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Research Article (Open Access)

COMPUTATIONAL SIMULATIONS-OPTIMIZATION OF UHMWPE KNEE ARTHROPLASTY ABRASIVE WEAR. SECOND PART

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ABSTRACT
This second part shows the most important results got in this TKA (Total knee arthroplasty) research line. Abrasive linear-wear erosion model simulations for TKA implants are developed/shown. Material selected, widely used in TKA Orthopedic, Rehabilitation, and Sports Surgery, is ultra high molecular weight polyethylene (UHMWPE). The main mathematical model applied is the classical/modified Archard's model. For TKA, it is formulated/developed in Integer and one Author's Integral Formulation. Selected literature experimental data, both *in vitro* and *in vivo*, is implemented for programming software and 3D imaging-processing. Computational simulations software in 3D are made with Graphical Optimization and Interior Optimization methods. Results for Linear Wear, both numerical and 3D simulations image-processing graphs, with numerical dataset inset, are presented. Biomechanics and Biotribology/Biomaterials applications for knee artificial replacements are briefed.

Keywords: *TKA (Total knee arthroplasty), 3D Simulations, Optimization, Linear Wear, Mathematical Model, Load, Sliding Distance, PE (Polyethylene)*

INTRODUCTION
The biomechanics and TKA is rather complicated by a number of unlimited reasons, Sketch 1. First, its most important function is the total weight support as the third biomechanical system of the anatomy, [books, 1,2,5,6,10, Dawin, Schakdach, Sculco, Tokgoz, Affatato], (first system in head-neck, second is thorax-abdomen-spine-hip, and third is knee-feet). That is, the legs and the feet. The second reason is the biodynamics of walk and movement that requires, while walking and moving, balance and support for the weight/gravity center of the total body. The third, and not the less, is that the articulations of knee, ankle, and feet constitute an essential biomechanical system for walk and basic life movements. Complementary reasons are the biomedical cartilage and bone aging-degeneration and forced movements injuries probabilities. All of them are mutually synergic-interacting and constitute a rather complicated biomechanical system. In other words, if the knee joint cartilage degenerates soon, causes a bone damage, this creates instability and balance loss at knee, and in consequence the movement dynamics is limited or impeded. Just remind that histologically cartilage cells cannot regenerate like the elastic skin fibers (up to current science-research, it is tried to resolve the problem with stem cells, but that matter is out of this research scope). That is, any individual/patient is born to get a fixed number of skin-organs elastic fibers and cartilage cells when his growth-development is completed. Furthermore, the second biomechanical system, in particular the hip articulation, can be damaged by forced/biased movements and biomechanical abnormal load distributions at knee joint. In general, all the articulations constitute a system whose parts, as said, interact one another. That is, if knee joint fails or misfunctions, the hip articulation could get a biotribological-pathological wear. And what is more, if the hip articulation fails in that chain, the lumbar vertebras biodynamics and normal spine balance can be changed, and so on. All this briefing gives a

basic idea of the complications that may occur in surgical-traumatological pathology and biomechanical diseases at knee articulation.
On the other hand and also, knee injuries, joint traumatological pathologies, and concomitant reumathological or infection diseases, creates a high medical-industrial demand. Then, the economic cost, [books, 1-8, Dawin, Schakdach, Sculco, Munzinger, Tokgoz, Kumar, Kretzer], is rather high for both public, private, or mixed health services at many countries. Therefore, TKA investigation for reliability and high-durability of new TKA prostheses is among the current priorities in biomedical industry. Biomathematical studies with optimization modelling take the task for wear prediction and durability of TKA prostheses. An additional question is the number of model variants and large amount of different testing laboratories. This implies the requirement for standards methods both experimental and theoretical-modelling. In this contribution, the most usual standards, ISO-related, [books, 1-10, Dawin, Schakdach, Sculco, Munzinger, Tokgoz, Kumar, Kretzer, D'Lima, Affatato], are prioritized for the objectives of the study.
The mathematical equations and models used are for Linear Abrasive Wear (in mm) without Creep and Lubrication Factors [articles, 4, Soni] at this stage. For Volume Wear (in mm^3), [Algorithm (3)], the Finite Elements Method is widely applied [books, 1-10, Dawin, Schakdach, Sculco, Munzinger, Tokgoz, Kumar, Kretzer, D'Lima, Affatato], [articles, 1-12, Triwardono, Abdelgaied, Pecora, Soni, Innocenti, De Ruiter, Kumar, Fisher, Fuchs, Koh, Stukenborg-Colsman, Uvehammer].
In summary, after these fundamental concepts introduction, the study is focused on biomechanical models computational intelligence-optimization and practical numerical and image processing results for mainly ultra high molecular weight weight polyethylene (UHMWPE).

