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Wichterle hydron for breast augmentation – case reports and brief review

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Summary

During the period of 1960s and 1970s, a new alloplastic material – Wichterle gel – was introduced in the field of plastic surgery. In 1961, a Czech scientist, prof. Otto Wichterle, had developed, along with his research team, a hydrophilic gel made of polymers, which fulfilled the high standards for prosthetic materials due to its hydrophilic, chemical, thermal and shape stability that provided a better tolerance in the body compared with other hydrophobic gels. Plastic surgeons had started to use the gel for breast augmentations and reconstructions. Success of the gel had been reinforced due to its easy preoperative preparation. The material had been implanted during general anaesthesia via submammary approach over the muscle fixed with a stitch to the fascia. Fixing corset bandage was applied after the surgery. The implanted material had proved to be suitable for postoperative processes with a minimum of complications. In the later postoperative period, however, serious complications occurred – mainly infections and calcifications. Long-term results are presented by case reports. Today, this material is no longer used and it is replaced by more modern implants.

Key words

breast implants – breast reconstruction – breast augmentation – Wichterle – hydron – hydrophilic polymer – polyglyconmethacryl – calcification

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Introduction

History of foreign material implants for restoration of body contours was quite unsatisfactory within the field of reconstruction surgery in the 1960s. Alloplastic materials used for implants had not been properly investigated before their use in clinical practice because of the absence of preclinical studies. Clinical applications of these materials, longitudinal outcomes and possible failures had rarely been published after adequate observation time [1–5].

Attempts for breast reconstruction or augmentation can be traced back to the end of the 19th century. During this time, Czerny implanted a lipoma that was removed from the lumbar area into a breast after adenoma removal [6]. Later, artificial materials – implants – had started to be used. Probably the first surgeon who used these materials, specifically liquid paraffin oil shots, was Gersuny [7]. Later on, surgeons started to use glass balls [8], liquid silicon [9], polyvinyl foam [10], polyethylene [11,12], polyurethane [13] and others. However, from a long-term point of view, all these materials had been associated with unsatisfactory outcomes and serious complications.

A Czech scientist, professor Otto Wichterle (Fig. 1), along with a chemist Drahoslav Lím (1961), synthesized a new biomaterial suitable for implantation that promised better tolerance and favourable outcomes due to its qualities. The material consisted of a set of polymers, including chemical stable netting gels (polyglycolmethacrylates) that had been hydrophilic due to a high number of hydroxylic units within its structure (Fig. 1).

Hydron

Polyhydroxyethylmethacrylic polymers are known as hydrons. Hydrons had been isolated from polymerization of hydroxyethylmethacrylate (HEMA) solution with a presence of small number of netting agents, such as ethylenglycoldimethacrylate(diester) with a formation of netting gels, either transparent (homogenous gels) or opaque/sponge (heterogeneous gels), that have a variable extent of pores – open/closed pores. It was not possible to dissolve those gels in acid, alkylates or other basic organic dissolving agents. During polymerization, hydronic gel was able to gain 30–90% of its weight in water, due to the netting density and the capacity of a dissolvent. For various purposes, it was possible to make gels with various consistency based on the amount of water in hydron – from solid and flexible gels, to very soft gels with consistency similar to the eye vitreous body [1].

Hydron was thus an unusual structure with variable consistency that, due to its variability, offered a wide range of uses, and had to appeal to every reconstructive surgeon [2].

Fig 1. Prof. Otto Wichterle [5].

Polyglycol methacrylate gels designed by Wichterle and Lím specifically for the use in surgery did not demonstrate the main disadvantage of other plastics – hydrophobicity and impermeability. Due to their hydrophilic nature and relatively sparse structure, the polymer networks swelled in water and diffused aqueous solutions and body fluids through them. However, they fully retained the advantages of other plastic materials. They were chemically stable, mechanically and thermally resistant and easy to shape. They were also extremely well tolerated by the body, better than commonly used implants of a hydrophobic nature (Fig. 2).

Polyglycol methacrylate gels could be prepared in a wide range of mechanical properties. For the purposes of breast tissue replacement or augmentation, it was therefore necessary to choose a suitable consistency for the breast implant so that its elasticity corresponded to the original tissue. Spongy gel with pores of 40–80 µm in size and equipped with a polyester knitted mesh in the areas where the implant was to be fixed with stitches appeared to be optimal for the purpose of breast reconstruction or augmentation. If the pore size was kept within the specified range, the surrounding tissues in the experiment did not grow deeper than about 500 µm into the implant mass and no changes in consistency should occur [1].

