definition

Results: ***Proposal of learning modules: summary, duration, classification of the theoretical contents, practical contents, clinical cases, sources of information.***

Group A: Biomechanics

- Bone biomechanics.
- Biomechanical study of the fracture.
- Bone remodeling. Mechanical adaptation.

Group B: Reparation systems

- Orthopedic fracture reparation systems.
- Surgical fracture reparation systems.
- Controversies and new trends. Follow-up.

Group C: Clinical treatments

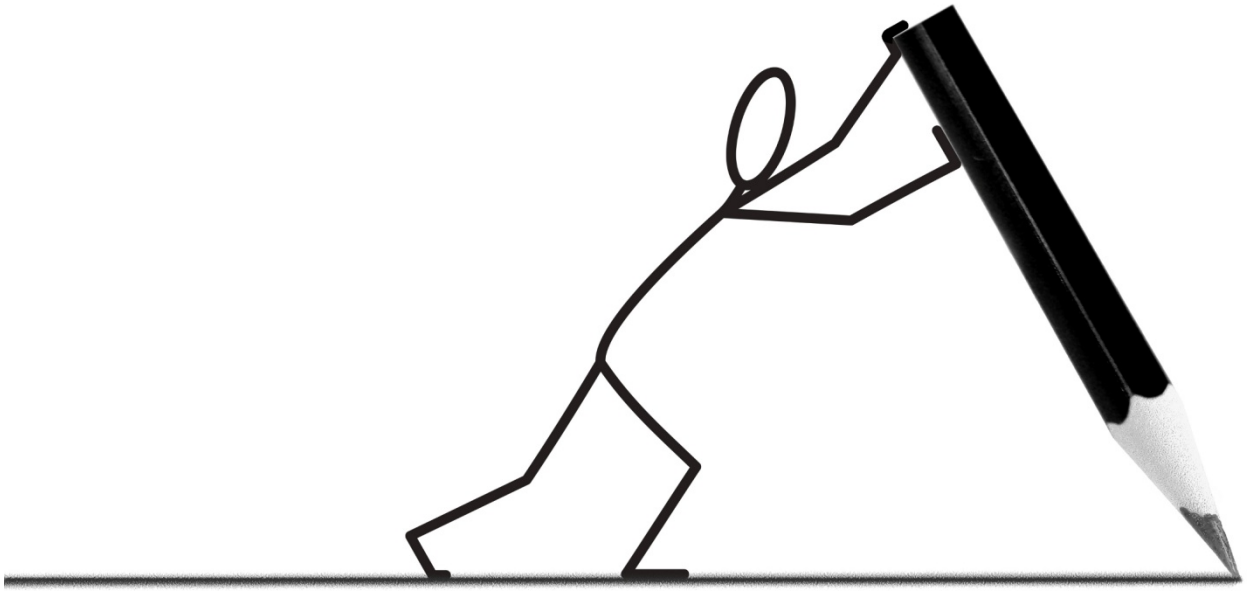
- Fractures reduction
- Vascular preservation
- Osteosynthesis mistakes

PRACTICAL

- Fracture classification.
- Preoperative surgical simulation (FEM).

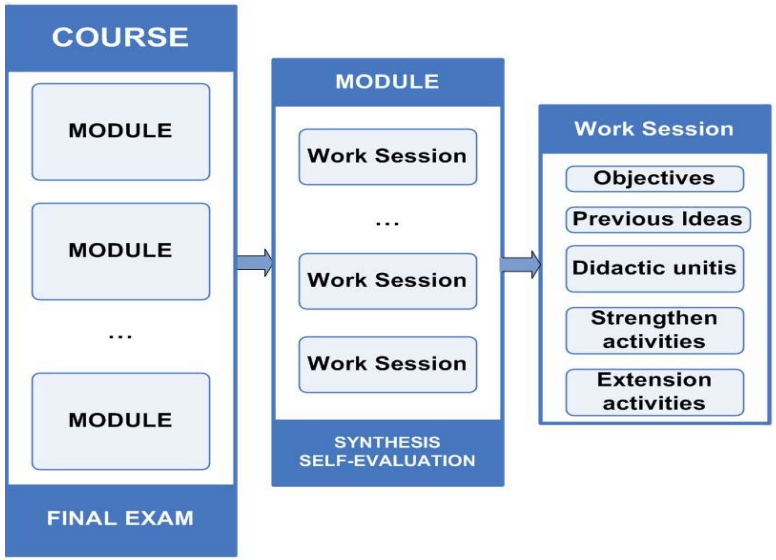
2.- Integration and adaptation of learning contents

- Objectives:
  - Development of the learning modules
    - Focused in fulfilling the learning needs detected
    - Contents prepared following IBV didactic guidelines



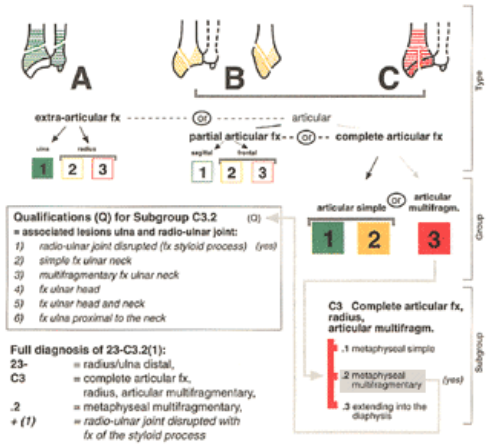
2.- Integration and adaptation of learning contents

- Activities:
  - Learning modules: developed according to the needs detected.
  - Modules translated to English, German and Polish
  - Practical contents



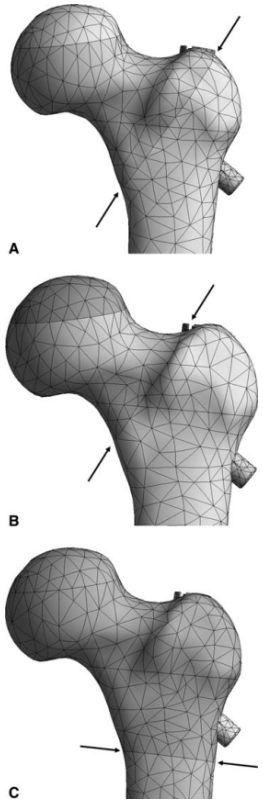
2.- Integration and adaptation of learning contents