The Biomechanical Concepts of Knee Articulation

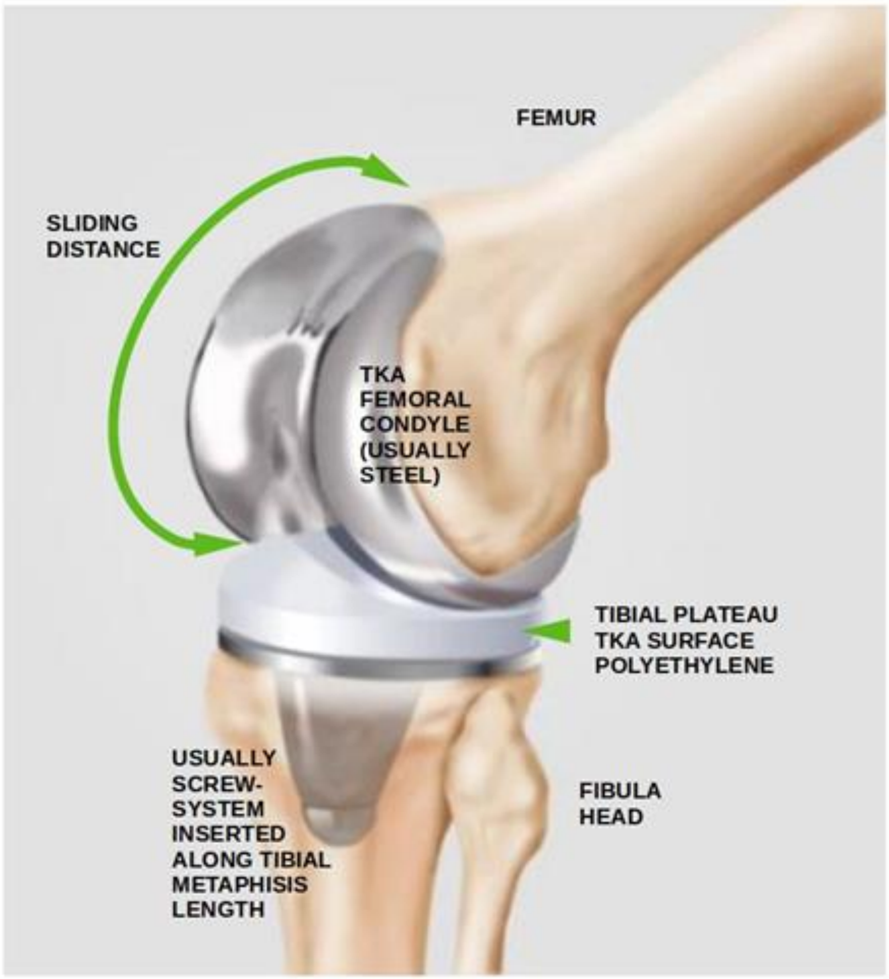
At Sketch 1, it is shown the basic knee biomechanical system after TKA implantation (parts and movement concepts). For normal life, the knee articulation supports biomaterials stress, loads, flexions, extensions, torsions, rotations and more complicated movements. Furthermore, it is not exclusively the articulation, ligaments, e. g., cruciate ones, and external, internal, lateral ligaments form a rather complicated articulated biosystem. This makes the incidence/prevalence of knee biomechanical pathology rather frequent. The sport activity increases these risks of injuries, and in that field, the knee articulation supports loads and extreme movements continuously, [books, 1,2,5,6,10, Dawin, Schakdach, Sculco, Tokgoz, Affatato] . The sport-medicine specialization for knee is a branch with deep knowledge and applications.

Biomechanical Knee Implants

The most common TKA prostheses resemble the femur natural condyles, that is, they are bicompartmental. However, monocompartmental TKA prostheses have also been developed. For the standard TKA, the number of variants, related to biomaterials, biomechanical design, and forces-distribution designs are rather high. This makes complicated the laboratory testing, both *in vitro* and *in vivo*. What is more, the wear, creep, lubrication and other biomechanical parameters differ substantially in literature for the amount of methods, techniques, and laboratory apparatus, ISO variants are large. All in all, the TKA study constitutes a difficult biomechanical and biopathological field actually, [books, 1,2,5,6,10, Dawin, Schakdach, Sculco, Tokgoz, Affatato], [articles, 1-6, Triwardono, Abdelgaied, Pecora, Soni, Innocenti, De Ruiter].

Objectives of Study

The objectives of the study are primary and secondary ones. The primary objective is to develop computational intelligence software efficacious and useful for accurate simulations. That is in order to presents practical data for TKA research. The second main objective is to demonstrate how simulations and optimization of TKA can be useful for the previous intention. Secondary, applications, algorithmic developments, and mathematical proofs are shown. At this stage, Lubrication Factors for the models were not set [books 1-6, Dawin, Schakdach, Munzinger, Sculco, Kumar, Tokgoz], [articles, 1-8, Triwardono, Abdelgaied, Pecora, Soni, Innocenti, De Ruiter, Kumar, Fisher].



Sketch 1. [Google free images, Dr Albrecht, knee and cartilague specialist], modified and drawn by Francisco Casesnoves. The sketch is completed with main parts of TKA. Inset, the most important anatomical parts are marked. Note that the femur condyles are made in steel, and the tibial plateau is polyethylene.

In brief, the article presents Computational Intelligence simulations and Graphical Optimization for PE TKA abrasive. Results match standard laboratory measurements and literature publications. New software for mathematical models was originally created and Biomechanical-Biotribology applications are briefed .

MATERIALS AND METHODS

Primary approximations are to consider exclusively the TKA wear, and exclude Creep and Lubrication Factors. Therefore, the calculations of this study constitute the wear optimization-determination to get wear durability predictions of the TKA implant.

The Model algorithm(s)

The basic algorithm-model from [books, 1, 9,10] [articles, 1,4], applied and analyzed reads,

The Archard's Model applied on TKA,

$$L_{wear} = K_{wear} \sum_{j=1}^{N} \left[\sum_{i=1}^{n} p_i \, |\overrightarrow{v_i}| \, \triangle t_i \right]_j ;$$

(1)

where,

L_{wear} : Linear abrasive wear (mm) .
K_{wear} : Wear constant, standard (mm^3 / N mm) .
p_i : Pressure (N / mm^2) .
v_i : Sliding discrete Velocity for discrete time increment (mm / s) .
Δt_i : Discrete time interval (s) .
i, j : Summatory indexes .

Hence, taking limits for getting an integral form,

The Archard's Model applied on TKA, integral form,

$$L_{wear} = K_{wear} \sum_{j=1}^{N} \left[\int_{0}^{t_i} p(t) \, |\overrightarrow{v}(t)| \, dt \right]_j ;$$

(2)

where,

L_{wear} : Linear abrasive wear (mm) .
K_{wear} : Wear constant, standard (mm^3 / N mm) .
p(t) : Instantaneous pressure (N / mm^2) . Function of time.
v(t) : Instantaneous sliding velocity for integral. Function of time (mm / s) .
dt : Differential of time during i-interval (s) .
j ; Summatory index .

Proof

$$\text{The Archard's Model applied on TKA, integral form proof,}$$

$$For\ one\ cycle,$$

$$L_{w1} = K_w p S;$$

$$where\ S\ is\ sliding\ distance,\ hence$$

$$L_{w1} = K_w p\, v\, t;$$

$$therefore, provided\ \vec{v}\ constant\ and\ taking\ derivatives\ for\ time\ variable\ ,$$

$$\frac{dL_{w1}}{dt} = K_w p\, v\ ;\ or,$$

$$dL_{w1} = K_w p\, v\, dt,\ integrating,$$

$$\int_0^t dL_{w1} =$$
$$K_w \int_0^t p\, v\, dt,\ supposing\ instantaneous\ pressure\ and\ sliding\ velocity\ during\ one\ cycle\ ,$$

$$Therefore, taking\ N\ cycles,\ and\ integrating,$$

$$L_{wear} = K_{wear} \sum_{j=1}^{N} \left[\int_0^{t_i} p\, |\vec{v}|\, dt \right]_j ;$$

[Casesnoves Bioengineering Laboratory Algorithm 3114]

Computational intelligence Dataset Software

Dataset selected from literature is set in wide ranges at programs, because the commercial materials, TKA sizes, and Algorithm constants applied differ along authors, laboratories, testing apparatus, testing temperature, etc. Therefore, the practical objective of the simulations-optimizations is to provide with large scale range that can be used to predict durability for all of those variants. Software is based on hip wear previous Author's contributions [hip references, 1,2,18,24,38,39,40] .