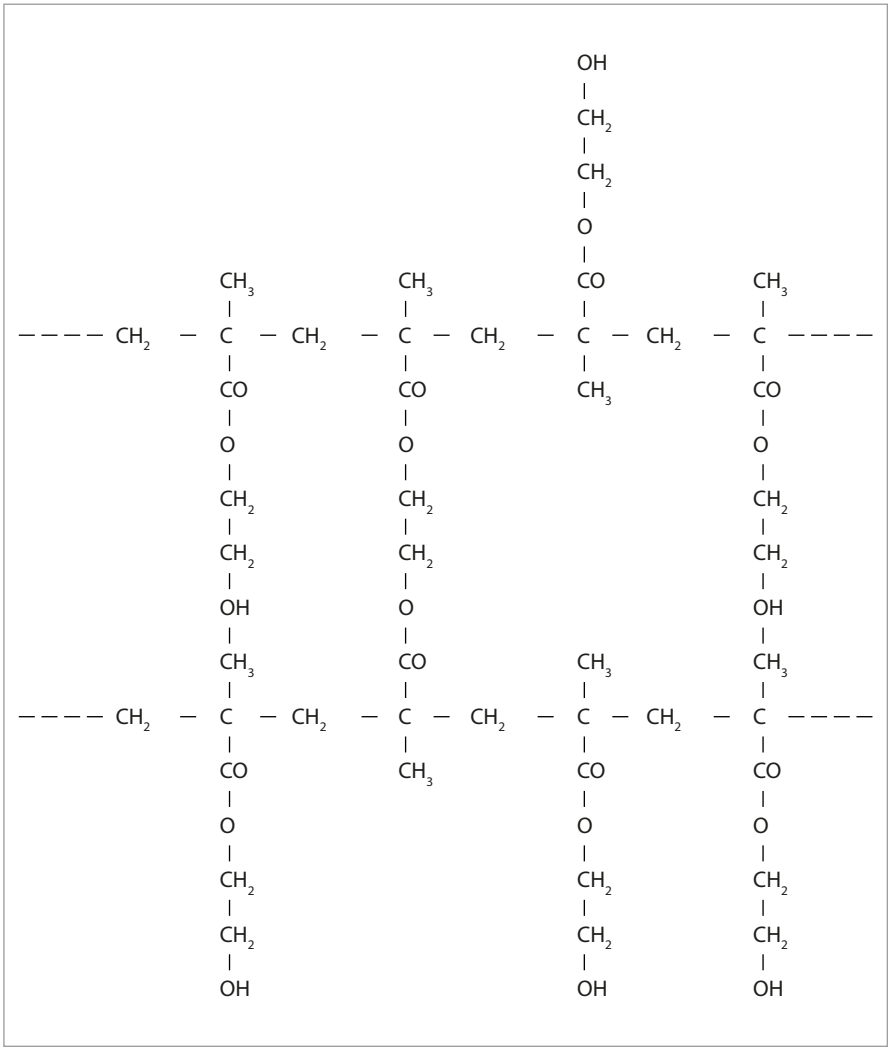

Fig. 2. A polymer molecule of hydron [2].

The use of hydrons in medicine

In their time, hydrons have found application in many branches across surgical disciplines. For example, they can be used for the reconstruction of the back wall of the trachea by reinforcing the terylene mesh, for coverage of an extensive chest wall defect, for the reconstruction of the vestibule as a carrier for a dermoepidermal graft, during reconstruction of the middle ear – stirrup in non-inflammatory processes, in orthopaedics during total hip replacements on the treated femoral head; hydrophilic gels have been a huge success in facial reconstruction – mainly chin, nose, cheeks and eyelids – and of course in breast reconstruction. However, the most successful field was ophthalmology; as the inventor of contact lenses, prof. Wichterle was nominated for the Nobel Prize in chemistry [4].

Advantages of alloplastic materials

When using autogenous choriofat grafts or autologous fat for augmentation, volume loss and sometimes even complete resorption of the transplant with the need for reoperation has to be expected. In addition, a sufficiently high layer of subcutaneous tissue was often missing in the tissue harvest sites, especially in the buttock region or the lower abdomen. The operation was relatively expensive; it left scars even at the site of graft removal and quite often led to patient's dissatisfaction.

