



The induced membrane technique for treatment of bone defects: What have I learned?

I started using the induced membrane technique approximately thirty five years ago. Initially, I had to deal with the treatment of the challenging bone defects resulting from post-traumatic septic non unions of the leg. I had to apply a rigorous strategy including the eradication of infection by radical debridement, the adequate stabilisation of the limb, the soft tissues repair by flaps and finally the restoration of the bone that was missing with bone grafting.

With time the indications to apply this technique were extended to other aetiologies of bone defect, such as tumor or congenital pseudarthrosis, to all bone segments and more recently to recalcitrant non unions [1–4]. The basic technique as it was originally described can be applied to the different aetiologies of bone defects and different anatomical locations.

Many patients have been managed successfully with the technique [5–7]. Looking ahead at the future however, we need a global approach if we want to make further advances. A global approach means a ‘conceptual approach’ resulting from definitions of concepts. These concepts must be defined from the empirical experience (ascending approach). Interestingly, once defined, the concepts allow expressing new hypothesis which must be tested (descending approach).

From the facts to the concepts: an ascending historical approach

The membrane which is induced by the PMMA spacer is not a concept: it is a biological fact. The discovery of the role of the membrane in the bone segment reconstruction is a mixing of non-rational events and scientific methods. During the first three years of my experience, I performed several large-scale reconstructions without knowing the role of the membrane. I put the spacer into the defect only in order to spare the space of reconstruction for the graft. At that time, it was not realised that the surgery carried out was based on a triple transgression: the introduction of a foreign body (the spacer) into an initially infected site, the conservation of the membrane and the reconstruction with cancellous bone of substantial bone defects, which was strongly discouraged throughout the literature. Preservation of the membrane then, followed a set of vague arguments combining an aesthetic feeling and the principle of preserving of blood and energy. It was not rationale. The conservation of the membrane and the emergence of the hypothesis of its role in consolidation and integration of the graft material applied to bridge the defect is the result of serendipity, which is “the art of making discoveries unintentionally”. The establishment of indisputable facts or explanations of phenomena belongs to the scientific method and the cornerstones of the validity of the technique were an animal experiment in Davos thanks to a grant from the AO foundation, successive clinical series and mainly the results of basic research initiated by Philippe Pélissier [8] who showed that the membrane was biologically active.

At that point we can say that the induced membrane technique is inserted in a biological framework and not yet in a conceptual vision. Formulation of concepts is a mind operation which allows to define general ideas and to consider the technique as a particular case of an expanded conception.

The arguments of maintaining the induced membrane technique are based on the concept of irritability of living tissues and the concept of being a bioactive envelope.

For a long time, a foreign body reaction has been considered as a lifeless fibrous wrapping. Irritation of a living tissue activates a very complex inflammatory response that its final goal is a regeneration of the injured tissues. From this point of view, there is no difference between the induced membrane technique and the scraping of a superficial wound to enhance the skin healing.

The second concept is the bioactive envelope. The envelope induced by the irritation of the tissues has a protective role against the

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local environment (i.e. muscles), and a nourishing function which depends on the nature of the local environment (i.e. bone). The concept of envelope is well illustrated by the nice words of Goethe [9] who wrote in “The Metamorphosis of Plants”: “All that lives must be protected by an envelope”.

From the concepts to the facts: a descending fertile approach

What can bring a descending approach from the concepts? First it permits to unify several facts or notions that seem very different and apart. For instance, the irritative capacity of the spacer according to the shape, the nature and the composition. The radio opaque component of the PMMA cement is probably important. The controversies about the time of the second stage can be explained by the fact that the set of small pieces of graft initiate an iterative inflammatory response even in very old membranes. One may wonder if a very firm stabilisation is needed at the first stage of the technique. As a matter of fact, flexible or temporarily stabilisation (i.e. external fixator) may enhance the irritation of the surrounding tissues by micro movements. Nonetheless, stabilisation must be reinforced at the second stage to promote the biological process of graft revascularisation. The concept of irritability might also allow to explain why some consolidations are successful in spite of the presence of a residual low-grade infection.

The concept of envelope is not new. The two stages technique of tendon grafting, described by Hunter [10] is applied by the need to restore a pseudo synovial sheath for the tendon grafts. One may apply this notion of nourishing envelope to improve the quality of nerve grafts.

These are some examples of hypothesis which are emerging from the initial concepts.

Finally, formulation of concepts allows transferring an initial specific experience to other fields.

The process of thinking presented above it is hoped to be used as a ‘food for thought’ within our profession. Hopefully, what we have learned and will continue to learn from the induced membrane technique can be transferred to other fields of medicine for the benefit of our patients.

Declaration of competing interest

The authors declare that they do not have any conflict of interest with the content of this manuscript.

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