Benchmark polyethylene model

The size used for simulations was the most standard one, [1]. That is, 78.2 x 44.2 the total coronal dimension, from that size contact surface was approximated-calculated. That size is according to ISO.

Sliding Distance (SD)

Sliding distance recommended by ISO is about 80 mm. However, it was set 60 mm, [books, 9].

Load

This is the most common assumed magnitude by majority of investigations [books 1-6], [articles 1-14]. That is, [2000, 2600] N interval. Here it is taken a maximum of 2300 N in most programs.

Standard Unit System

The standard TKA erosion Archard's model units used in literature, most times, are mm^3 of eroded material or mm depth of erosion along contact surface. It is not an objective of this study to discuss the optimal unit system. Instead, the image-processing and numerical data is expressed in both ways to bring for user the choice to compare dataset appropriately, [books, 1-10]. The physics dimension equations for Linear and Volume Abrasive Wear are explained in (3).

Standard literature units for Archard's model dimension equations,
For example,

Erosion in mm depth,

$$L_w\,(mm\,depth) = K_w\,(\frac{mm^3}{N\,mm})\,Pressure\,(\frac{N}{mm^2})\,Sliding\,Distance\,(mm);$$
$$as\,a\,result\,,L_w\,is\,in\,mm,$$

Erosion in mm^3 eroded material volume,

$$V_w\,(mm^3 volume) = K_w(\frac{mm^3}{N\,mm})\,PressureForce(\,N\,)Sliding\,Distance(mm);$$
$$as\,a\,result\,,V_w\,is\,in\,mm^3;$$

(3)

The first one is the primary method applied in this paper. That is Abrasive Linear Wear. The second dimension equation for volume wear usually has the pressure expressed in Pascal units. Then, it is: [(N/mm^2 (Pascals)) x (implant contact area (mm^2)] . As a result, equal to N , as it is at Pressure Force in (3). Calculating the K dimensions, the dimension of longitude L (in mm) gives L^3 . That is, the V_w result is given in mm^3 .

Table 1: Selected Dataset used for simulations and optimization software. Disclaimer: some variants were applied for trial programs and images.

SELECTED DATASET USED FOR SIMULATIONS			
PARAMETER AND UNITS	**INTERVAL SOFTWARE IMPLEMENTED**	**REFERENCE**	**COMMENTS**
LOAD (N)	[2000,2300-2600]	[books, 1-6] [articles, 1-7]	Standard magnitude, usually agreed by most authors.
SLIDING DISTANCE (mm)	60	[books, 9]	ISO Standard, it varies according to studies.
K_W (mm^3 / (N x mm)	[2.20×10^{-7} , 10^{-6}]	[books, 1-6]	The constant K_W has different values in literature. It is implemented an interval that comprises most published magnitudes.
LOAD SURFACE (mm^2)	[1000 , 2300-2600]	[books, 1-10]	This varies significantly according to several publications.

CYCLES NUMBER (in M (millions)) notation standard: Mc	[1 , 5] image-processing is shown for [1 , 5] Mc	[books, 1-10] [articles, 1-10]	It is presented, usually, dataset from 1 M to 5 M. Most authors show predictions and calculation testing for 1-5 Mc.
IMPLEMENTED: K_W (mm^3 / (N x mm)) x 10^{-3} according to (3)	[2.20×10^{-10} , 10^{-9}] See Figures 1-7	[books, 1-10] interval taken from [books, 1]	K_W has different magnitude according to authors, [books, 1], and some researchers propose values of K_W , for example [articles, 4] .

Table 2: Selected Dataset literature and Author sources for Table 1

DATASET REFERENCE SOURCES		
PARAMETER AND UNITS	**REFERENCES FOR SOFTWARE IMPLEMENTED**	**JUSTIFICATION**
LOAD (N)	[books, 1-6, 10], [articles, 1-8]	Standard magnitude, usually agreed by most authors
SLIDING DISTANCE (mm)	[books, 9]	ISO Standard, it varies, from
K_W (mm^3 / (N x mm)	[books, 1]	The [books, 1] range is applied for software.
LOAD SURFACE (mm^2)	[books, 1-10] [articles, 13, useful ISO standards]	[1] shows standard coronal size and loads.
CYCLES NUMBER (in M (millions)) notation standard: Mc	[articles, 1,4] [books, 1-10]	It is presented, usually, dataset from 1 M to 5 M
IMPLEMENTED: K_W (mm^3 / (N x mm)) x 10^{-3} according to (3)	From [books, 1] [2.20×10^{-7} , 10^{-6}]	It is considered sufficient confident interval that comprises almost all authors publications.

