The Classic

Report on the Positive Results Obtained by the Modern Surgical Experiment Regarding the Suture and Replacement of Defects of Superior Tissue, as well as the Utilization of Re-absorbable and Living Tamponade in Surgery

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Abstract This Classic Article is a reprint of the original work by T. Gluck, Report on the positive results obtained by the modern surgical experiment regarding the suture and replacement of defects of superior tissue, as well as the utilization of re-absorbable and living tamponade in surgery. An accompanying biographical sketch of T. Gluck Albright is available at DOI [10.1007/s11999-011-1836-8](https://doi.org/10.1007/s11999-011-1836-8). The Classic Article is ©1891 and is reprinted from Gluck T. Report on the positive results obtained by the modern surgical experiment regarding the suture and replacement of defects of superior tissue, as well as the utilization of re-absorbable and living tamponade in surgery [In German]. *Arch klin chir.* 1891;41:187–239.

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(Translated by Antonia Woehln, MD, with syntax clarifications by Drs. Aaron Johnson and Richard Brand).

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(From page 187)

Gentlemen! Surgery in the 19th Century is under the spell of three fundamental advances: anesthesia during surgery (especially anesthesia through chloroform), Esmarch's tourniquets for the extremities, and antiseptic or Lister's wound treatment. Based on the blessing of these methods, which have the ability to reduce to a certain ideal level the pain, fear, blood loss, shock, and danger of wound infection, modern surgery has developed a youthful enthusiasm and boldness, and a noble competition and a striving to do the best possible; to bring it about fills both the disciple and the master of our art. Surgery on the whole retains a destructive character, but despite this unavoidable aspect, this last decade has brought to full blossoming and development, conservative and reparative approaches. However, the so-called boldness in surgery has not experienced a fair and favorable evaluation from all sides.

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The use of ivory sleeves and hollow cylinders which are placed over the bones and nailed to them, may be recommended to a certain degree, but it is perhaps still too complicated to be recommended as a general method. Since Abulcasis in this century, Mitscherlich and Suersen succeeded in the re-implantation of teeth in their alveoli and their re-attachment and painless continued use; there is also the fact, already known since Ambroise Paré, that projectiles can safely remain lodged in the medullary cavity of the long bones; Simon also, for example, retained an encapsulated bullet as a harmless formation in the medullary cavity. Based on these experiences, I was led to the fortunate idea to choose the medullary cavity of the skeletal bones as the implantation organ for the cosmetic replacement of a substance that is deemed defective. In fact, it has been proven that the medullary cavity tolerates

Fig. 19 An example of the ivory hollow cylinder with a large central canal with peripheral circular openings.

Fig. 20 The hollow cylinder pictured in Fig. 19, as implanted in the medullary canal and used to bridge a bone defect.

foreign objects, and furthermore, if an aseptic status can be preserved and if stable fixation can be guaranteed, this new method of implantation or invagination of foreign objects in the medullary cavity appears promising.¹

In May 1888, Dr. Schuler has, on my behalf, described the method in detail in his Berlin dissertation. Since then, I have tried to simplify and perfect the method. From the originally solid, spindle-shaped cones, emerged an ivory hollow cylinder with a large central canal and a large number of circular openings (Figs. 19, 20²).

To further allow the insertion of the materials into relatively small wounds, the proximal and distal stumps of a resected bone or a resected joint are later each capped with

an ivory cylinder that is inserted into the medullary cavity. The cylinders allow joint mobility when a hinge is applied between the ivory cylinders, similar to that of orthopaedic braces of our manufacturers, and ensures stability of the fragments with the hinges (Figs. 14, 15). When two pieces, a and b, are connected to each other as fixed or movable, they can substantially alleviate the technical execution of the operation, and make the execution possible by means of relatively small wounds, and this is of crucial concern, without harming the fixation between the fragments. In other cases, simple, solid bones, forked rod cones, or ivory appliances manufactured on a rod, may be developed for this purpose.