- Results:
  - Teaching contents adapted to the e-learning structure provided by IBV
  - Practical modules developed



CLASSIFICATION

SIMULATION



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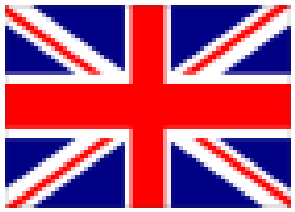
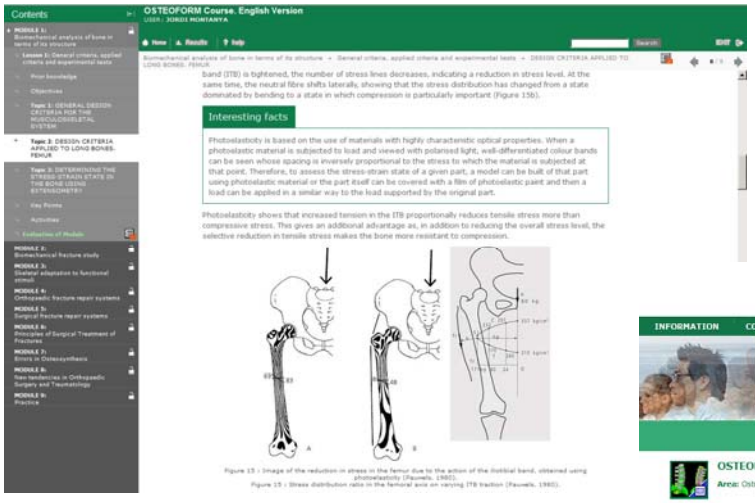
3.- Online course development

- Objectives:
  - Contents implementation
    - Integration of the previously developed modules into a e-learning online platform.
    - A training tool based in real clinical cases, and finite elements models simulations incorporated.
    - Course implemented in English and in the partners' languages: German, Polish and Spanish.

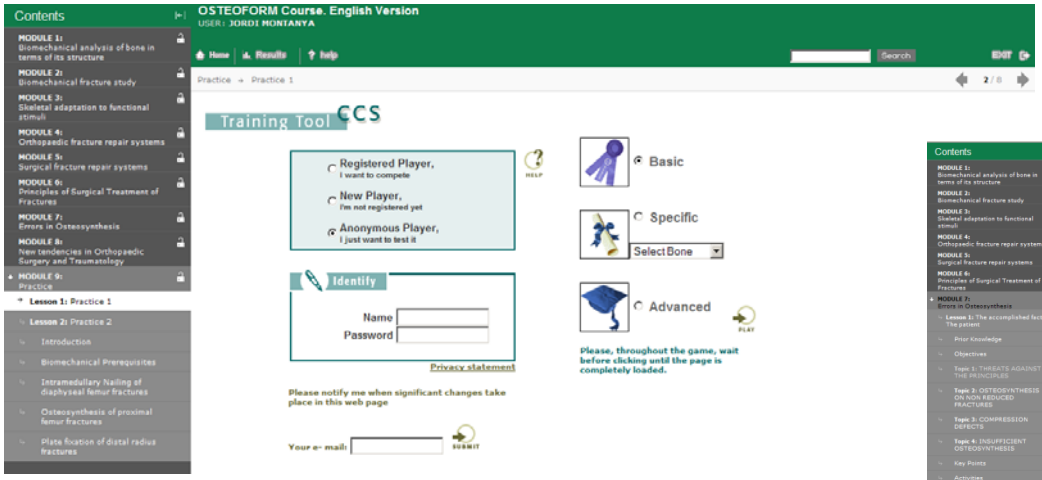
3.- Online course development

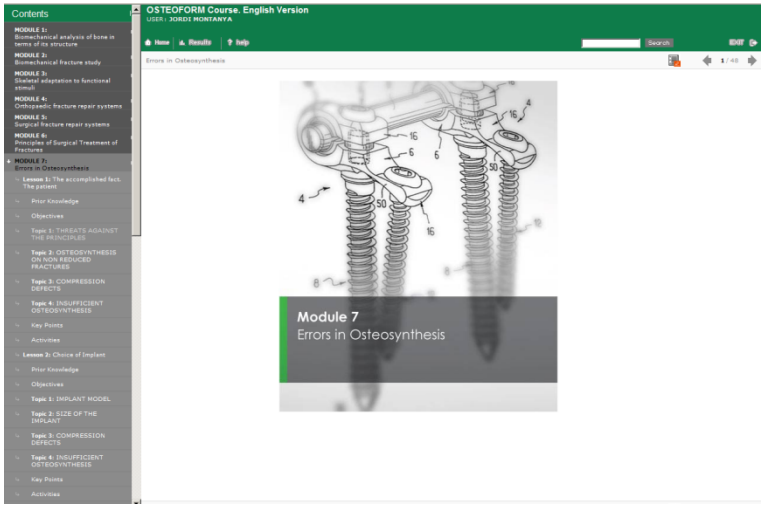
- Activities:
  - Online course implementation based in contents developed, including theoretical and practical ones.
  - Course implemented in English, German, Polish and Spanish



3.- Online course development

- Results:
  - Online course ready to be tested
    - Technical and Graphical implementation
    - Integration in “Adapting Campus” e-learning platform





http://osteoform-campus.adapting.com/

4.- Pilot course. Validation

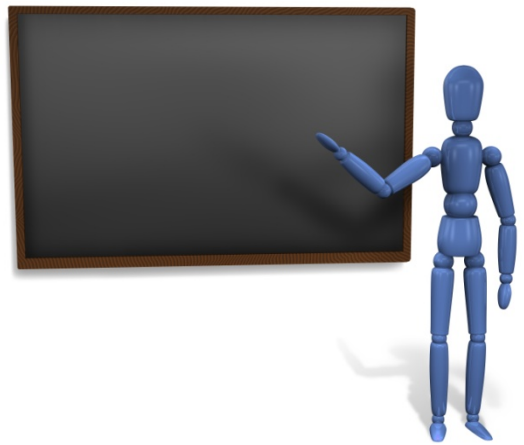
- Objectives:
  - Get the Feedback

4.- Pilot course. Validation

- Activities:
  - Users panel and satisfaction survey

    A panel of 32 students created to evaluate the course through an specific satisfaction survey
  - Support figures

    Two specific figures supported the student during the course reducing the defection risk: an academic tutor, to clarify any doubts; and the dynamizator, to motivate and monitor her/him.