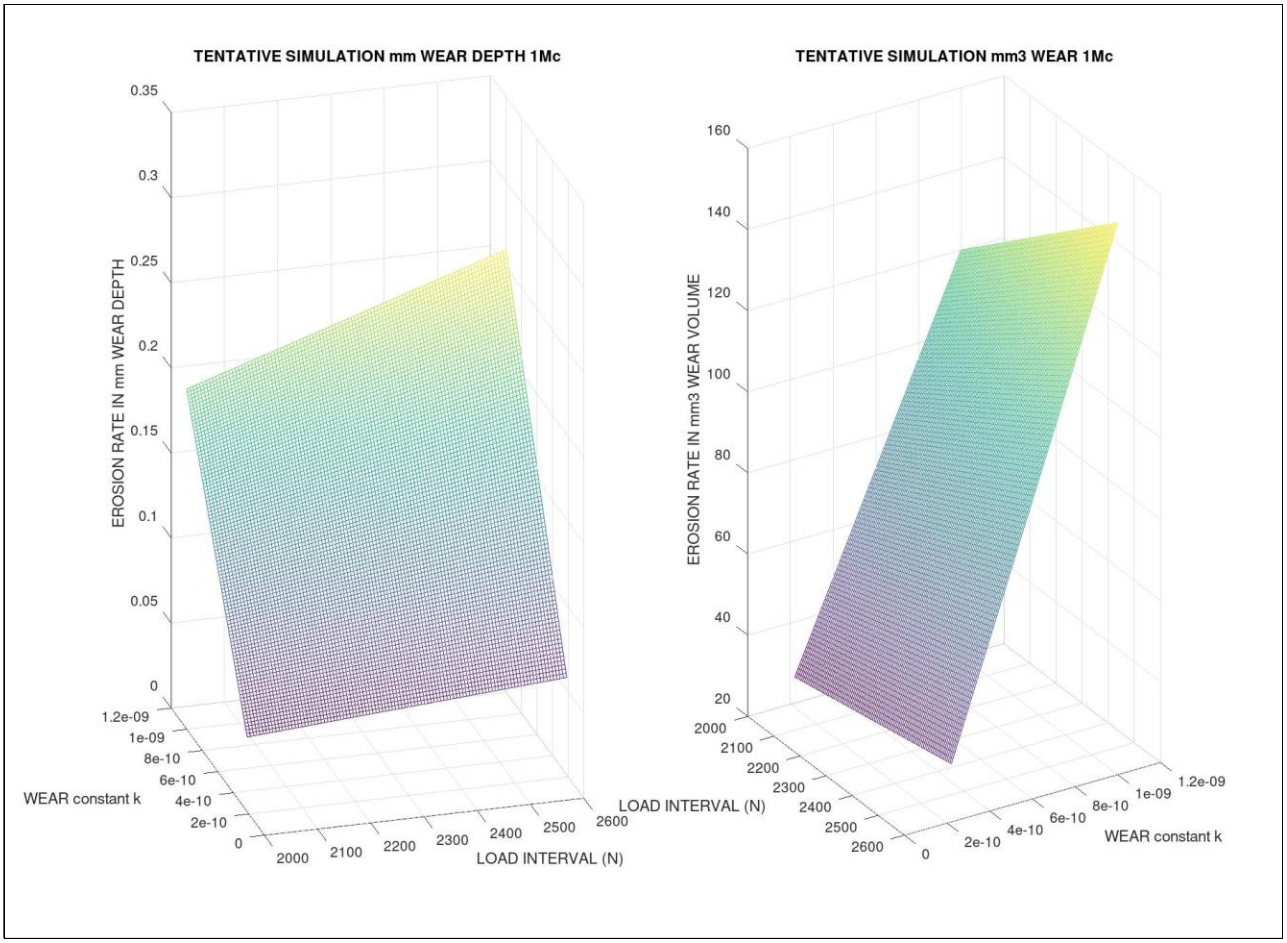
Computational intelligence Software

The software programming was developed mainly from previous experience in hip wear models [Author's hip wear references 1,2,18,24,38,39,40]. Systems used were Matlab and GNU-Octave. For programming algorithms 1-2, the difficulty was the matrices congruency and the loops for arrays.

RESULTS AND DISCUSSION

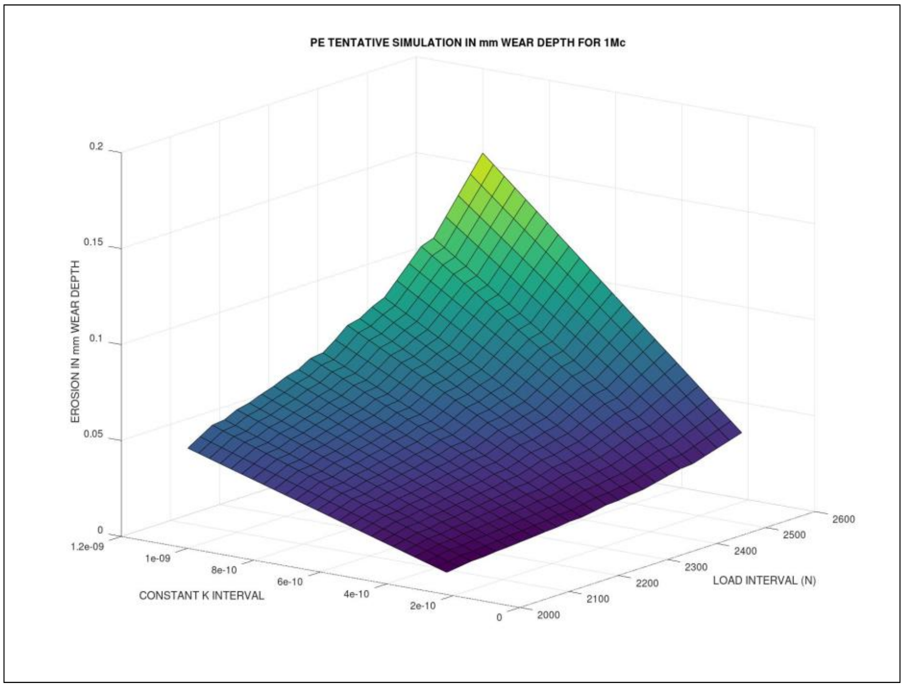
Results are divided into Graphical and Numerical. In this primary stage, the numerical ones were determined by Matlab graphical methods. The sharpness of 3D Graphical optimization is acceptable, and numerical figures match standard literature [books, 1-6], [articles, 1-8] .

