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What's new in orthopedics and traumatology?

Co nowego w ortopedii i traumatologii narządu ruchu?

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S u m m a r y

The average life of the society extended a few years in the last decade, as a glorious part of many components, including medicine. Derivative of this social achievement, is directly proportional increase in the number of patients orthopedic and traumatic. Orthopedic due to wear of the joint, especially hip and knee. Traumatic because of numerous injuries, everyday people with reduced physical and decreased elasticity of the bone tissue. It follows that the number of orthopedic patients, and post-traumatic increases. This element is a major challenge for both preventive and therapeutic, and is the basis of the need for modification and implementation of medicines, including operating. Thus, the "what's new" in biology and biomechanics of treatment?

S t r e s z c z e n i e

Średnia życia społeczeństwa wydłużyła się o kilka lat w ostatnim dziesięcioleciu, jako chwalebny element licznych składowych, w tym medycyny. Pochodną tego osiągnięcia społecznego jest wprost proporcjonalne zwiększenie się liczby chorych ortopedycznych i pourazowych. Ortopedycznych ze względu na zużywanie się stawów, a szczególnie biodrowych i kolanowych. Pourazowych z powodu licznych obrażeń codziennych, osób o obniżonej sprawności fizycznej i zmniejszonej sprężystości tkanki kostnej. Wynika z tego, że liczba chorych ortopedycznych i pourazowych zwiększa się. Element ten stanowi poważne wyzwanie zarówno profilaktyczne, jak i lecznicze oraz jest podstawą konieczności modyfikacji i wdrożeń leczniczych, w tym operacyjnych. Stąd próba odpowiedzi na pytanie „co nowego" w biologii i biomechanice leczenia.

INTRODUCTION

The question "what's new?" is often asked in many areas of medicine. Such a question is usually deep, because it is not just about new theoretical issues but those that can be applied in clinical practice and, above all, result in improved results of current treatments. The answer to such a question in the field of orthopedics and traumatology is mainly due to biological reasons. We often pose additional questions, such as: what biological needs must we meet in order to obtain the desired outcome of treatment? This is the most difficult question in our specialty and answering it results from the new things that we introduce into the treatment process.

The "what's new?" question is usually an expression of the environment's interest in the development of the field of medicine with the hope of enhancing treatment effectiveness and increasing the possibility of healing the sick. Therefore, the convention of the development of the medical "from patient to patient" art testifies to practical development, avoiding the merely theoretical development contributing much to clinical practice. The significant role of the basic sciences, whose achievements condition the development of the applied sciences, should be differentiated in the preliminary considerations. The implementation of these achievements in clinical practice is always a joint success and often a contribution to the next research stages (1).

DEVELOPMENT

Orthopedics and musculoskeletal traumatology are extremely demonstrative fields as regards their progress or lack thereof in treatment and the image of her effectiveness.

Elements of biology, biomechanics and mechanics are indispensable components of treatment. Each component includes biologically key or apparent elements in the so-called modernity or innovation of procedures.

In other words, modernity is not always a cure, it happens so when modernity is not due to the basics of the biology, biomechanics and procedure mechanics of treating diseases and musculoskeletal injuries.

What's then new in biology, biomechanics and procedure mechanics in traumatology and orthopedics?

What's new in the biology of treating musculoskeletal tissues, especially bones? It is true that biological processes of bone healing have been unchanged since the time of the evolutionary formation of the human skeleton but the ability to stimulate bone healing with the use of fracture fixation instruments has developed very slowly over time.

The possibility of learning the process of the clinical biology of bone healing has proven to be a complex issue and the ability to stimulate bone healing with the use of instruments, in other words, optimizing bone healing without external immobilization, has proven to be even more difficult. The need for surgical treatment of fractures was due to the expectations of patients and doctors in terms of getting comfortable treatment without plaster and the possibility of obtaining bone healing in the most optimum time. It is known that the time of bone healing cannot be accelerated, but we can influence the elimination of the components delaying healing, resulting in obtaining bone healing in the optimum time for the type of fracture, treatment method and biological condition of the patient.

No-gypsum treatment eliminates the time needed for the treatment of the so-called gypsum damage, which is often longer than bone healing and significantly shortens the time to improve movements, executed from the first day after surgery.

