Coral as graft in cervical spine surgery

Le corail comme greffon intersomatique dans les arthrodèses cervicales

P.H. Kehr, A.G. Graftiaux, F. Gosset, I. Bogorin et K. Bencheikh

Unité du Rachis, Hôpital Chirurgical Orthopédique Stéphanie, Hôpitaux Universitaires de Strasbourg, F-67026 Strasbourg Cedex, France

Résumé. L'intérêt d'utiliser des biomatériaux et particulièrement du corail en chirurgie rachidienne cervicale est lié à la volonté de supprimer les inconvénients liés à la prise de greffe osseuse dans les arthrodèses, que cette greffe soit iliaque ou encore péronière ou tibiale. L'étude du corail depuis 1970, chimique, microscopique, biomécanique puis clinique a permis de montrer l'intérêt d'un matériau dont la structure rappelle celle de l'os, se dégradant complètement et étant remplacé par de l'os néoformé. Nos premiers résultats sur 37 cas revus confirment ces données en étudiant l'évolution du corail, sur la bonne tolérance clinique, sa bonne incorporation radiologique sans modification de la statique rachidienne. Une revue de la littérature au sujet des biomatériaux utilisés montre les avantages et les inconvénients de chacun expliquant le pourquoi de notre choix.

Mots-clés : Corail — Greffon intersomatique — Arthrodèses cervicales — Chirurgie

Abstract. The value of using biodegradable devices and particularly coral in cervical spine surgery is linked to the desire to suppress the disadvantages of taking bone graft for arthrodeses (using the Robinson's technique), be it iliac, fibular or tibial. The chemical, microscopical, biomechanical and clinical study of coral since 1970 enabled us to show the value of a material whose structure resembles that of bone, degrading itself completely and being replaced by newly formed bone. Our first results in 37 cases confirm these data by studying the evolution of coral, the good clinical tolerance, its good radiological incorporation with no alteration of the static balance of the cervical spine. A literature review on the subject of the use of biodegradable devices shows the advantages and disadvantages of each explaining the reason for our choice.

Key words : Coral — Graft — Cervical spine — Surgery

Why replace bone?

The idea of replacing bone by another material in order to restore bony continuity is not new. One of the first examples known was the use in the nineteenth century of the first substances of non osseous origin which was plaster of Paris. The idea of looking for material different from bone was originally proposed to augment the deficient quantity of bone available. Indeed in the one patient it is sometimes difficult to find "autograft" bone in great amount. The first allografts proposed by Ollier [13] were soon limited by storage problems. It was only in 1912 that Carel and Elbee proposed deep frozen conservation of bone leading to the actual concept of a bone bank the first of which was set up in 1950 by Herbert and Sicard [18].

In the second stage the idea of using a biodegradable material was no longer linked to storage problems but to getting an easily transportable and storable material, to easy use replacement in bone and if possible ending in the formation of new bone. In parallel the taking of bone grafts and the problems (Table 1) linked to this are avoided [11, 20].

Table 1. Risks and disadvantages of iliac graft harvest

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<tr>
<td>Second operating site (scar)</td>
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<tr>
<td>Increase of operating time</td>
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<td>Increase of hospitalization time</td>
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<td>Risk of persisting pain</td>
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<td>Infection risk</td>
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<td>Haematoma risk</td>
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<td>Meralgia risk</td>
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</table>
In the third stage we widen the goal by looking for non immunogenetic devices, resorbable and replaced by newly formed bone. Furthermore reducing hospitalization time, the biodegradable material can reduce the total hospitalization cost.

These arguments led us, like others, to become interested in biodegradable devices, while demonstrating the value of a material able to resorb itself by stimulating the formation of new bone. This substitute having to be biologically inert, easily available and easily adjustable in size and shape to the osseous site to graft.