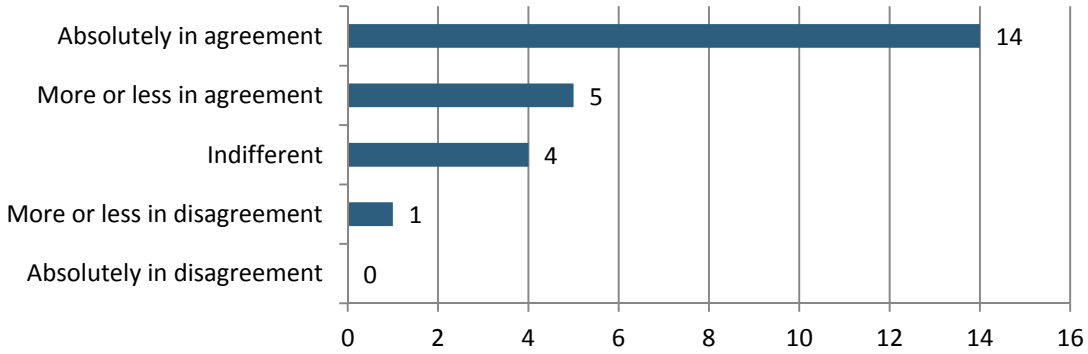
4.- Pilot course. Validation

- Results:
  - Two Reports:
    - ***"Usability of the system and appropriateness of the teaching contents"***
    - ***"Satisfaction survey results"***
  - Revised course

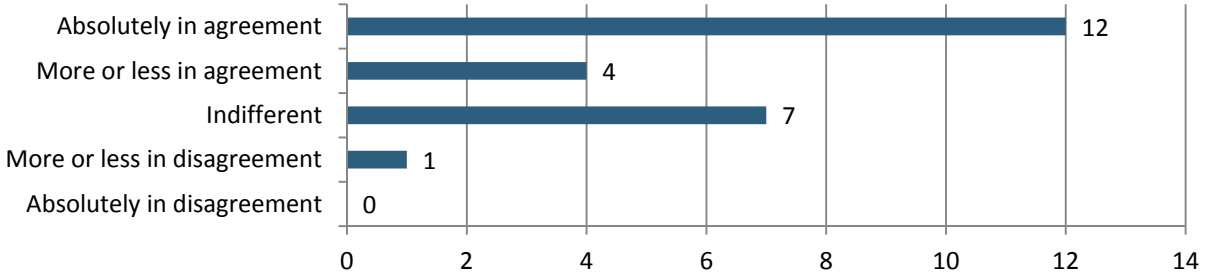
4.- Pilot course. Validation

- Results:

I consider the activities, the monitoring exercises, the further activities and the auto-evaluation good enough to strengthen the acquired knowledge



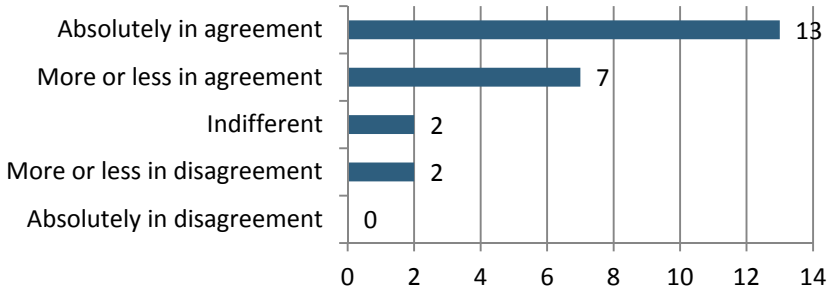
My technical problems, with regard to the web course running, were attended quickly



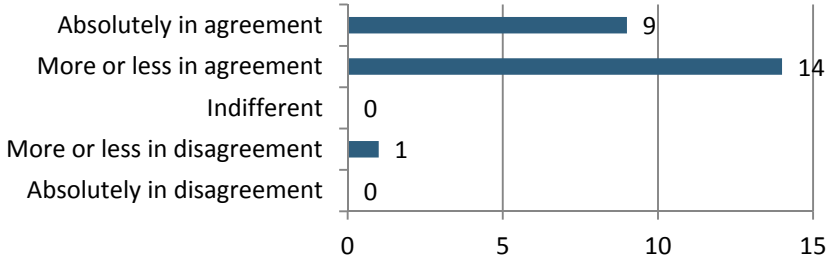
4.- Pilot course. Validation

- Results:

