BIOMECHANICS OF THE KNEE JOINT

THESIS

SUBMITTED IN PARTIAL FULFILLMENT
FOR THE DEGREE OF MASTERSHIP IN
(Orthopaedic Surgery)

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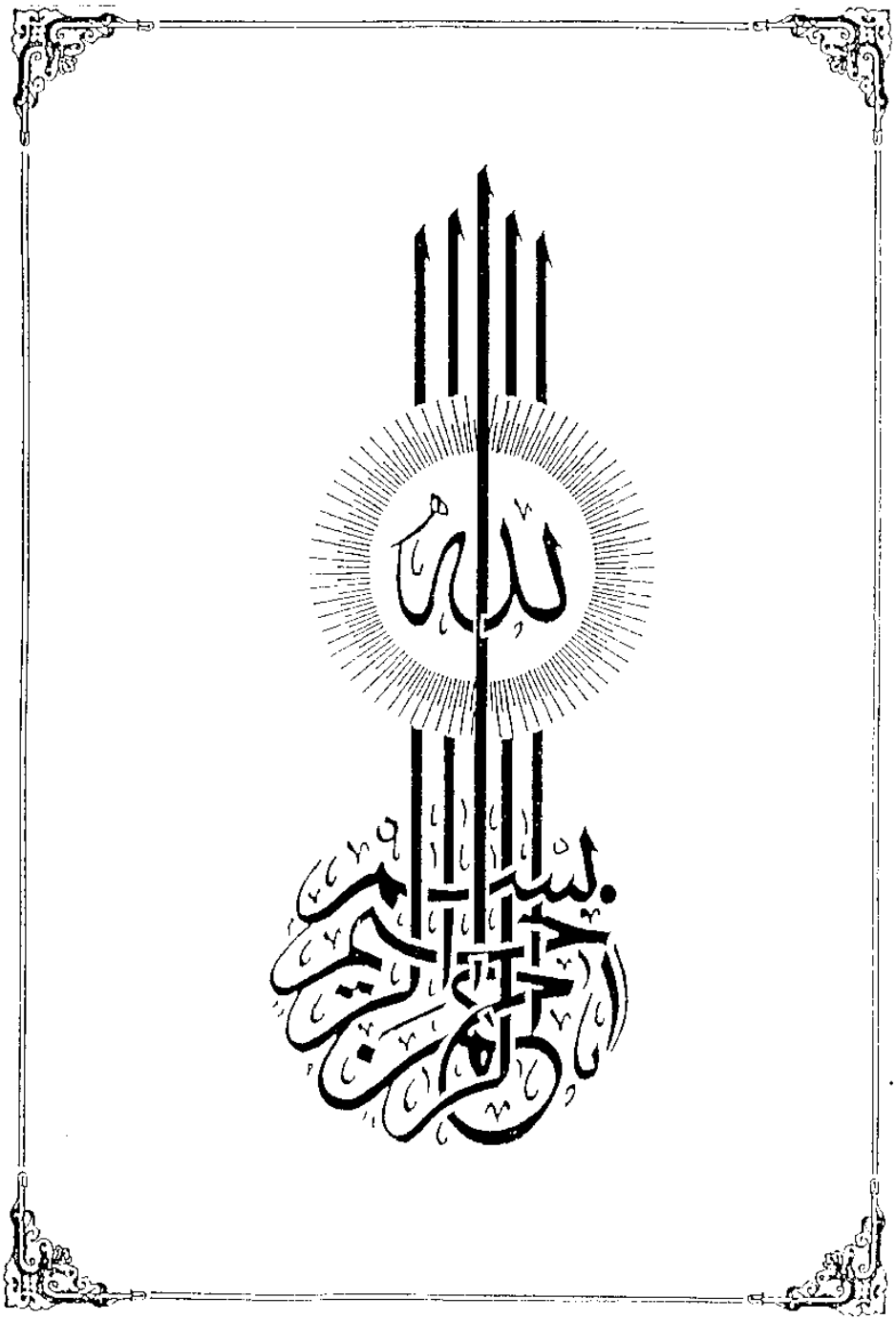
بسم الله الرحمن الرحيم

﴿ وفى أنفسكم أفلا تبصرون ﴾

﴿ صدق الله العظيم ﴾



TO :

MY PARENTS

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C O N T E N T S

PHILOSOPHY OF THE THESIS

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The science of Biochemistry is a chemical view towards the living body, composition and reactions.