Graphical Optimization Results

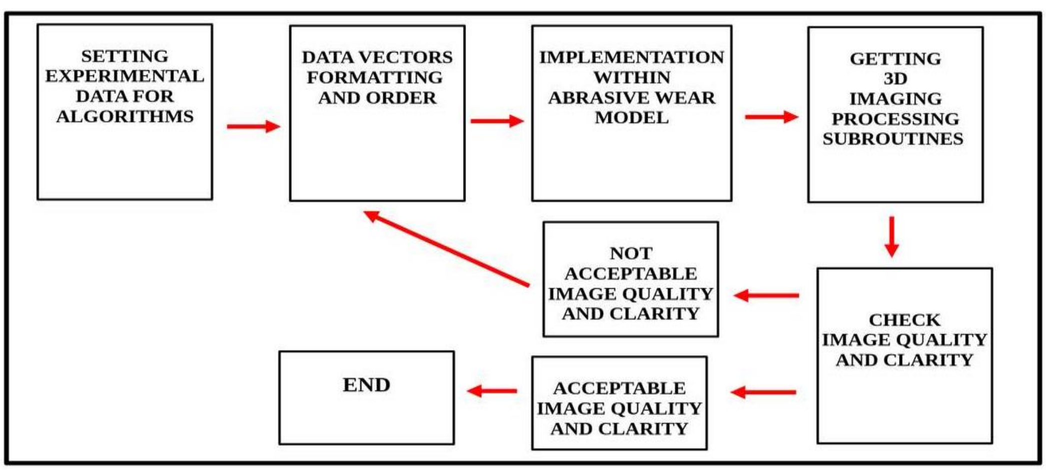


Graphical Optimization Method was developed during PhD Thesis and PhD Program publications, later in series of articles [Hip References, 1,2,18,24,38,39,40]. It essentialy consists in finding the global/local minima by sing the 3D imaging surfaces of the algorithm objective function plus two selected parameters. Here it is applied on the wear formulas (1,2) to determine the optimal minima or any desired values subject to particular constraints along the 3D surface. In Ilustrative Example 1, it can be seen the process initiation. Firstly some tentative programs are designed, after that, when checking the functionality of the software and the numerical congruence of the 3D graphs, the definite 3D Graphical Optimization Image-Processing charts are done with accurate parameters and interval. [Software-engineering simplified flow chart , Casesnoves Bioengineering laboratory 311-K].

Illustrative Example 1.- First trial tentative simulation with GNU-Octave. It is shown the basic model simulated in wear mm Depth (when the surface contact is implemented), and (right), the basic model simulated in wear mm^3 volume. Since it is tentative to show the computational method, magnitude-parameters model are not too much significative. Matlab programs are equivalent. [Casesnoves Bioengineering Laboratory Software 2025-k-1].



Illustrative Example 2. Continuing the software improvements, second trial tentative simulation with GNU-Octave. It is shown the basic model simulated in wear mm Linear Depth (when the surface contact is implemented, [1-8]). It is set 1 Mc. Since it is tentative to show the computational method, magnitude-parameters model are not too definite, but approach experimental laboratory literature, [books, 1-6], [articles, 1-8] Matlab programs are equivalent. [Casesnoves Bioengineering Laboratory Software 2025-k-2].



Software-engineering simplified flow chart. The programming structure for 3D graphical optimization is shown. There were applied several variants from this method.

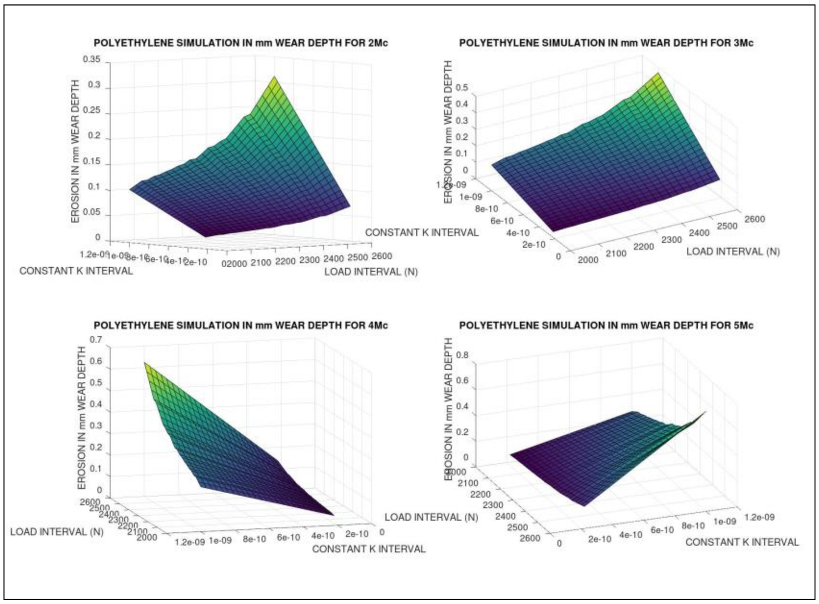


Figure 1: Multiple simulation with GNU-Octave for (2-5) Mc. It is shown the basic model simulated in wear mm Depth (when the surface contact is implemented, [books, 1-6], [articles, 1-8]). It shows the different wear magnitudes when Mc are increasing. The computational method, magnitude-parameters belong to Table 1. GNU-Octave imaging-processing is acceptable. This figure software is also developed in Matlab, Figure 2. [Casesnoves Bioengineering Laboratory Software 2025-k-3]