Contents were carried out correctly throughout the course

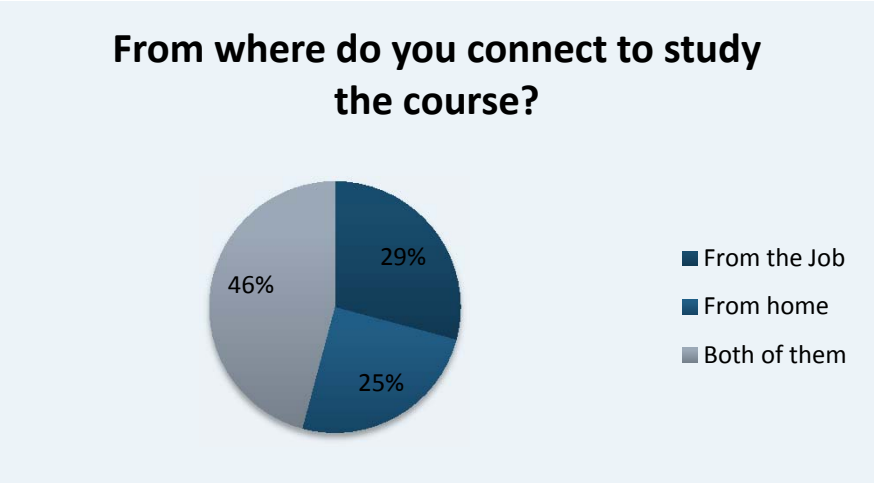


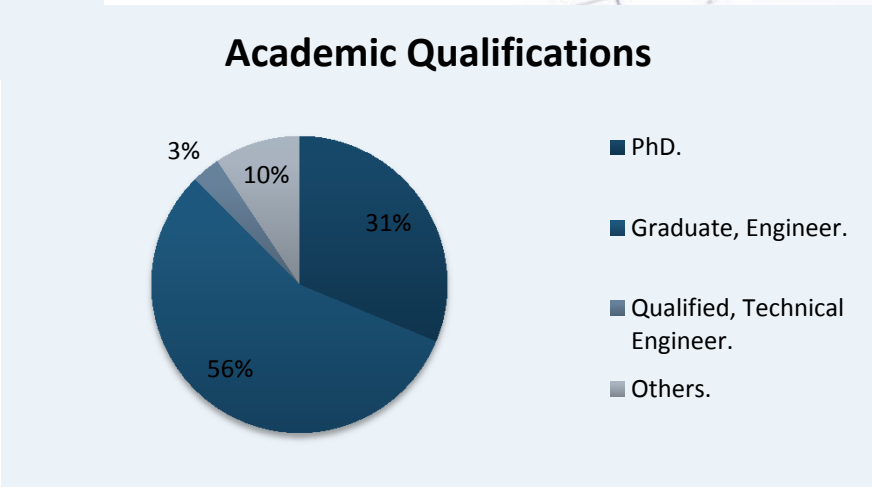
I think that the medium used for the formation (internet) has more advantages than disadvantages



4.- Pilot course. Validation

- WP Results:





COURSE CONTENTS

1. **Theory documentation**

2. **Practical contents**

3. **Training tool (Fracture classification game)**

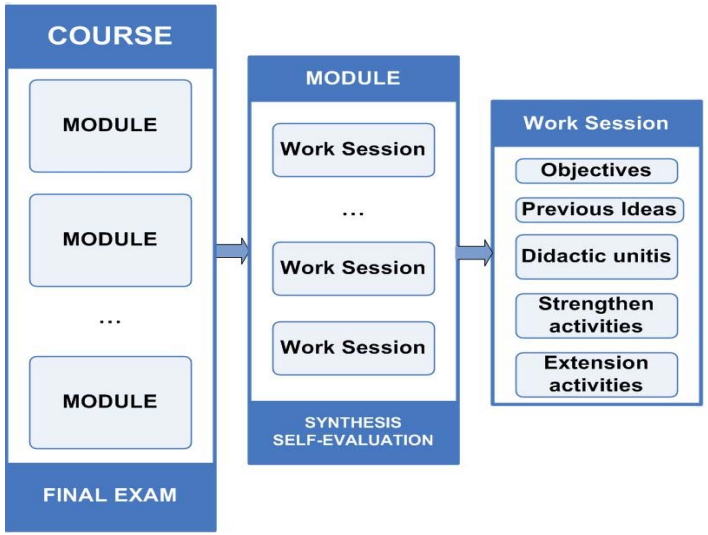
2.- Theory documentation

• The course is divided into different modules.

•Each module is divided into works sessions.

•Estructure of work sessions :

- •Objectives
- •Previous ideas
- •Didactic units
- •Strengthen activities
- •Extension activities



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2.- Theory documentation

MODULE 1: Biomechanical analysis of bone in terms of its structure

MODULE 2: Biomechanical fracture study.

MODULE 3: Skeletal adaptation to functional stimuli

MODULE 4: Orthopaedic fracture repair systems

MODULE 5: Surgical fracture repair systems.

MODULE 6: Principles of Surgical Treatment of Fractures.

MODULE 7: Errors in Osteosynthesis.

MODULE 8: New tendencies in Orthopaedic Surgery and Traumatology.

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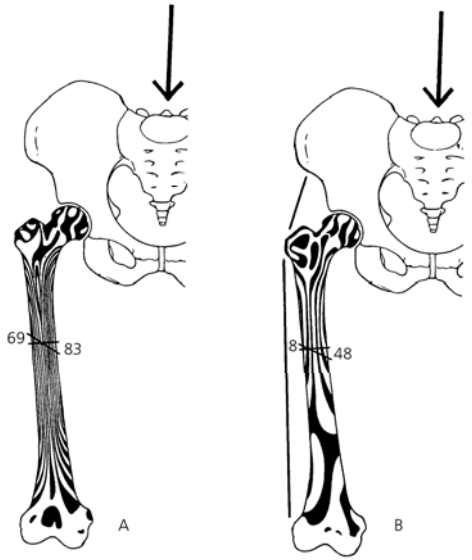
2.- Theory documentation

MODULE 1: Biomechanical analysis of bone in terms of its structure

Lesson 1: General criteria, applied criteria and experimental tests.

Objectives :
- To learn the structural behaviour of the bone.
- To study the design criteria applied to the femur.
- To determine the stress-strain state in the bone using extensometry.



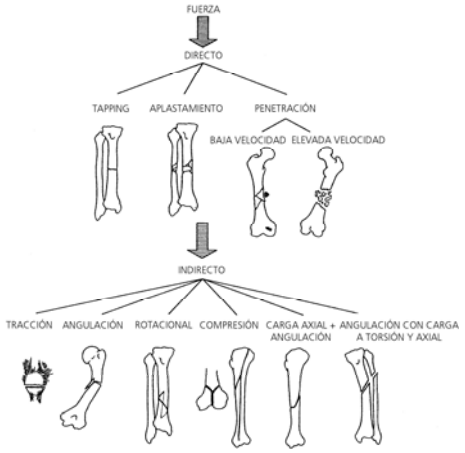
2.- Theory documentation

MODULE 2: Biomechanical fracture study.

- Lesson 1: Fracture and consolidation mechanisms.
- Lesson 2: Factors influencing fracture repair and assessment methods.

Objectives :

- To learn about the main bone fracture mechanisms.
- To learn about the consolidation mechanism and each stage of the repair process.
- To study the main factors influencing fracture repair, according to the different dependent variables.
- To learn more about the therapeutic factors.
- To learn about the non-invasive assessment methods and to study their essential characteristics.