Answering the fundamental "what's new?" question should not involve talking about the numerous company technological solutions, as there are a lot of them but they unfortunately often delay the process of bone healing or make it impossible to obtain it, because they are often not biologically compatible with the process of bone healing histology and biomechanics.

Refining the instruments of no-gypsum treatment, with their optimization, has also been an epoch novelty in the treatment of fractures in recent years. This treatment consists in locking long bone fractures, their shafts, epiphyses and sometimes metaphyses in intramedullary stabilization, depending on the experience of the operator. It is biologically very important not to open the fracture site, as instruments are introduced from the end of the bone piece through a very small, approx. 4 cm surgical approach. Therefore a post-traumatic hematoma is left with numerous progenitor (mesenchymal) cells conditioning the initiation of a bone union. This item is biologically important to starting the process of a bone union (2).

Another novelty in the treatment of fractures using the mentioned method optimizing the time of bone union is the ability of self-reducing resorption gaps in the locking intramedullary instrumentation. The resorption gap of bone fragments is formed as a result of necrosis of their ends. The necrosis is a consequence of their traumatic lack of blood supply as a result of damage to blood nutrients. The compact bone tissue of which long backbone is built is sufficiently well-vascularized, but only until the fracture. Fractures interrupt intraosseous vessels, resulting in the necrosis of bone fragments ends in the first weeks after the fracture. Necrotic bones get resorbed. The extent of the zone of the necrosis of bone fragments ends is not possible to be determined, therefore, even with anatomical setting fractures and their static union, the resorption gap becomes the cause of the delay or no union of elements. An important novelty of conduct is the use of locking intramedullary stabilization with autoreduction of resorption gaps by using a dynamic fixation. The dynamic union of bone fragments, their mechanically pressing of each other with reducing resorption gaps, is obtained through the use of a dynamic intramedullary nail hole in the longer fragment. A novelty in this method is patient's comfort resulting from their treatment without immobilization, with the possibility of movement and exercising neighboring joints, early verticalization in the first postoperative day after surgery and walking with progressively increased burden of the fractured limb, which stimulates the progress of bone healing. Such opportunities have not yet been achieved during treatment with many other types of fixations, including plates. The plates, particularly those conventional, fixed the fragments only mechanically, not biomechanically, without the possibility of stimulating bone union and it being significantly delayed or pseudarthrosis of fracture healing.

The novelty thus relates to the possibility of developing the biomechanics of stabilizing fractures with a bone union and not only the mechanics of unions which impedes, or even prevents, the progress of bone union.

Stabilization with locking plates is a technological novelty for the treatment of fractures of spongy bones, in particular epiphyseal and metaphyseal fractures of long bones. The plates are used when it is not possible to use the locking intramedullary stabilization. Stabilization with such plates should concern only the spongy bone tissue, or epiphyseal-metaphyseal fractures. Spongy bones are much better vascularized than the compact tissue of bones, it has a greater tolerance of stabilization shortages and achieving stable bone union. The technology of locking plates means the possibility of locking screws in the holes of the plates, in other words, there is no possibility of micro-motions between the screw and the plate, which is the fundamental cause of other screws' loosening and union instability. Thus, locking plates are a novelty in treating geriatric (low-energy) fractures within the spongy bone, where the poor mechanical value of bones predisposes the loosening of non-locking plates. Locking plates also enable non-gypsum healing without immobilization, therefore, they do not generate algodystrophic bone loss resulting in many months of symptoms, regardless of the fracture healing.

A biological novelty in orthopedics is the issue of articular cartilage protection. This tissue as the primary structural element of each joint and it is a prerequisite for its existence and motor skills. After a huge uptake of prosthetic arthroplasty, there were complications, particularly in cases of knee prosthetic arthroplasty, development was implemented of directions enabling the extension of the existence of articular cartilage, especially in the case of the knee joint, to delay, and repeatedly abandon, prosthetic arthroplasty. These opportunities exist only when there is the articular gap in the X-ray image, which is equivalent to the presence of articular cartilage varying with respect to quality. This complex and responsible process takes into account various treatment techniques of a few generations, depending on the biological etiology of cartilage damage: the biomechanical, humoral, cellular, tissue, tribological, substitution and regeneration techniques. Predictively, the techniques can be divided into biomechanical, mechanical and biological. Any method changing the biomechanics of the joint is a biomechanical method. Mechanical methods are those with mechanical protection of joint cartilage. Biological methods are characterized by their impact on the biology of cartilage, therefore, are prognostically creative. In practice, mechanical and biomechanical methods support biological methods (3-6).