Besides the insertion into the medullary cavity, one can increase the certainty of continued fastening by means of ivory pins, which are pushed through the bone and the appliance, but they do not seem necessary.

For the joints of elbows, hands, shoulders and feet there are, besides other usable models, joints with a combination of hinge and ball joints that are proven especially useful, also allowing, besides flexion and extension, adduction and abduction, and supination and rotation.

Since the notch with the ball joint is circular, or just a circular arc, we have the option for either full rotation or restriction for pronation and supination movements. In the case of the joints of the hand and foot, the fixation of a row of bones, ivory forks with the corresponding number and length of removable pieces can be used for the medullary cavity of the respective bones, combined with hinge and ball joints for the intended functional effect. With the design of the appliance, I have kept in mind the principle for which our skeleton is built, and to combine, if possible the lowest volume and weight with the appropriate form and greatest strength. Based on this, hollow cylinders with thick walls and lateral openings were made with the construction of the hinges and other joints, and also with the acute awareness of the principle of invagination.

Besides replacements of different forms and constructions for continuity defects of bones and joints, I have constructed ivory replacements for non-unions and pseudarthroses, as well as other orthopaedic bone surgeries; for example, with knee valgus, not only to correct the position through wedge resection, but also to rigidly connect the bone fragments immovably in the corrected position in the simplest way, through pieces of ivory.

For complicated jawbone fractures and defects, healing replacements and fixation pins as well as artificial teeth with threads screwed deep into the jaw are indicated. Moreover, replacements have been constructed for the surgery of the spine, palatal defects, as well as ivory frames for rhinoplasty. The insertion of an appliance should be easy and accomplished by means of a relatively small wound.

¹ Editor's Note: "...appears promising" in the original is literally translated as: "can be considered a positive horoscope."

² Editor's Note: We have inserted references to figures throughout the text. These references were not in the original article; authors during the time of this article frequently appended figures without specifically referring to them in the text.

Fig. 14 Diagram of the hinged implant described in Fig. 15 implanted to act as a prosthetic knee. Distal femoral and proximal tibial resections are made to expose the medullary canal, in which the cylindrical ends of the prosthesis is implanted.

The appliance itself may be technically complicated, ingeniously executed, rotatable in several directions, but it should not present surgical difficulties. The use of nickel-plated steel screws is only necessary in case of shoulder and hip joints.

To simplify the technique, the joint or hinge component of the appliance can be connected with the diaphyseal part, intended for the medullary cavity, by means of ivory screw threads. Also, ancillary components of different thickness and length can be screwed into the same hinge component.

Appliances made of aluminum, wood, glass, celluloid, nickel-plated steel, etc., which I have ordered to be constructed as models, are cheaper and can most likely, according to me and other authors of animal experiments and experiences, allow healing without reaction. Ivory has shown itself as an appropriate material, which for the time being I would recommend as the first choice.

I have presently further experimented with inserting ivory cylinders into resected knee joint systems of skeletons and fresh cadavers and with inserting the cylinders through small cylindrical ivory rods, which made the condylar approach possible for a hinge movement.

The advantage of this ivory articulated joint appliance is that the fragments are fixed and that it replaces the lost joint not just in function and form, but also in structure, a

fact that should certainly not be underestimated. Complete disinfection of the parts of the joint to fit with ivory does not present any difficulties.

In cases when the medullary cavity is very wide or the appliance for the respective defect proves to be too short for a simple insertion, I have tried inserting multiple layers of shorter and longer tubes made of parchment paper, cork sheets, smoothed felt, and finally, decalcinated cow bones; the latter is recommended as being the most easily insertable as it provides a compressible and elastic interlayer, which, inserted into the respective medullary cavity, constricts its opening to such an extent that it allows the insertion of an excessively short or thin ivory cylinder and its fixed frame.

My experience with nonabsorbable sponges gave me a basis for suggesting a further way to prevent failure of the artificial joint due to ingrowth of tissue into the artificial parts. For this purpose, the joint part contains a silk or muslin sheath sealed with a double string from a tobacco pouch. Furthermore, an absorbable surgical sponge can be used, as needed, for filling and padding.