The same meaning can be considered by the science which can be called Biophysics, through which one can see the living bodies by his physical eye. Biophysical view may be Bioelectrical, Biomagnetical, Biothermal, . . . or Biomechanical.

So, the science of Biomechanics is the science which deals with the living body as a machine controlled by the vital energy.

In this thesis, I try to introduce the biomechanics of one of the most complicated joints in the body,the Knee joint. I tried to simplify the way of theintroduction, neglecting the details of the rough mathematical and mechanical laws without a dificiency in the data itself.

The aim of this study is to translate the Knee joint into a machine (design, static states and dynamic conditions), telescoping on the machanical stresses may influence this machine affecting the articular surfaces and the proper surgical interferenee to reduce the stresses applied on it.

GENERAL BIOMECHANICS OF THE LOCOMOTOR SYSTEM

1. Abstract.

The following summarises the previous memory and formulae, the knowledge of which is essential to study the subject of Biomechanics.

1.1. Geometry: (Abd-el-Rahman et al. 1979)

a- In a right angled triangle. (Fig. 1)

$$c^2 = a^2 + b^2.$$

b- In an obtuse angled triangle (Fig. 2)

$$c^2 = a^2 + b^2 + 2bd.$$

c- In an acute angled triangle. (Fig. 3)

$$c^2 = a^2 + b^2 - 2bd.$$

1.2. Trigonometry:

a- In a right angled triangle. (Fig. 4)

$$b/c = \sin 0$$
$$a/c = \cos 0$$
$$b/a = \sin 0 / \cos 0 = \tan 0$$
$$c/b = 1/\sin 0 = \text{cosec } 0$$
$$c/a = 1/\cos 0 = \sec 0$$
$$a/b = \text{Cos } 0 / \sin 0 = 1/\tan 0 = \cot 0$$

b- In any triangle. (Fig. 5)

$$a/\sin.A = b/\sin.B = C / \sin.C$$

1.3. The Three Dimensional World:

We live in a three dimensional world, and the position of any particle must be determined according to the three axes perpendicular to one another (x, y and z). This frame is known as the "Cartesian Coordinates". (Fig. 6).

The body is divided by the sagittal plane (x-z), coronal plane (y-z) and transverse plane (x-y). (Fig. 7).

1.4. Scalars and Vectors:

Scalar quantities are those which have magnitude only, such as mass, volume,time , etc.

Vector quantities are those which determined not only by their magnitude but also we need to know their directions, such as force, velocity, acceleration etc. The vectors are represented graphically as straight lines of lengths proportional to their magnitude and their directions are indicated by the angles they make with the cartesian axis. (Fig. 8)

The vector may be composed into two or more vectors whose sum equals to the vector (Fig. 9), where increase in the magnitude of one means a proportional decrease in the magnitude of the other, and their directions are also taken into account. (Frankel, 1971).