Hip and knee prosthetic arthroplasty procedures are novelties in the mechanics of orthopedic treatment. Prosthetic arthroplasty of joints is merely a mechanical, not a biological, solution, due to no compliance between the bone tissue and the prosthesis metal. This element is at the threshold and is the cause of after-prosthetic complications of various types. Joint prosthetic arthroplasty procedures result from no biological solution, due to the irreversible destruction of cartilage as a prerequisite for joint action. Given this situation, many innovations have been developed in the world aimed at reducing the number of after-prosthetic complications. The mechanical premise of prosthetic arthroplasty procedures is the method of insertion in the pelvic bone – the acetabulum and the femur – the prosthesis stem. Traditionally, elements of prostheses were cemented to the bone. Bone cement is used as a binder between the prosthesis metal and the bone. Cemented prostheses are still used in the case of poor bone quality, or osteoporotic bones. Cementless implantation is also a new way of implantation. This innovative solution is used effectively in patients of all ages, but without severe osteoporosis. Another novelty in hip prosthetic arthroplasty procedures applies to a biological innovation, saving bone tissue by reducing the size of hip replacements. The hip capoplasty, also known as hip resurfacing procedure, is a modern and reproducing biomechanics of the hip during which no bone resection is carried out. Thus, the biomechanical parameters of the hip remain virtually unchanged. Surface prostheses should be implanted only to bones of good mechanical properties, practically up to 55-60 years of age for men and 50 years of age for women, as osteoporosis occurs much earlier in their case. The group of short-stem prosthetic arthroplasty procedures is a significant novelty in hip prosthetic arthroplasty procedures, the basic assumption of them is the highest possible resection of the hip femoral neck and a small cave of the prosthesis stem fixation in the femur. These two elements are biologically relevant, they spare the removed bone mass and fix the prosthesis in a biomechanical stable manner, providing its effective use. There are several technical solutions of short-stem prostheses and they all, if properly implanted, meet the expectations of the patient and the doctor. The traditional (with a longer stem) prosthetic arthroplasty procedures of the femoral part of the prosthesis is still used in the situation of patients with poorer properties of bone tissue and then this is the only opportunity to help the patient, restoring their painless possibility of joint movement, eliminating disability.

Prosthesis durability, abrasion of prosthesis friction elements, tribology of the artificial head and the acetabulum, commonly called articulation, is a novelty in hip replacements. Friction materials used years ago unfortunately underwent abrasion in the process of prosthesis tribology, resulting in their premature wear, tissue reactions and prostheses' loosening. These items were a contribution to the search for other, better solutions. Years of technological and tribological research have resulted in the development of superior materials with very low abrasion.

The new generation polyethylene used as an input to the metal low-abrasion acetabulum is a significant technological novelty. The formation of the so-called polyethylene acetabulum "hood", which very effectively prevents dislocation of the prosthesis, is also a new technological solution.

Ceramics is yet another novelty in articulation. The new generation of "biolox" ceramics is a material of very low abrasion. The ceramics is used both for the acetabular insert and the femoral head. Such an articulation, technologically, has the proper coefficient of friction performance, providing negligible abrasion of the head and the acetabulum of the prosthesis, and therefore the longevity of its mechanical use. The biological element of using prosthesis depends, however, on the durability of adhesion of its metal elements to the bone, which affects the loosening of the prosthesis and the need for replacement. This issue is difficult to be solved due to the tissue incompatibility of the prostheses' metal and the bone. A novelty in this respect is the introduction of several measures aimed at biological "fixation" of the prosthesis metal and the bone of the recipient through osseointegration. Osseointegration is the uptake (ingrowth) of bone tissue to the acetabulum metal and the stem of the prosthesis by coating metal elements with a suitable material, for example: hydroxyapatite, or a porous material of appropriate pore size to allow osteoconductive bone tissue "ingrowth". These solutions, combining mechanics with biology, are a significant novelty in prolonging the biological use of prosthesis.