A suitable alloplastic material had to eliminate the problem of volume loss after implantation, mutilation, and the morbidity of the harvest site. The opera-

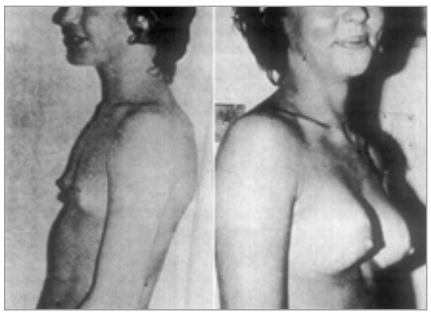

Fig. 3. Before and after implantation [2].

Fig. 4. Hydron implants before application (from the archive of the author).

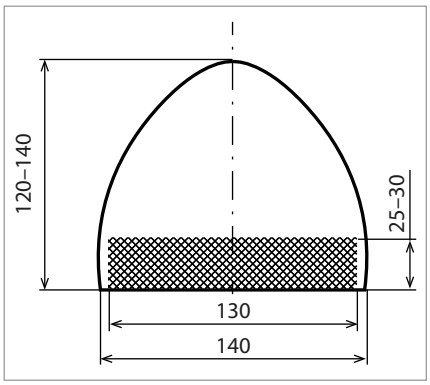

Fig. 5. Typical shape of a hydron implant (dimension in mm) [1].

tion itself was relatively simple and with minimal scars.

The burden on the patient was less; the hospitalization and the recovery periods were also shorter (Fig. 3).

Preparation of breast implants for hydron

The implants were prepared by solution polymerization of glycol esters of methacrylic acid (ethylene glycol monomethacrylate and ethylene glycol bismethacrylate) in a large amount of water; ammonium persulfate was used as a polymerization initiator. A typical polymerization mixture contained 70.0% of ammonium persulfate solution (10%) and distilled water, ethylene glycol monomethacrylate (29.7%), and ethylene glycol bismethacrylate (0.3%).

Glass forms of two implant shapes – conical and round – were used for preparation. Other appropriate adjustments were easy to make due to the easy way to work with the material with any commonly used surgical instrument before or during surgery [1].

The weight of the implant varied between 150 and 200 g. The consistency was spongy and porous. The surface was smooth and whitish in colour. The implant base was reinforced at the edges up to a height of 30 mm with polyester silk braided mesh to prevent pulling out of sutures during implant fixation (Fig. 4) [1].

The finished implant was cleaned from all the remnants of low molecular weight substances by repeated washing and boiling in distilled water. The main low molecular weight substance that had to be washed out was ammonium sulphate (derived from persulfate, used as a polymerization initiator), a simple barium chloride test was used. If the washing water still contained traces of sulphate after the addition of chloride, a white sediment appeared. After washing, the implant was sterilized by boiling and kept in sterile physiological solution (Fig. 5) [1].

Hydron breast reconstruction and augmentation

Augmentation was mainly performed in cases of agenesis, aplasia or significant hypoplasia of the breasts for aesthetic and medical reasons. After excellent primary results, it was also used in cases that were more complex. In the territory of the former Czechoslovakia, hydronic breast implants were implanted in patients after breast removal due to cancer for the first time in 1964. In some cases, previously used unsatisfactory acrylic or silicone implants were replaced with new ones made of hydron (Fig. 6).

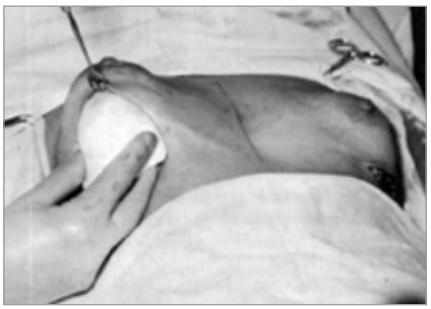

Fig. 6. Implantation itself [1].

Before surgery, the implants were stored for 12 hours in distilled water, sterilized by boiling, and immediately before application, they were placed in an antibiotic solution containing 6 IU of crystalline penicillin and 1 g of streptomycin per 500 mL of distilled water for 2 hours [1].

The operation was performed under general anaesthesia with antibiotic prophylaxis. The incision was made laterally in the inframammary crease. Above the pectoral fascia, the skin and gland were mobilized with blunt dissection to create sufficient space for the implant. After implantation, the implant was caudally fixed to the fascia with two thin nylon monofilament sutures. Suturing of the subcutaneous tissue and skin was performed with single non-absorbable sutures and the wound was closed without drainage. After the operation, a wet modelling bandage and a fixation corset bandage with cotton were applied [1].