Just as I have allowed recreation of the natural joint parts to be connected to an articulating appliance through ivory, I have also supplied appliances with hinges and ball joints; for example for the shoulder and hip joint, simple

Fig. 15 This is an illustration of how two ivory implants can be connected to form a hinge. The proximal and distal portions are connected by a pin, which acts as the bearing, and thus allows for single-axis rotation about the pin.

joint parts with ivory hooks and the same after insertion of cylinders in the medullary cavity of the humerus or femur, to the connection to that is attached to the screw that has been drilled into the acetabulum, *cavitas glenoidea*, respectively. To implant a technically complicated appliance with the same ease and certainty and to protect the nonabsorbable sheath and the future passive movements of the joint against atrophy and failure, it is certainly recommended to use the technically more perfect method, which does at most bring about higher costs.

For natural healing, joint parts removed from cadavers, as well as fully disinfected and preserved tendons and nerves, certainly do not give rise to ethical objections.

As opposed to the rudimentary attempt to compensate against bone defects with autoplasty of *osseuse à lambeaux* ("bone graft") and the inevitable failure of suture of non-unions and pseudoarthroses, the invagination method of osteoplastic and arthroplastic surgery stands as fundamental progress.

Ollier (1889) spoke of "action of the present" (*action de présence*) of transplanted bones, to explain the favorable

attempts by Mac Ewen and Poncet. For him, however, this action consists of the stimulus provided by the implanted bones that will induce a bone-forming osteitis.

This action of the present of implanted substances plays a profoundly important role when there is a desire to regenerate superior tissue to force a certain direction and trajectory. I remember my attempt to sheath resected nerve endings with decalcinated cow bones fixed through sutures. Vanlair has been successful with this experiment to force nerves from their physiological trajectory and to grow themselves to a length of 12–16 centimeters in a backward direction as he desired.

Parallel attempts with other tissues have given similar results, and sheathing resected bones with ivory cylinders has also been successful, making displacement of fragments impossible, and forcing the production of a bone-forming periostitis next to, and in the central canal so as to cause regeneration on the periphery of the invaginated cylinders. The inevitable tissue irritation from secondary blood and lymph extravasates that result from fixation and fragments dislocated through movement, dissipates during

Fig. 8 8.1 Illustrates ulnar defect, and an ivory cylinder that is to be “invaginated.” 8.2 and 8.3 are anterior and posterior views of “complete regeneration” of the defect following the bone-forming osteitis reaction with “no excessive callus with its purposeless deformity.”

the healing of these fractures because of this treatment and allows the regeneration process to play itself out through absolute rest of the part. As a result, we obtain in these cases a beautifully smooth neoformation of the bone, and no excessive callus with its purposeless deformity.

In these cases, the invaginated ivory cylinder plays a temporary, but essential role and a bone-forming osteitis is initiated, which in the end results in a complete regeneration of the defect (Fig. 8); this reaction does not compare in any way with the small, purposeless, and inadequate bone production that in fortunate rare cases succeeds with the Dieffenbach method of inserting ivory pins through the ends of the fragments of nonunions and pseudarthroses. The temporary task of the invagination method suggests fundamental progress in comparison to the means previously used.

However, the exact framing and securing of ivory hinged appliances in skeletal bones gives rise to and justifies very different hopes for the future of the invagination method of osteoplastic and arthroplastic surgery.

My artificial bones and joints instantly and permanently replace even the greatest defect; they instantly and permanently render the fragments stable; grow around their peripheral parts a callus ring as a defensive enclosure from within the fracture or grow within its cavity a circular marrow callus; this occurrence is agreeable, but not necessary for the functional end effect. Simple scarring and healing without reactive bone formation is much more satisfying for making function possible.

The tolerance of the medullary cavity of the insertion of these parts is remarkable and desirable; in spite of the evacuation of the marrow, insertion of the cylinders, and removal of the periosteum; under sterile conditions there is neither inflammation, nor necrosis of the fragments on which extensive surgery is performed.