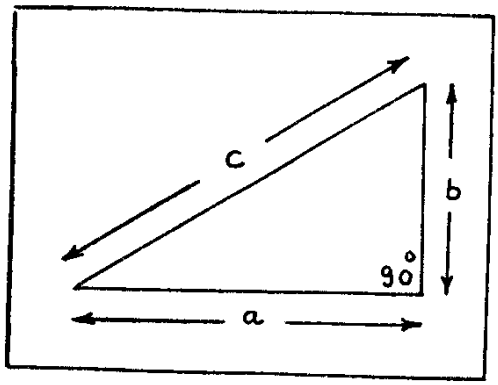

Fig. 1:
$c^2 = a^2 + b^2$

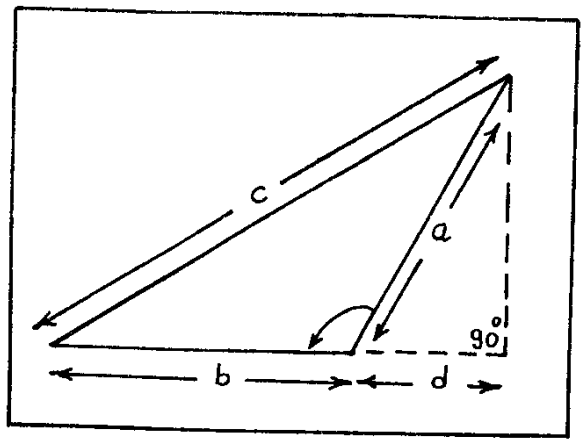

Fig. 2:
$c^2 = a^2 + b^2 + 2bd$

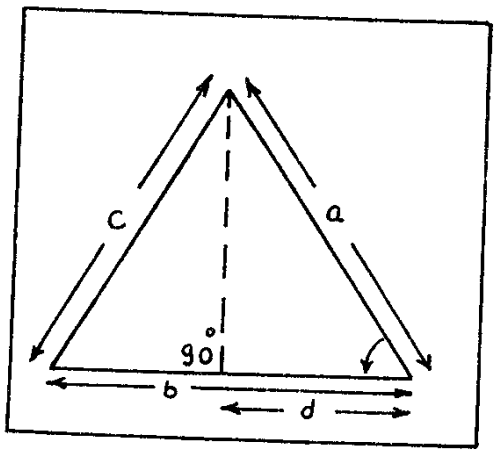

Fig. 3:
$c^2 = a^2 + b^2 - 2bd$

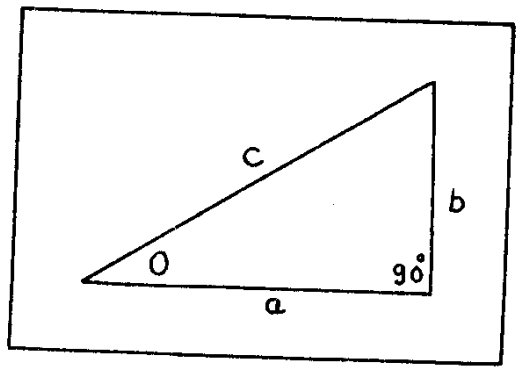

Fig. 4:
Trigonometry of right angled triangle.

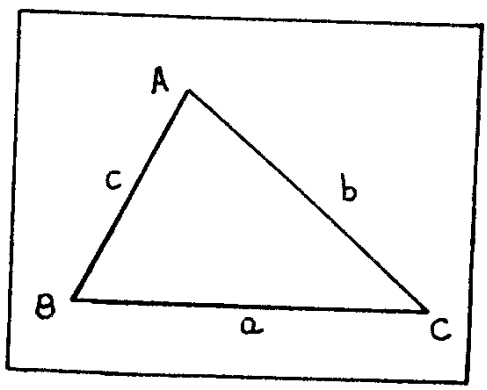

Fig. 5:
Trigonometry of any triangle.

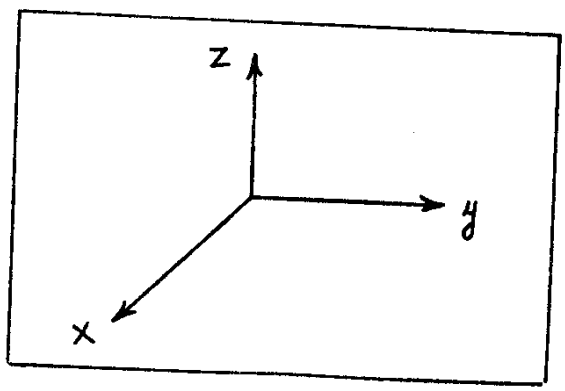

Fig. 6:
Cartesian Coordinates.