Postoperative care included removing the dressing after 3–5 days and changing to a new and identical dressing for 2–3 weeks. Local depot antibiotics in the implant were supplemented with general application of penicillin and streptomycin. Hospitalization lasted for at least 14 days (Fig. 7, 8) [1].

Complications after implantation of hydron to the breast

In addition to early postoperative complications (especially infectious), it

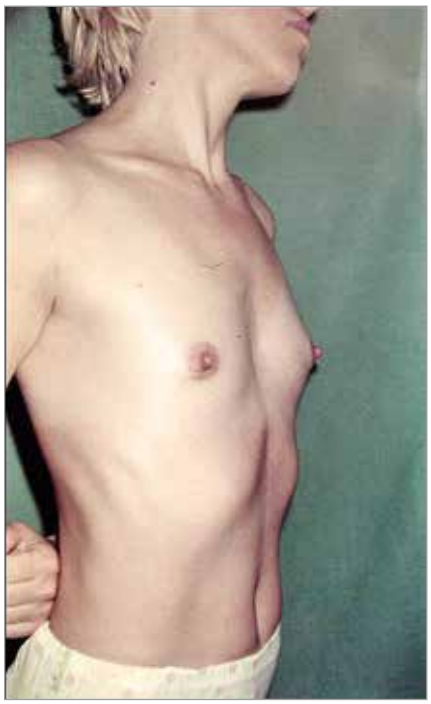

Fig. 7. Before implantation (from the archive of the author).

Fig. 8. After implantation (from the archive of the author).

seems that later complications probably occurred depending on the production technology (heterogeneous/homogeneous; open/closed pores). For porous implants and heterogeneous gels, macroscopic tissue ingrowth up to a depth of 12 mm with a rigid scar capsule of 1–2 mm thickness occurred more often. Later on, calcium salts were deposited in the scars and capsule with the formation of calcifications.

Wichterle implants in the early 2020s – case reports

Case report 1

An 81-year-old patient felt a "lump" in her right breast after augmentation with Wichterle implants in 1970; ultrasound examination showed no signs of malignancy; encapsulation was present on both sides. Clinically, the right breast was larger by about 200 mL with deforming arching in the lower half of the breast. Both breasts were firm on palpation; the axillae were without palpable mass. The patient was indicated for explantation of Wichterle implants, bilateral capsulectomy with mastopexy and immediate augmentation with round silicone implants – medium profile of 275 mL.

Fig. 9. Case 1 – before surgery (from the archive of the author).

The operation and the postoperative course were without complications, the drains were removed on the 3rd postoperative day and the patient was discharged with Augmentin 1g every 12 hours for a total of 5 days. The wounds healed primarily in 3 weeks. The patient is still being followed up without complications (Fig. 9–14).

Case report 2

After implantation of Wichterle implants in 1982, a 78-year-old female patient

Fig. 10. Case 1 – explantation 1 (from the archive of the author).

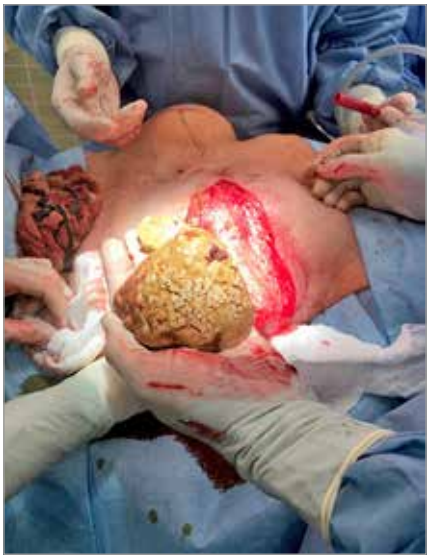

Fig. 11. Case 1 – explantation 2 (from the archive of the author).

Fig. 12. Case 1 – a hydron implant with calcification (from the archive of the author).

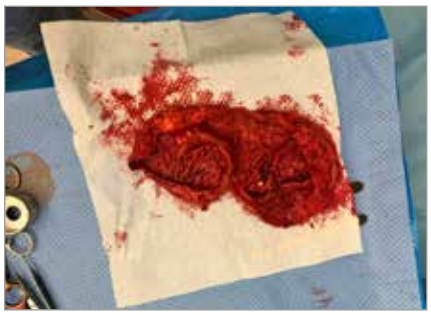

Fig. 13. Case 1 – a capsule (from the archive of the author).

