

INJECTABLE OR IMPLANTABLE BIOMATERIALS FOR FILLING OR BLOCKING LUMENS AND VOIDS OF THE BODY

FIELD OF THE INVENTION

This invention is in the field of medical implants and injections. More particularly, it concerns methods for completely or partially blocking, augmenting, sealing, or filling various biological lumens and voids within the body of a patient.

BACKGROUND OF THE INVENTION

Lumens (or lumina) are the spaces in the interior of a tubular structure, such as an artery, vein, intestine, Fallopian tube, trachea, and the like. In some instances, it may be desirable to augment, block, or fill these spaces to effect a preferred biological result. Further, some biological disease states, or treatments for such disease states, cause the formation of undesirable voids within various tissues or organs of the body.

One important lumen structure is the Fallopian tube, which is either of a pair of slender ducts that connect the uterus to the region of each of the ovaries in the female reproductive system. One existing form of birth control is the ligation of both tubes to prevent the movement of eggs or ova into the uterus, thus preventing pregnancy. Unfortunately, this method of birth control requires surgery and is irreversible unless the tubes are cut to remove the ligated portion and the remaining sections of the tubes are reconnected.

As a result of this surgery, the female patient is at greater risk of complications or of failures in the procedure. Further, this type of surgery is expensive and requires hospitalization. Therefore, other methods of birth control, which are less risky and more economical, are preferred.

SUMMARY OF THE INVENTION

The present invention discloses a general method for completely or partially blocking, augmenting, sealing, or filling a biological lumen or void within the body of a patient comprising administering an effective amount of a biomaterial into the lumen or void. A particularly preferred method of the invention comprises administering by injection into the lumen or void an effective amount of a biomaterial composition comprising a biomaterial and a crosslinking agent before substantial crosslinking has occurred between the biomaterial and the crosslinking agent. Another preferred method of the invention comprises injecting an effective amount of a biomaterial composition comprising a particulate dehydrated crosslinked biomaterial and a non-aqueous carrier into the lumen or void. In an alternative method, one or more rods comprising an effective amount of a dehydrated biomaterial composition comprising a crosslinked biomaterial are implanted into the lumen or void.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

Preferred Biomaterials for Use in the Invention

Biomaterials for use in the practice of the present invention must be biocompatible, essentially non-immunogenic, and injectable, threadable, or otherwise readily implantable.

It is necessary that such biomaterials be in pharmaceutically pure form, or capable of being purified to be in pharmaceutically pure form, such that they can be incorporated into a human body without generating any significant immune response. Biomaterials for use in the invention should be capable of persisting at the site of placement for, preferably, three months or longer; more preferably, six months or longer; most preferably, one to two years or longer. It must be noted that the terms "biomaterial" and "biomaterial composition" are used interchangeably herein and are intended to encompass mixtures of the biomaterials described below.

Preferred biomaterials for use in the practice of the invention include, in general, all biocompatible, naturally occurring or synthetic polymers and, specifically, naturally occurring proteins such as collagen; various synthetic polypeptides such as poly(lysine); polysaccharides such as glycosaminoglycans; proteoglycans; and various polymeric hydrogels.

Proteins such as collagen, fibrin, and elastin are particularly suitable for use in the methods of the present invention. As used herein, the term "collagen" is intended to encompass collagen of any type, from any source, including, but not limited to, collagen extracted from tissue or produced recombinantly, collagen analogs, collagen derivatives, modified collagens, and denatured collagens such as gelatin.

Collagen is the major protein component of bone, cartilage, skin, and connective tissue in animals. Collagen in its native form is typically a rigid, rod-shaped molecule approximately 300 nanometers (nm) long and 1.5 nm in diameter. It is comprised of three collagen polypeptides which form a tight triple helix. The collagen polypeptides are characterized by a long midsection having the repeating sequence —Gly—X—Y—, where X and Y are often proline or hydroxyproline, bounded at each end by the "telopeptide" regions, which constitute less than about 5 percent (%) of the molecule. The telopeptide region of the collagen chains are typically responsible for the crosslinking between chains and for the immunogenicity of the protein.

In general, collagen from any source may be used in the practice of the present invention; for example, collagen may be extracted and purified from human or other mammalian source, such as bovine or porcine corium and human placenta, or may be recombinantly or otherwise produced. The preparation of purified, substantially non-antigenic collagen in solution from bovine skin is basically a three-step process involving solubilization, enzyme treatment, and purification, as described in U.S. Pat. Nos. 4,140,537 and 4,488,911, which are incorporated herein by reference. Commonly owned, allowed U.S. patent application Ser. No. 07/921,810 discloses methods of extracting and purifying collagen from the human placenta. Commonly owned, copending U.S. application Ser. No. 08/183,648 discloses methods of producing recombinant human collagen in the milk of transgenic animals, including transgenic cows. The term "collagen" or "collagen material" as used herein refers to all forms of collagen, including those which have been processed or otherwise modified.

Collagen of any type, including, but not limited to, types I, II, III, IV, or any combination thereof, may be used, although type I is generally preferred. Either atelopeptide or telopeptide-containing collagen may be used; however, when collagen from a xenogeneic source, such as bovine collagen, is used, atelopeptide collagen is generally preferred, because of its reduced immunogenicity compared to telopeptide-containing collagen.