In clinical cases, it is surprising that besides the immediate functional effect, the part has been absolutely free of pain immediately after the surgery. There is a total lack of fracture pain because of the absence of motion of the fragment.

If an avoidance of additional injury and irritation in the tissue (nerves, etc.) has been successful, much less pain occurs because the medullary cavity, to the extent that the appliance has been inserted, has been completely replaced.

This remarkable fact I already observed in Bulgaria in 1885-1886, where by means of a steel fixation appliance constructed by a mechanic, in the case of a gunshot fracture of the femur with bleeding and painful muscle contractions, the pain immediately subsided and the patient was able to change position by actively elevating the injured leg in the appliance.

The importance of primary stable fixation and obstruction,³ or nailing it at once is proven by the successful healing by means of glass and ivory implantations in the clinical and experimental cases of Heine, Salzer, and Rose. The fragments remained just as movable because continuity was restored, but fixation was disregarded.⁴

This was also the case with a dog, which I presented at the last surgical congress. The dog was walking with a cicatrized wound; the healing of all the ivory replacement pins was successful, the fragments were still movable, because at the time I did the experiment, I did not possess a brace that could guarantee complete fixation. The functional effect was, however, ensured by the ivory.

³ Editor's Note: The meaning of “obstruction” in this context is unclear. It may relate to the filling of the medullary cavity with the device. Gluck seems to have induced bone and periosteal nerve death through medullary evacuation and periosteal stripping, which may have accounted for the pain loss observed.

⁴ Editor's Note: Gluck's meaning is unclear. Bone healing did not appear to be the goal of this procedure, as the structural integrity provided by the glass or ivory nail was sufficient to restore functionality, hence, “...fixation was disregarded.”

Fig. 9 The osteosarcoma of the distal humerus.

Fig. 10 An ivory cylinder designed to function as a distal humeral replacement.

In this case, I was also able to remove an osteosarcoma of the lower epiphysis and condyle of the humerus (Fig. 9); after resection of the diseased distal humerus, a 15 centimeter long ivory cylinder (Fig. 10) was centrally inserted into the medullary cavity of the end of the humerus, and was sutured only peripherally to the olecranon (Fig. 11); 12 weeks after the operation, the ivory cylinder could again be removed from the top of the olecranon; while in this first clinical case it was too thick, not sufficiently fixed and a regenerating diaphyseal sheath was progressing, something I have not encountered with my exactly executed ivory preparations of the newest models that are connected by a hinge and are fixed with crossed pins to the framework and I suspect that the diaphyseal sheath will not recur. In any case, the “action of the present,” in the sense intended by

Fig. 11 Illustration of implantation and fixation of the ivory cylinder to replace the distal humerus. Proximally, the ivory cylinder is inserted into the medullary cavity of the humerus. Distally, it is sutured to the remaining portion of olecranon.

Ollier, has determined the functional success and protected the patient against the high amputation of the humerus. Because of the irritation of the material that is inserted in the medullary cavity, a vigorous bone-forming osteitis occurs in the strong and youthful patient, which made a protective enclosure around the cylinder, primarily through an advancing marrow callus that came through the cylinder, so that an olecranon arose in the area. In this sense, the ivory cylinder also predetermined and promoted in a purposeful way the building up of callus. The preparation itself is noteworthy. The surface of the ivory looks worn and eroded in places. The central canal is fully obliterated and body tissue has grown through it, and here and there, granulate papillae occur on the surface, which is evidence that even the powerful foreign bodies of organic nature succumb to a gradual corrosion and substitution by living tissue. The temporary fixation during the healing of the wound also worked its blessing through the predetermined “action of the present”; there also is no pressing evidence to remove the ivory cylinder based on either pain or rise in temperature, because the foreign body in this case fulfills its temporary task; this prompts me to assign the prominent position to the olecranon and to remove the ivory cylinder from its newly built cylindrical shaped bone shell.

I have written in another publication about the clinical cases in which the invagination method of the osteoplastic surgery was successfully applied.