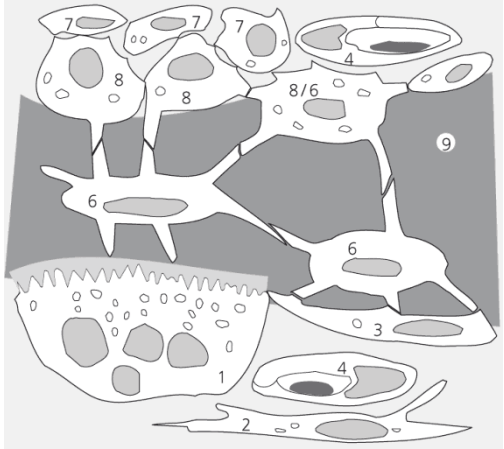


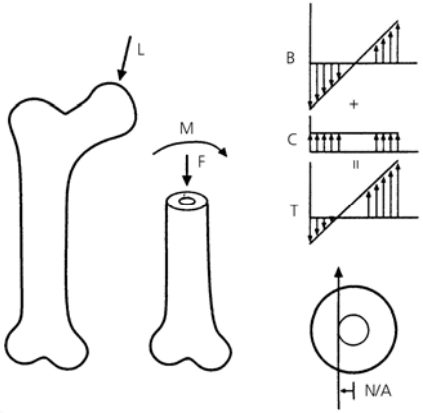
2.- Theory documentation

MODULE 3: Skeletal adaptation to functional stimuli.

- Lesson 1: Introduction and experimental studies
- Lesson 2: Variables influencing mechanical adaptation .

Objectives :
- To review basic concepts relating to bone remodelling.
- To review the main studies on bone remodelling and adaptation.
- To analyse the different variables that influence the mechanical adaptation process of bone tissue.
- To study the rules for bone adaptation.



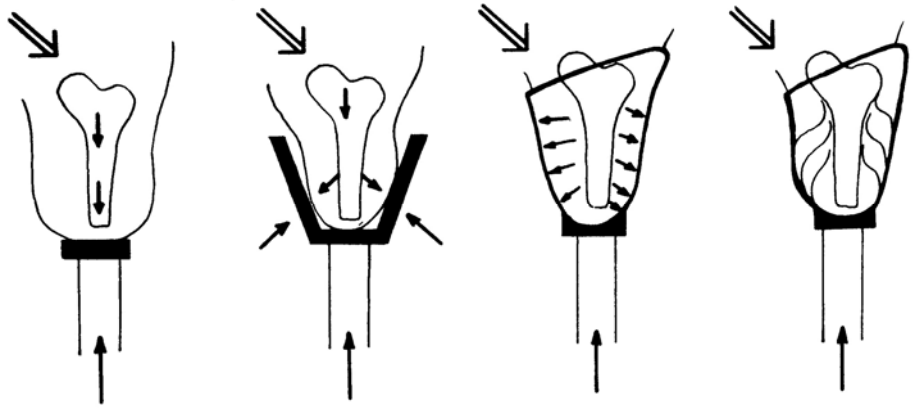


2.- Theory documentation

MODULE 4: Orthopaedic fracture repair systems

- Lesson 1: Treatment of fractures.

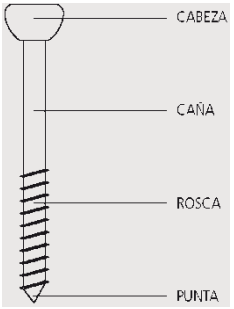
Objectives :
-To study the application of conventional and functional plaster casts.
-To learn about the most important characteristics of the main plaster cast systems used today.

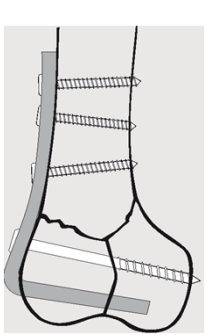


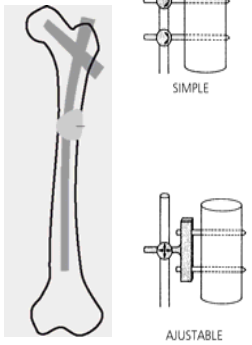
2.- Theory documentation

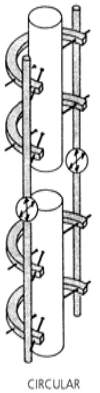
MODULE 5: Surgical fracture repair systems

- Lesson 1: Introduction. Screw fixation
- Lesson 2: Plate fixation
- Lesson 3: Intramedullary fixation
- Lesson 4: External fixation of fractures









Objectives :

- Understand the mechanism of fracture repair, as well as its characteristic properties.
- Be familiar with the main screw fixation systems .
- Identify the different parts of a screw and how they affect the fixation process.
- Be familiar with the different types of plates in current use and their function
- Understand the basic principles relating to the function of plate fixation and the considerations to bear in mind when using it.
- Be familiar with the function of intramedullary fixation, its objectives and the field of application
- Identify the various factors that affect nail resistance

-Know which factors should be considered when using intramedullary fixation.
-Understand the main aims of external fixation and when its use is indicated.
-Understand the advantages and disadvantages of such fixation systems.
-Identify the different types of fixation in current use and understand the differences between them through comparative studies.

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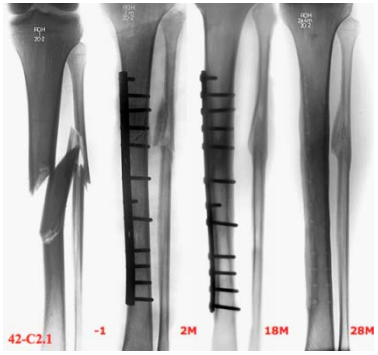
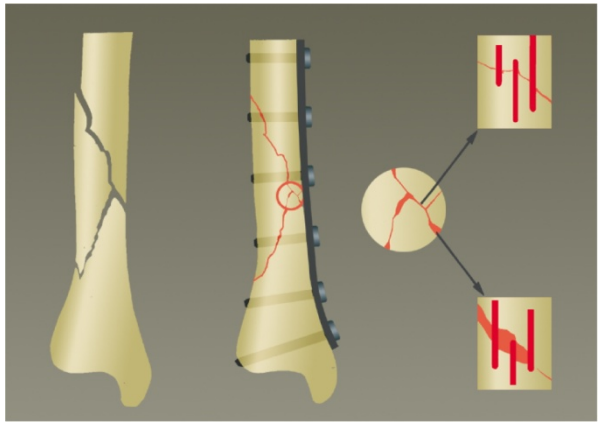
2.- Theory documentation

MODULE 6: Principles of Surgical Treatment of Fractures





- Lesson 1: Anatomic Reduction
- Lesson 2: Stable Osteosynthesis
- Lesson 3: Preserving blood supply

Objectives :

- To study of the principles and basis of osteosynthesis.
- Understand each of the principles on which the surgical treatment of fractures is based.
- Importance of anatomic reduction in fracture healing.
- Importance of anatomic reduction in the final clinical outcome.
- Understand the concept of stability in osteosynthesis.
- To know the importance of vascularisation for the fracture healing process
- To learn the different types of bone healing.
- To refresh the main differences between cortical and cancellous bone and implications in the healing process.
- To know the chronological phases of bone healing.