A clinically practical novelty is striving to reduce blood loss in the postoperative period, as well as eliminating post-operative pain, which measurably improves the comfort of the patient and thus facilitates early rehabilitation. For this purpose, injecting the surgical wound prior to suturing was done with a mixture of 60 ml of vasoconstrictors, reducing postoperative swelling, with anti-inflammatory and analgesic properties, according to the long-standing practice in the US. These preparations exclude pain for two days, which is the most crucial postoperative period for the patient, enabling painless improvement. Later, patients feel virtually patient no pain. In order to reduce operative and postoperative bleeding, administration of Exacyl was implemented just before the surgery incision. This is not a new preparation, but the novelty is its use in orthopedic practice in our country, despite its universal implementation many years ago in the Nordic countries and the USA. Elimination of postoperative hematoma in orthopedic practice results in reduced inflammatory, especially periprosthetic, complications, being a complication forcing to remove the infected prosthesis (7-9).

Currently, achieving a high level of orthopedic and traumatic treatment in the biological and biomechanical field is becoming the most important element of the capability of preventing infectious complications which completely undermine results of the best surgeries.

The undoubted novelty in this eternal issue is a very detailed development of the principles of prevention and treatment of inflammatory complications in orthopedic patients called the "Philadelphia Consensus". This document was developed by the world experts, including four from Poland (including the author) and published as a book – 350 pages. Last year, the document was published in Polish, prepared by a team from the Orthopedic Clinic in Otwock. This innovative nature and detailed procedures, aimed at preventing postoperative inflammation, greatly reduce such serious complications requiring the removal of joint prostheses or fixation of fractures (7).

Biofilm sonicate testing, ultrasonically sampled from a prosthesis removed as a result of inflammation, is also a diagnostic novelty in determining a reliable "orthopedic" inflammation pathogen in the environment of the implanted implant. The tests have shown significant differences between the results of planktonic cultures of the soft tissue of the inflamed joint and flora of the biofilm, both as to the type of pathogen and to its drug resistance. This innovative element seems to explain so many failures in the treatment of inflammation around implants (7).

Cellular, humoral and tissue stimulations are new methods of treating bone defects or union disorders used in practice (1, 10).

Cellular stimulation of osteogenesis has been implemented by administering stem cells as an important biological novelty in orthopedics and traumatology. Practically, it is believed that stem cells of myeloid origin have a significant predisposition to morph into osteoblasts, and those of adipose origin morph into chondro- and fibroblasts. Thus, the two groups of stem cells have been implemented in treatments. Recommendations for their use take place in the stimulation of impaired wound healing at the cellular level of individual tissues (1).

Hormonal stimulation for disorders of healing both the bone tissue and degenerative and overload syndromes is obtained through the use of growth factors. The method of obtaining the appropriate concentrations of each growth factor has been validated in a hospital in Otwock and effectively implemented. It should be noted, however, that both stem cells and growth factors are a notable complement to a method of treatment, in line with the diagnosis established by the Evidence-based medicine, which should not be overlooked. Using these valuable elements only symptomatically is of little use (1).

Tissue stimulation in the treatment of no union, false joints and extensive loss of bone tissue refers to the administration of bone grafts and bone substitutes. The novelty in the above-mentioned treatment is the method and differentiation of administration of bone grafts, usually frozen and sterilized by irradiation. It happens that these grafts are administered including bone substitutes based on hydroxyapatite in various forms, densities and volumes. Both bone substitute materials have become indispensable in the process of supporting tissue treatment in the absence of the possibility of collecting such large quantities of autologous transplants (1).

The possibility of cultivating osteoblasts and chondroblasts, as the domain of cellular engineering, is a novelty in the treatment of bone tissue and articular cartilage losses. The development of this field of medicine has become the basis for new products in orthopedics and traumatology, and the broad implementation of research achievements will contribute to improving treatment outcomes and reducing disability (1).

CONCLUSIONS

The doctor – engineer cooperation in which the doctor determines the needs and the engineer works out the technical solution is the basis for optimizing the treatment of fractures through approaching the so-called biological treatment – stimulation of the union, and not just through a mechanical stabilization of fractures impeding bone union.

Numerous procedures for the reduction of disability in the field of orthopedics and traumatology result from close cooperation between the basic and applied scientific fields with technological engineering solutions.

Advanced multicenter research supporting orthopedic and traumatic procedures is in the process of further development and is another example of developing future collaboration for the further development of the basic sciences with applications in the field of applied sciences. So, the What's new? question is, and may always be, open.

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