It is surprising how one can immediately after an extensive resection of the extremity that was operated on, lift, twist and move all-around, without the occurrence of even the slightest dislocation. The crux of the method provides evidence of the tolerance of the medullary cavity against the inserted foreign body, the mutual stable fixation of the fragments in case of fractures, and the immediate replacement of bone defects by way of invagination and insertion. With all other applications I have indicated, I emphasize, besides the operative technique, the conservation of the part, the fixation of the fragments, and also the replacement of a possibly complete functioning of the extremities.

Should an energetic resorption and wear and tear occur with the ivory application in the course of time, a situation one cannot anticipate, not only the integrity of the joint movements, but also the continuity of the strong ivory mass could be reversed; in my experience, such resorption will be accompanied by such an energetic substitution and creation of a defensive enclosure by living bone, the fixation process will not suffer any interruption during the transitional process.

Interesting in this regard is also the elephant tooth preparation that has been stored in the University dental clinic; the designs and microsections of Professor Busch have been published in the proceedings of the odontological society. One or more iron bullets have been found healed in several teeth without reaction, surrounded by a solid shell of newly built dentin (ivory); in other cases, the bullet has been left healed in spite of the occurrence of an abscess.

If for some reason the continuing integrity of the ivory appliance would be questioned, resorbing appliances can be constructed from other materials; from a theoretical point of view nothing can be brought against use in healing, and their use would not be damaging to the integrity for the lifespan of the wearer of the reconstructed bone or joint under any circumstance. I personally would for the time being give preference to just the ivory appliances or pins, or combined with naturally sterile, dead or freshly living, human or animal skeleton bone or joint systems, and in some individual cases, additionally, I recommend the use of nickel-plated steel screws.

The ivory appliances I have constructed are so completely made that their construction and appropriate fixation are of extraordinary ease in use. For added security, I have experimented with cement ("Kittsubstanz"), in particular the almost instantaneously congealing stone filler for hardness and proficiency of stone filler (colophony with pumice stone or gypsum). This substance can serve

extremely well as hardening cement or filler material and could possibly be called upon to be the cementing that plays a role with Gigli's saw heated with thermocautery and together with the invagination method and the crossed screw connection of the invaginated foreign body. The cementing and invagination of ivory in the medullary cavity could possibly supplement the method of the sutures used until now, and even that would be great progress. I have brought the replacement appliance and skeleton that I have presented to the scientific exhibition of the 10th international congress to be displayed separately, to demonstrate their functionality and appropriateness.

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We can certainly make the observation in medicine, as often also in other scientific disciplines, that certain facts have been known as such for a long time before their value is truly recognized. These facts may be generally applied, or, if one recognizes it from another critical perspective, they provide the anticipated meaning for practice.

If the method I devised for suture and molding of superior tissue, as well as the reabsorbing and living sponge, were to be vindicated for its value for the surgical practice, then it would not be unreasonable to allege the criticism, that in the form of unrecognized ideal material, which already been partly available for a long time, and that these known facts have already received a theoretical following.

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With the feelings of sincere thankfulness I look up to the Institute and look back with warm respect to its leaders, the Berlin Pathological Institute and the Royal Surgical Clinic, under whose aegis I was able to engage in a large part of my first investigations.

I believe that the full theoretical work in the science of medicine, in which an endless amount of unutilized idea material for the physician practice is stored up, from time to time has to be thought through and exploited by scrutinizing these practical experiences.

Theory and practice should go hand in hand; even the most speculative among the scientific researchers have to test their results from time to time, to see if they can be indirectly or directly utilized for all of those suffering.

It appears, indeed understandably, that as in other scientific areas, in case of techniques in our specialized field, the clinician argues general consequences from theoretical ideas. At the same time, going through life, the surgeon is always motivated and guided by the wish to alleviate suffering and to avert danger and on occasion is encouraged, by means of a new interpretation of known scientific facts, usually not previously discussed and therefore not utilized for a long time and facts with meaning that should not be underestimated.