2.- Theory documentation

MODULE 7: Errors in Osteosynthesis

- Lesson 1: The accomplished fact. The patient
- Lesson 2: Choice of Implant
- Lesson 3: Biological input
- Lesson 4: Type of Error
- Lesson 5: The accomplished fact. The patient

Objectives :

-The main objective of studying errors is to learn from them.
- Understand the concept of error in oteosynthesis.
- To differenciate *errors* from *complications* which may appear in any case that has been treated correctly.
- To avoid repeating known errors.
- To Raise awareness of the importance of self-criticism and self-audit as an improvement measure.
- Understand the need for preoperative planning.
- Understand the importance of the implant choice.
- To Know the importance of implant counouring in order to carry out a proper osteosynthesis.
- To Avoid implant incongruencies
- To Know the aim of bone graft addition.
- To Learn to discriminate in what cases is bone graft addition necessary.
- Understand the uses of decortication.

-To Know the potential errors to be avoided.
- To Know the possibility and need of the early detection of errors.

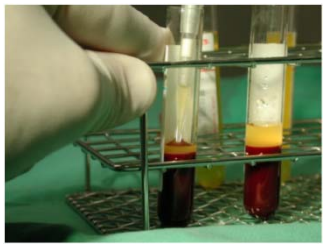
-To be aware of osteosynthesis contraindications.

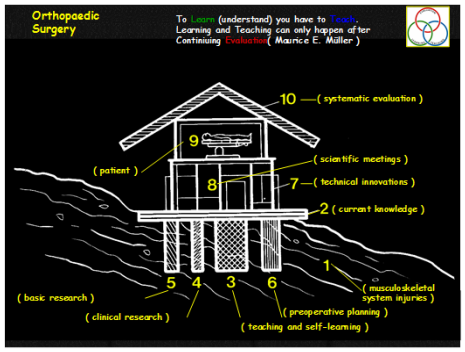
-To Think about the patients responsibility in the final outcome.

2.- Theory documentation

MODULE 8: New tendencies in Orthopaedic Surgery and Traumatology

- Lesson 1: Controversies
- Lesson 2: Tissue Regeneration Therapy
- Lesson 3: Good Practices, Documentation and Continuous Evaluation of Results in Orthopaedic Surgery and Traumatology.





Objectives :

- Understand the characteristics, indications and contraindications, of osteosynthesis with relative stability.
- Understand the concept and different applications of Platelet-Rich Plasma in the therapy of the musculoskeletal system pathology.
- Understand the concept of mesenchymal stem cells and their potential uses for treating the musculoskeletal system pathology.
- Understand the concept of Good Practices and its application in the scope of Orthopaedic Surgery and Traumatology (OST).
- To Learn the concept of Evidence-Based Medicine.
- Understand the concept of variability in clinical practice, adverse effects.
- To Learn the concept and most frequent standardisation systems of clinical practice.
- Understand the importance of documentation of clinical cases and the continuous evaluation of the OST results.
- Understand some reference examples of application of Information and Communications Technology (ICT) in the scope of documentation and evaluation of results.

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2.- Practical contents

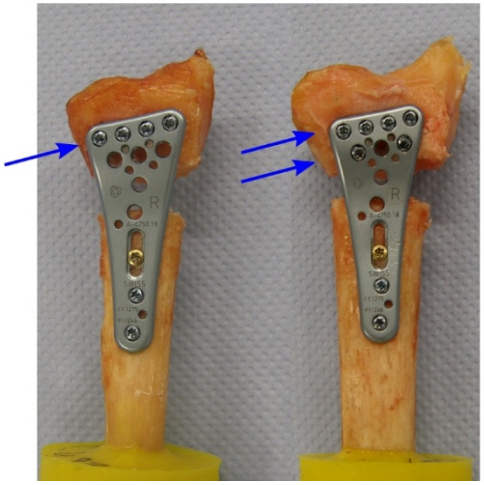
PREOPERATIVE SURGICAL INFORMATION, BY MEANS OF THE FINITE ELEMENT METHOD , FOR DIFFERENT OSTEOSYNTHESIS SYSTEMS

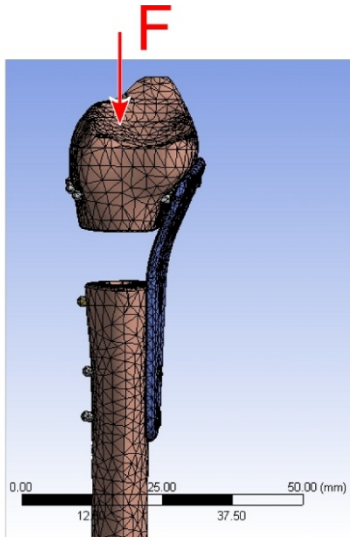
http://osteoform-campus.adapting.com/

Objective of practical course:

To learn about capability of numerical simulation in presurgical planning and clinical research

4 Units developed

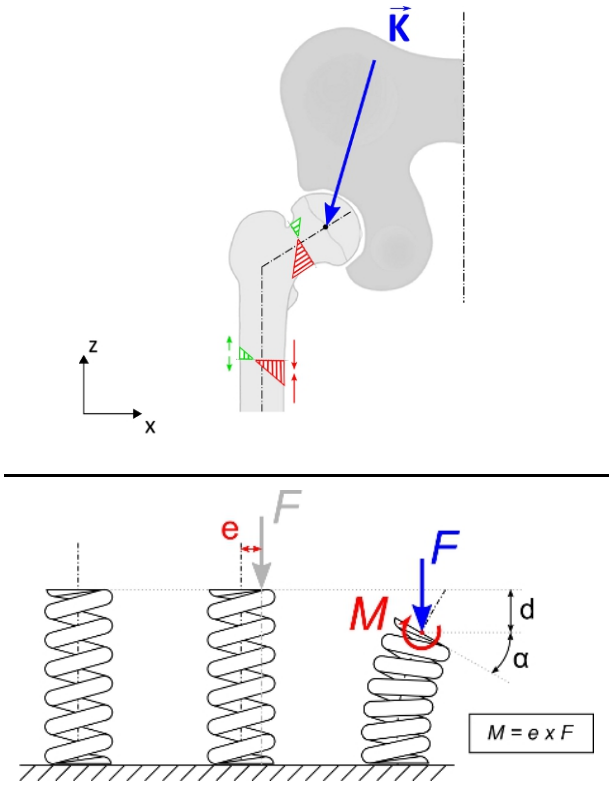




2.- Practical contents

Unit 1: Biomechanical Prerequisites

- loads in human body (external, internal)
- balance of forces / moments
- constitutive behavior
- clinical measures (structural stiffness, fracture gap movement)
- introduction to simulation / FEM