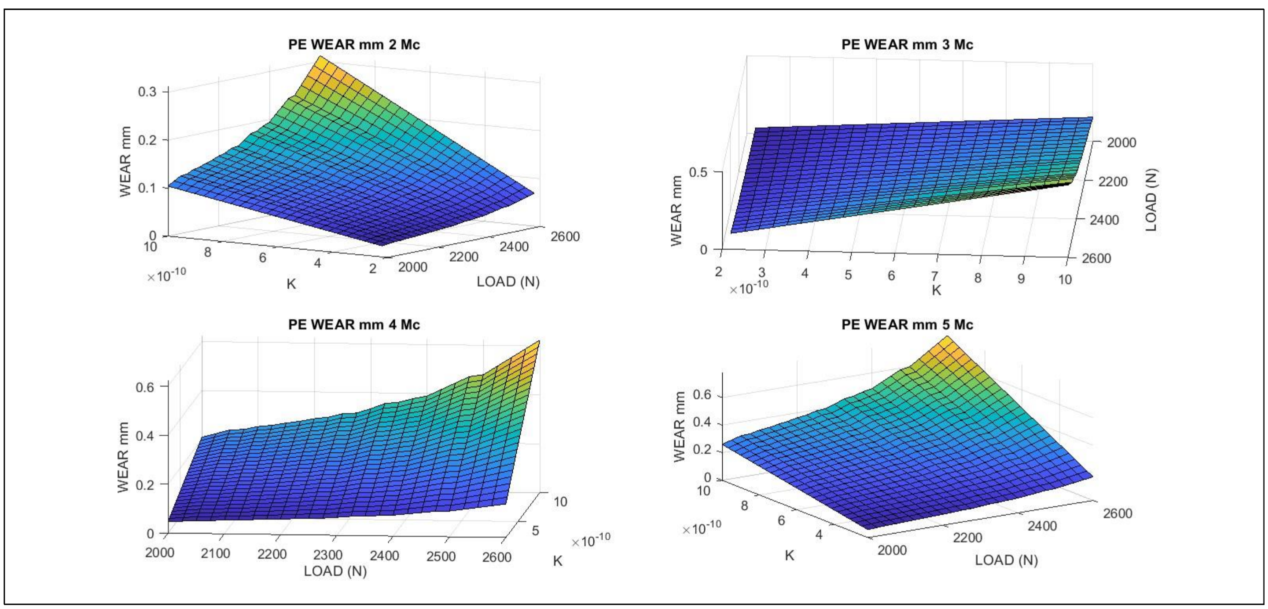


Figure 2.-Multiple simulation with Matlab, (2-5 Mc). It is shown the basic model simulated in wear mm Depth (when the surface area is implemented, [books, 1-6], [articles, 1-8]). It shows the different wear magnitudes when Mc are increasing. The computational method, magnitude-parameters belong to Tables 1-2. Note the K constant magnitude orders. Matlab image-processing is better than GNU-Octave in this case [Casesnoves Bioengineering Laboratory Software 2025-k-4].

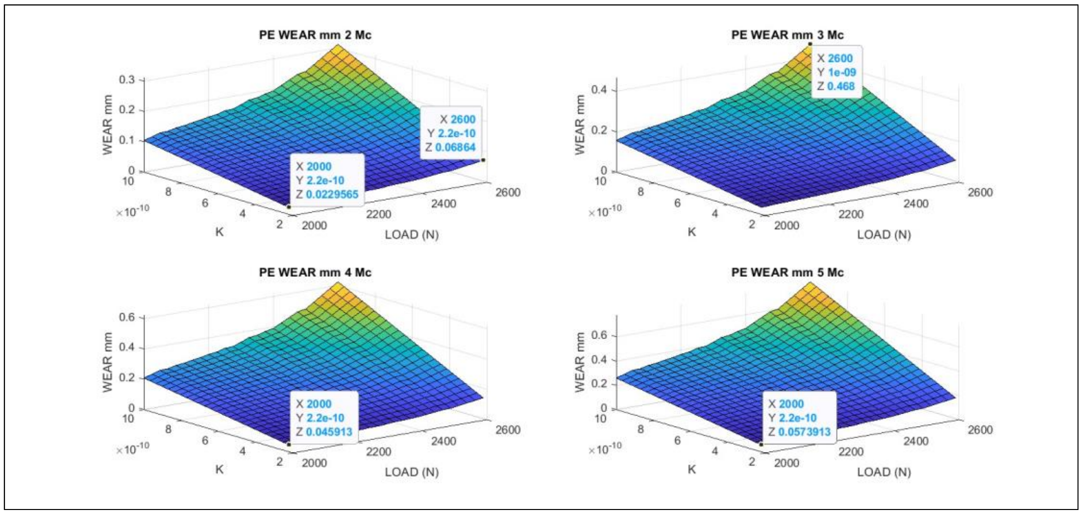


Figure 3. From Figure 2, a number of dataset values implemented at image. That is, a number of graphical data for multiple simulation with Matlab, (2-5 Mc). It is shown the basic model simulated in wear mm Depth (when the surface area is implemented). It shows the different wear magnitudes when Mc are increasing. The computational method, magnitude-parameters belong to Table 1. Matlab image-processing is better than GNU-Octave in this case. [Casesnoves Bioengineering Laboratory Software 2025-k-5]

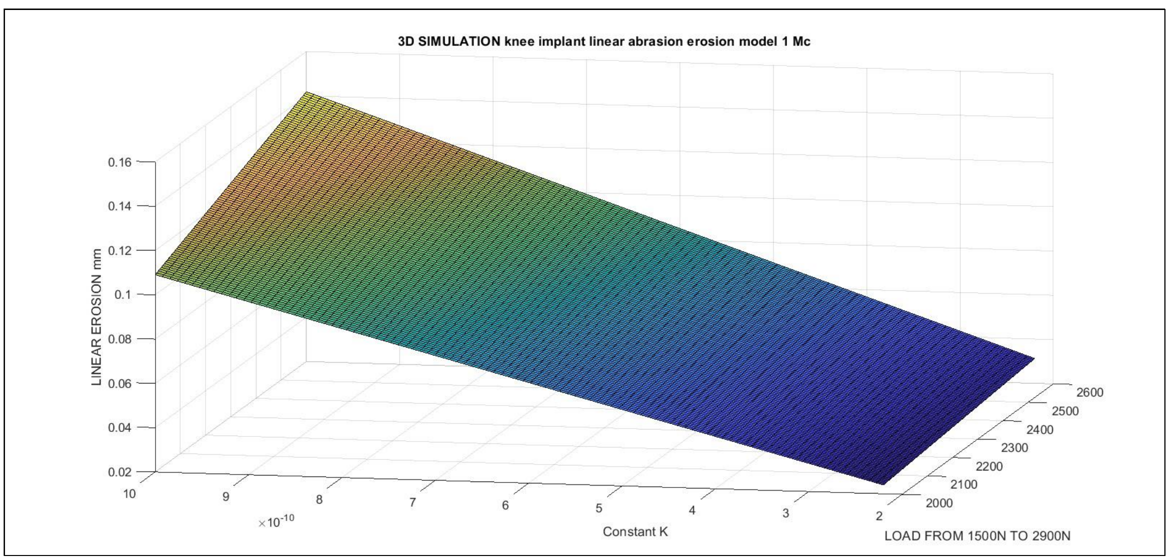


Figure 4. Matlab graphical simulation with different simpler program for 1 Mc . It is shown the basic model simulated in wear mm Depth. It shows the different wear magnitudes when Loads are increasing. The computational method, magnitude-parameters belong to Tables 1-2. Matlab image-processing is better than GNU-Octave in this case. [Casesnoves Bioengineering Laboratory Software 2025-k-6]