We used Acropora Coral to see if it is an efficient alternative to autografting in interbody cervical arthrodeses after transdiscal osteophysectomies. We use the Robinson technique [6, 16] in the surgical treatment of cervico-brachial neuralgia or of medullophtalies linked to a hard or soft discal hernia (osteophytes). Arthrodesis of the vertebrae at the end of the operation was for a long time done by tricortical autograft taken at the expense of the anterior iliac crest.

By using autograft the surgeon brings in autologous bone made of the osseous frame of the constituent cells. These cells will be able to continue their work of osseous regeneration on the site needing rapid integration. On the other hand in the case of biodegradable materials such as coral or allograft, sound and solid bone will develop on condition that the receiving bone provides the vascularization and the necessary cells to allow resorption and bone formation.

**Coral**

The study of coral as an osseous substitute began in 1970 within the Orthopaedics Research Institute in Garches. The discovery of a madreporic structure similar to that of bone with a porosity from 100 to 300 microns (Table 2) led to animal and clinical experiments. Thus in 1975 Chiroff [1] in the USA noticed incorporation with resorption at the twelfth month in the dog. In 1977 Guillemain [4, 14] noticed the same thing in the dog and Souyris [19] in 1980 in the dog and the monkey.

The histological studies done then showed invasion, within a few days, of extravasated marrow cells, then apposition of osteoblasts on the coral scaffold, forming osseous tissue. In parallel, osteoclasts on the borders lead to resorption. Hence the interest in this synergy. Other studies have also shown that the cells with osteogenic potential need a rigid wall in order to fix themselves before producing a calcifiable matrix, which is offered by the cartilage and the madreporic coral [4, 14].

These encouraging results led to clinical experiments from 1979. The first results were published in parallel in orthodontics and within the field of pseudarthroses, filling trepan skull holes, filling after tumor removal, grafting in compression fractures then from 1986 for posterior arthrodeses in scolioses [11].

It was during those first clinical experiments that precise conditions were defined for use:
- Contact space between the cancellous bone and the coral the biggest possible and stable
- Avoiding shifting zones between implant and bone.


The study of the bad results revealed the conditions which led to those situations:
- Mobility of the graft.
- The invading of the pores by a liquid destroying the coraline architecture (as lidocaine...) or neutralizing the invading (as the synovial liquid).
- The destruction of the architecture by trauma (impaction, per-operative modeling...) does not allow its integration.
- In the case of dura mater wound the graft will absorb the cerebral fluid, this being a counter indication for its use.

**Our cases**

Interbody coral grafts of 20% porosity were used in our department from January 1990 in transdiscal osteophysectomies (Figs. 1, 2, 3) done for hard or soft discal hernia (osteophytes) (CT diagnosis) showing neurologic compression signs (EMG).

Between January 1990 and July 1993, coral was placed in 45 cases (Table 3), 34 times at one level, 4 times at two levels (8 discal levels) and for 3 corporectomies (6 discal levels), i.e. in 45 patients. Furthermore, there are 2 patients in whom the coral had to be removed a few days after placement because of independent complications (leak of cerebral fluid), we shall return to that subject.

The average age was 47 ranging from 19 to 72 years; there were 18 women and 23 men. The average follow-up was 368 days ranging from 1197 to 42 days in 39 cases, 2 cases are recent.

The operated levels are shown in Table 4.

We used grafts of varying height, between 5 and 8 mm. For the 30 first cases, the grafts had a rectangular shape with round edges, imitating the iliac graft with a maximum transverse dia-

**Table 2. Compared mechanical characteristics of coral and bone**

<table>
<thead>
<tr>
<th>Constraints to rupture (MPa)</th>
<th>Acropora cortical coral 20 %</th>
<th>Porites cortical coral 50 %</th>
<th>Cortical human bone</th>
<th>Cancellous human bone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young Modulus (GPa)</td>
<td>110</td>
<td>26</td>
<td>150</td>
<td>5</td>
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</tbody>
</table>

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