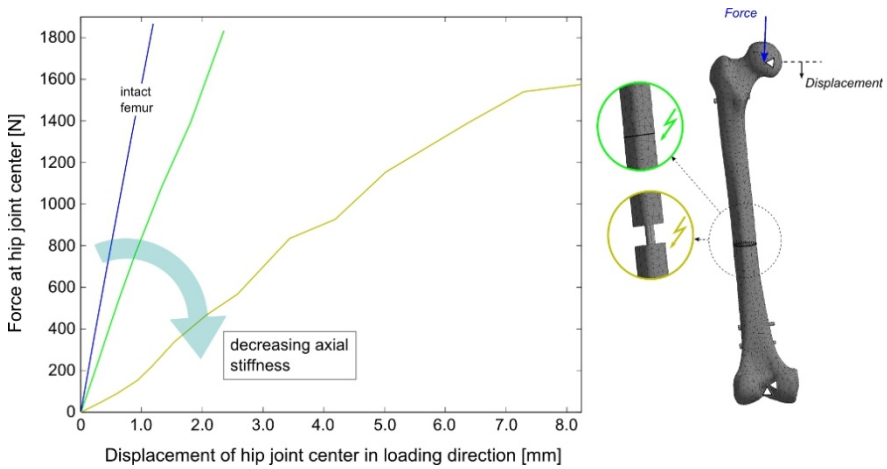


⇒**ensure basic knowledge of common mechanical parameters**

2.- Practical contents

Unit 2: IM Nailing of Diaphyseal Femur Fractures

- study influence of fracture type and fracture location on stability of treatment
- check implant specific parameters (geometry, material)
- investigate mechanical differences of various application options



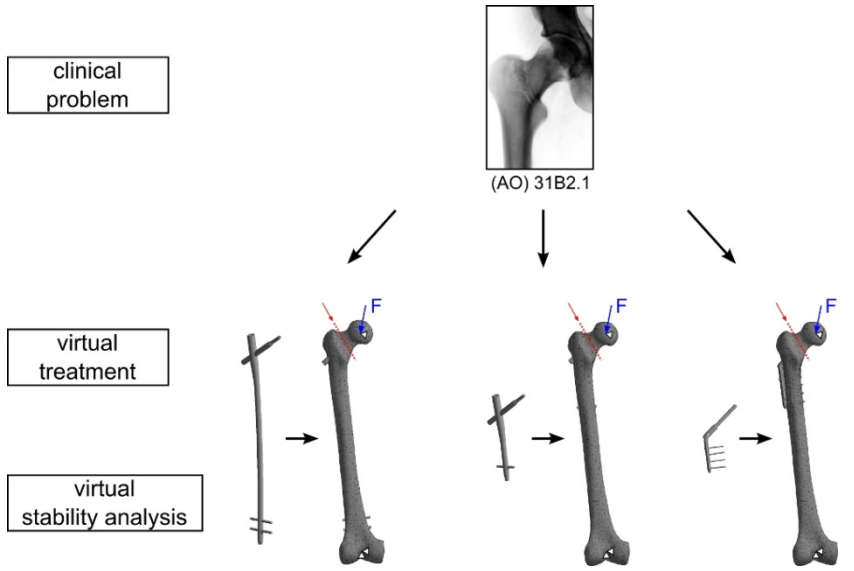
⇒study biomechanical aspects of IM nailing with precalculated FE models

2.- Practical contents

Unit 3: Osteosynthesis of Proximal Femur Fractures

- evaluation of different osteosynthesis techniques using FEA in combination with different fracture situations

- analyze mechanical suitability of various treatment options (structural stiffness, implant loading)

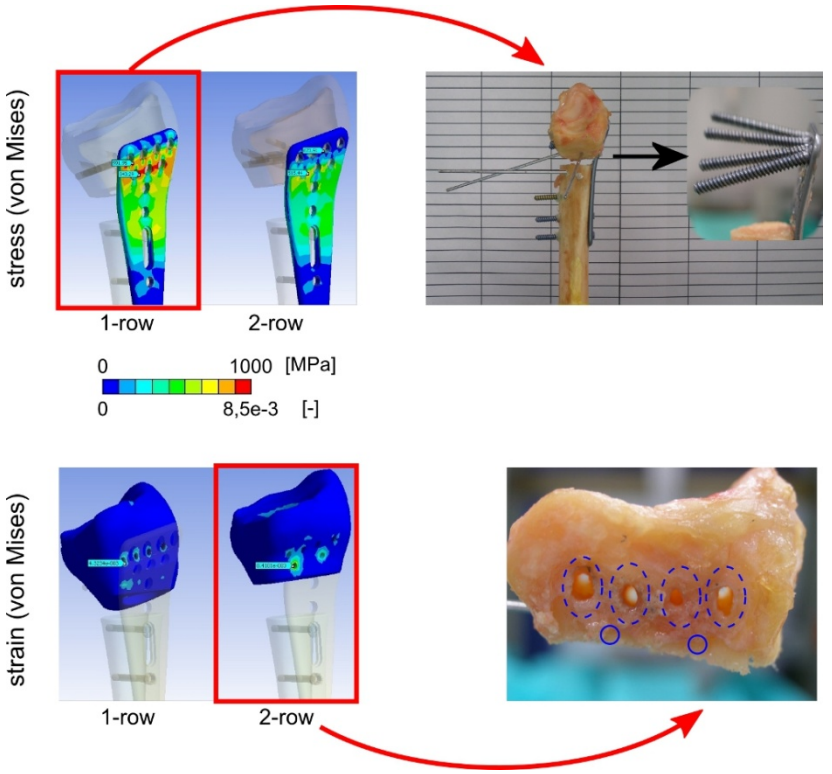


⇒**demonstrate benefits and shortcomings of FEA during presurgical planning**

2.- Practical contents

Unit 4: Plate Fixation of Distal Radius Fractures

- investigate clinical observations with the help of simulation models
- study mechanisms which lead to failure of a angle-fixation or screw loosening
- sensitivity to screw placement