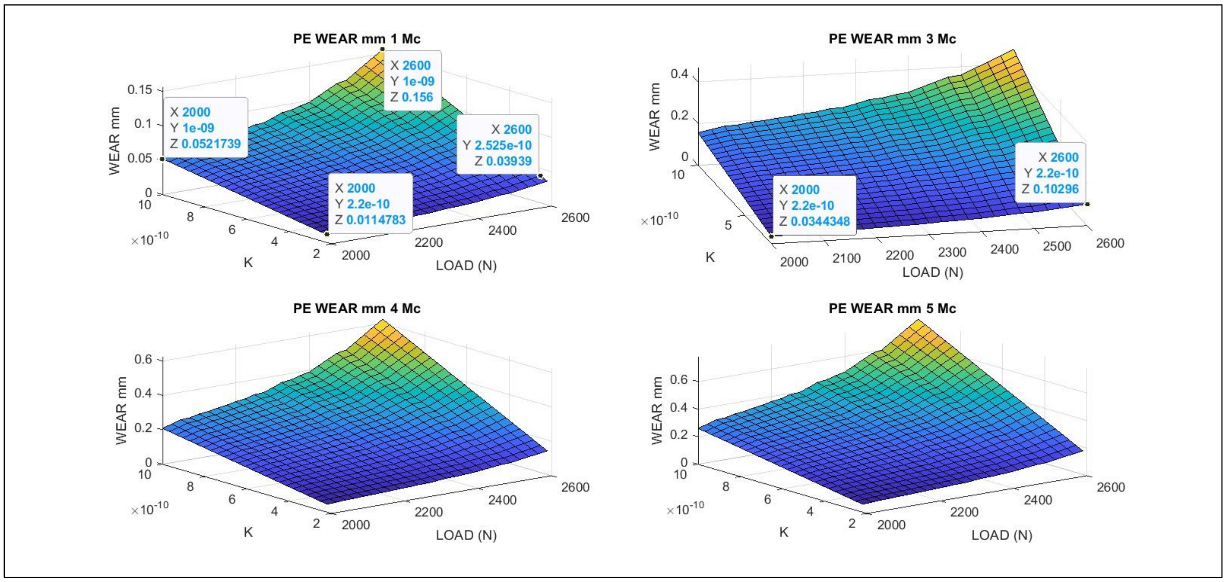


Figure 5.-For catching up the differences among 1 Mc and 3,4,5 Mc, it is shown a number of graphical data for multiple simulation with Matlab (dataset of 1 Mc included). Image-processing displays the different wear magnitudes when Mc are increasing. The computational method, magnitude-parameters belong to Table 1. Matlab image-processing is better than GNU-Octave in this case. [Casesnoves Bioengineering Laboratory Software 2025-k-7]

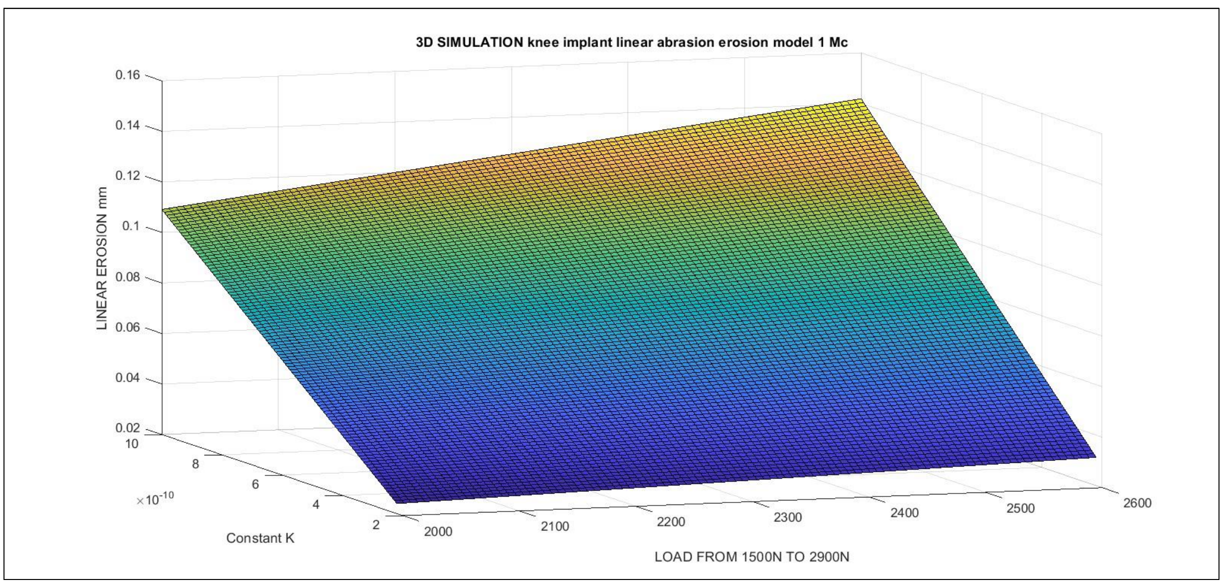


Figure 6. A different perspective for software of Figure 5. Matlab graphical simulation with different simpler program for 1 Mc . It is shown the basic model simulated in wear mm Depth. It shows the different wear magnitudes when Loads are increasing. The computational method, magnitude-parameters belong to Tables 1-2. Matlab image-processing is better than GNU-Octave in this case. [Casesnoves Bioengineering Laboratory Software 2025-k-8]