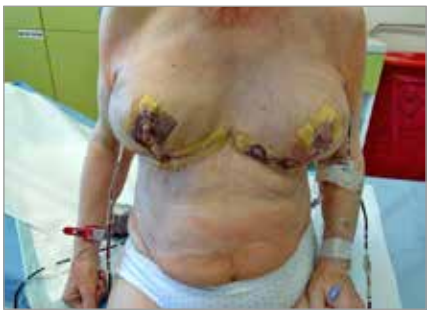

Fig. 14. Case 1 – after surgery (from the archive of the author)

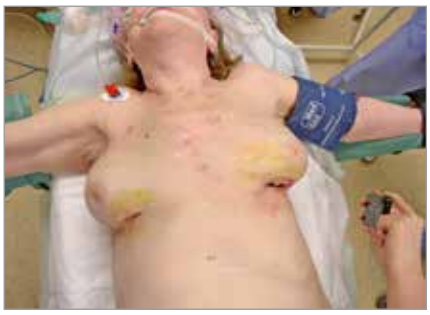

Fig. 15. Case 2 – before surgery (from the archive of the author).

Fig. 16. Case 2 – explantation 1 (from the archive of the author).

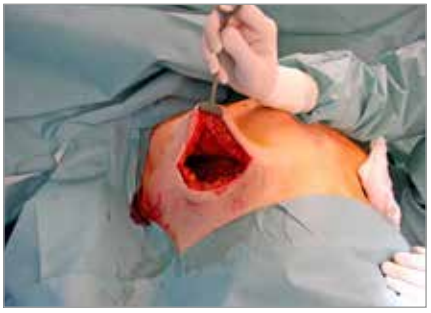

Fig. 17. Case 2 – explantation 2 (from the archive of the author).

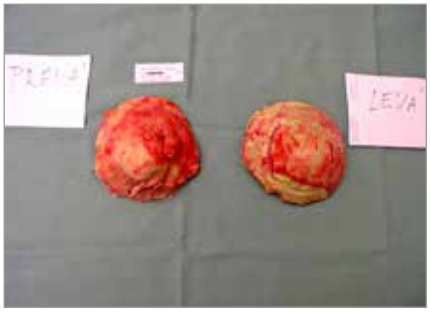

Fig. 18. Case 2 – a hydron implant 1 (from the archive of the author).

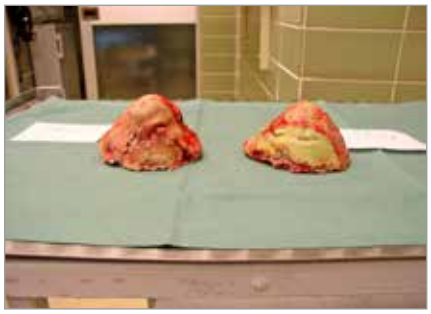

Fig. 19. Case 2 – a hydron implant 2 (from the archive of the author).

was hospitalized with protrusion and exposure of both breast implants and infection. The patient with impaired compliance was initially treated at another workplace, where she no longer came for a check-up. EMS transferred the patient urgently to our workplace due to extensive inflammation. Clinically, the left breast had an approx. 5 × 6 cm defect and an exposed implant, the right breast had two fistulas of 1 cm in size, both breasts had purulent and foul-smelling discharge. The patient was indicated for acute operative revision. Implant explantation, capsulectomy with irrigation and drainage were performed. The operation and the postoperative course were without complications. In the postoperative period, the patient was afebrile, the local findings were calm, and she was discharged on the 5th postoperative day. The patient healed primarily and did not come for the last recommended check-up (Fig. 15–19).

Conclusion

In the late 1960s and early 1970s, hydrophilic gel was almost a perfect alloplastic material. It had a wide range of mechanical properties that allowed variable use, it was inert, it could be easily sterilized by conventional methods and, if necessary, it could be used as a carrier for aqueous solutions of biologically active substances (antibiotics, etc.). Its shaping before or during surgery was easy and required no special tools. Healing was mostly uncomplicated and early results were favourable. Over time, however, imperfections became apparent, especially in the form of calcifications, and hydron was replaced by modern materials. However, this material clearly contributed to the development of reconstructive and aesthetic breast surgery. To this day, we still rarely meet patients

Fig. 20. A model (from the archive of the author).

who underwent hydron implantation (Fig. 20).

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