⇒**demonstrate incorporation of numerical simulation in clinical research**

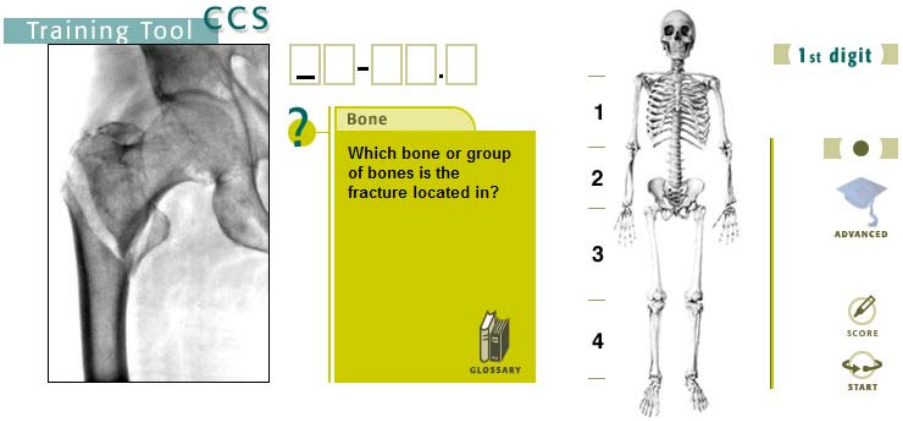
3.- Training tool

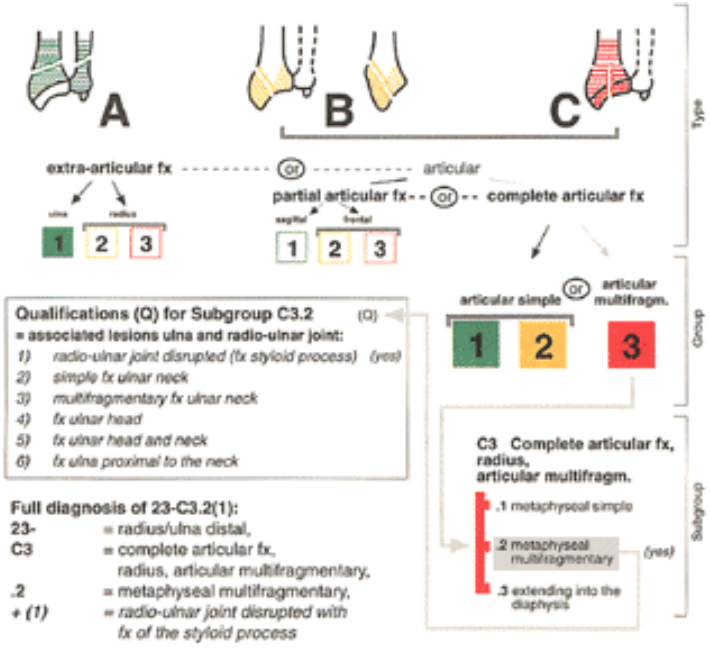
FRACTURE CLASSIFICATION GAME

Objective of practical course:

Provide several cases to help students improve their fracture diagnosing skills (3 levels of difficulty)

Estructure :





http://www.fundacionteknon.com/muller/

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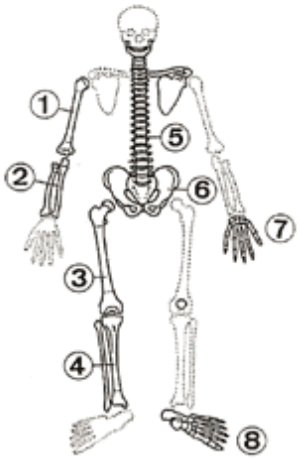
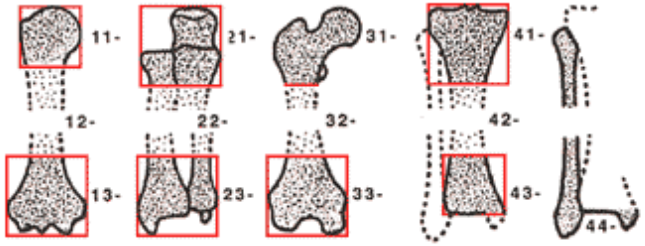
3.- Training tool

Includes Glossaries to help the student



Each bone or group of bones is designated by a number from 1 to 8: Humerus (1), Radius/Ulna (2), Femur (3), Tibia/Fibula (4), Spine (5), Pelvis (6), Hand (7), Foot (8). All the remaining bones are classified under 9: Patella (91.1), Clavicle (91.2), Scapula (91.3), Mandible (92), Facial Bones and Skull (93).



Segments of long bones.
Each long bone has 3 segments: the proximal, the diaphyseal, and the distal segment. The malleolar segment is an exception and is classified as the 4th segment of the tibia/fibula (44-).

Specific Terms for the Tibia/Fibula Diaphysis Segment

DEFINITIONS

■ **Simple fracture**
A single circumferential disruption of the diaphysis. Small cortical fragments which represent less than 10% of the circumference are ignored since they are of no significance for the treatment or prognosis.

Spiral: a result of torsion.
Oblique: the angle of the fracture line with the perpendicular to the long axis of the bone is equal to or greater than 30º.
Transverse: the angle of the fracture line with the perpendicular to the long axis of the bone is less than 30º. Usually small wedge of less than 10% of the circumference can be detected.

Specific Terms for the Humerus Distal Segment

DEFINITIONS

■ **Extra-articular fractures**
Extra-articular (or supracondylar) fractures do not involve the joint surface, although they may be intra-capsular. They include apophyseal and metaphyseal fractures.

Apophyseal avulsion: apophyseal avulsion of an epicondyle.
Metaphyseal simple: single circumferential disruption of the metaphysis.
Metaphyseal multifragmentary: a fracture without contact between the main fragments after reduction.

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Thank you for your attention

Cuidamos tu calidad de vida

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