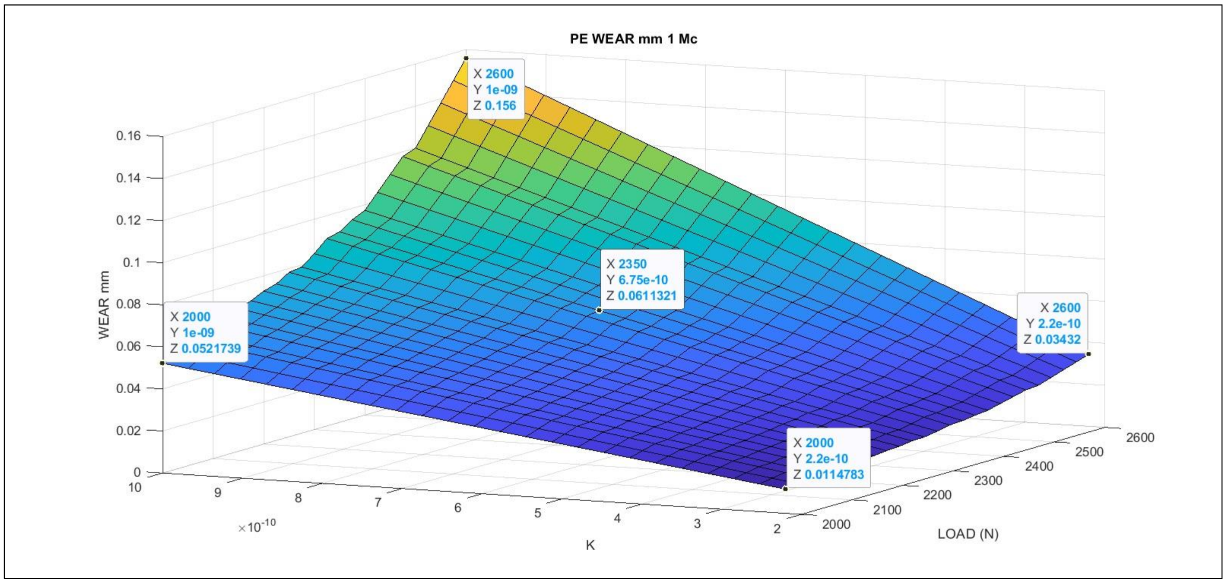


Figure 7. Setting the display of dataset for Figures 4,6 . Matlab graphical simulation with different simpler program for 1 Mc . Note the differences among maxima and minima, and one random interior value. It is shown the basic model simulated in wear mm Depth. It shows the different wear magnitudes when Loads are increasing. The computational method, magnitude-parameters belong to Tables 1-2. Matlab image-processing is better than GNU-Octave in this case. [Casesnoves Bioengineering Laboratory Software 2025-k-9]

Numerical Results

Table 3 show extracted from Graphical Optimization the numerical data results for linear wear. Figures and magnitude orders match the standard literature [refs].

Table 3.- Main numerical results in the study. Magnitudes match standard literature, [books, 1-6], [papers, 1-10].

NUMERICAL RESULTS						
Mc	**RESULTS MINIMA**			**RESULTS MAXIMA**		
	WEAR (mm)	**K_W (mm^3 / (N x mm)**	**LOAD (N)**	**WEAR (mm)**	**K_W (mm^3 / (N x mm)**	**LOAD (N)**
1 Mc	0.01	2.2×10^{-10}	2000	0.16	10^{-9}	2600
2 Mc	0.02	2.2×10^{-10}	2000	0.31	10^{-9}	2600
3 Mc	0.03	2.2×10^{-10}	2000	0.46	10^{-9}	2600
4 Mc	0.05	2.2×10^{-10}	2000	0.62	10^{-9}	2600
5 Mc	0.06	2.2×10^{-10}	2000	0.78	10^{-9}	2600
COMMENTS	Almost linear the wear magnitudes. Intermediate values at Figures.			Less linear. Intermediate values at Figures.		

Biomaterials and Biomechanics TKA applications briefing

Table 4 shows a concise concept of study applications. The most important is the erosion rate prediction in order to find approximations for implant durability. Several other applications can be guessed from Table 5.

Table 4. Biomechanical and Biotribological applications briefing.

APPLICATIONS BRIEFING	
PRINCIPAL UTILITY (BIOMECHANICS, BIOENGINEERING, ORTHOPEDICS)	Efficacious calculations at 3D image-processing graphs, specially with Matlab, to know the exact magnitude for any selected K_W and Load (x, y, coordinates), the approximate abrasive wear magnitude for 1-5 Mc. See Figures 1-7.
EROSION PREDICTION	This is the most important utility. TKA erosion prediction, specially for polyethylene materials, is essential.
TKA DURABILITY PREDICTION	To avoid re-operations and substitution for new prostheses.
INDUSTRIAL MANUFACTURING	To optimize manufacturing process and improve quality.
I+D RESEARCH	For future design of new types. Similar/variants of materials I+D.
PATIENT LIFE QUALITY	Very important for normal movement of patient. Walk and essential movements easy and comfortable for patient during all duration time.

The objectives of the Second Part research are to present and to simulate previous results for the PE linear wear without creep models for TKA in a primary approximation. The models applied are initially for linear wear depth. Graphical Optimization (GNU-Octave and Matlab) for those models, numerical results, and comparison with literature dataset, Tables 1-2. Some recipes to develop simulation-software and a briefing applications were included. At this stage, Lubrication Factors for the models were not set [articles, 4] .

The graphs obtained are acceptable and abrasive wear numerical results match approximately the standard dataset published [articles, 2,3,8]. For 1 Mc abrasive linear wear is of the magnitude order [10^{-2} , 10^{-1}] .

The image processing quality in GNU-Octave and Matlab is acceptable. It was tried to approach the most common numerical and graphical results published, given the large variety of variants for mathematical models-methods and ISO for abrasive TKA implants predictions, Table 3.

In brief, a Graphical Simulations-optimizations series for abrasive PE TKA implants were presented. Results match the literature figures and standards. Applications in Biotribology and Mathematical Optimization-Simulations are presented, Table 4.

SCIENTIFIC ETHICS STANDARDS

All the software was done by Author, based on hip wear previous articles. The article contains reviews of the previous publications essential for complete understanding. The 3D multidigital simulations are original from the Author, software, design, patterns and 3D image processing. The Graphical Optimization software-programs were developed by Author, based on literature and Radiotherapy publications, and previous experience. Article has very short review from literature to make all more sharp/perceptive. Number of hip biotribology Author's references is large due to computational-software evolved programs applied. New software-programs are developed by Author from literature and systems, always improved, changed patterns, values, and modified. No artificial intelligence (AI) tools were used for programming anyway. Radiotherapy references are included as they are the programming base. Model/algorithms is a slight modification from several authors. Methods in software for these publications were created by Dr Casesnoves in 2021-22. This study was carried out, and their contents are done according to the International Scientific Community and European Union Technology and Science Ethics [16-19]. References [16-19]: 'European Textbook on Ethics in Research'. European Commission, Directorate-General for Research. Unit L3. Governance and Ethics. European Research Area. Science and Society. EUR 24452 EN. And based on 'The European Code of Conduct for Research Integrity'. Revised Edition. ALLEA. 2017. When a mathematical statement, algorithm, proposition or theorem is presented, demonstration is always included. When a formula is presented, all parameters are detailed or referred. If any results inconsistency is found after publication, it is clarified in subsequent. When a citation such as [Casesnoves, 'year'] is set, it is exclusively to clarify intellectual property at current times, without intention to brag. The article is exclusively scientific, without any commercial, institutional, academic, religious or religious influences, religious-similar, non-scientific theories, personal opinions, political ideas, or economical influences. When anything is taken from a source, it is adequately recognized. Ideas and some text expressions/sentences from previous publications were emphasized due to a clarification aim.

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