

# Some suggestion for approaching the study and the conservation of ancient human biological remains. A syntesis of the conservation work in the body of Blessed Margherita of Savoia

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## Abstract

***This paper presents some suggestions for the application of a protocol for the correct approach to working with archaeological objects, mummies in particular, both in conservation and intervention.***

- a. A proposal for the creation of a National Committee for Anthropological Heritage through a public regional institution responsible for authorizing and controlling intervention and conservation.***
- b. To establish bonds between institutions that deal with cultural heritage.***
- c. To design a Restoration Form for the regulation of interventions and the substances used.***

## Introduction

In 1975, after many years of experience in the field of conservation of works of art as the director of the Cabinet of the Scientific Research of the Vatican Museum, I became involved with the restoration of the bodies of Saints. I started with the restoration of the body of st Ubaldo, the Bishop of Gubbio (1150). Since then I directed the following projects:

My degree in biochemistry was very helpful in my work on the conservation of the ancient bodies of Saints, but it was my experience in the restoration of works of art that turned out to be even more useful. In particular, I used my knowledge of the techniques and the substances that are used in the restoration of paintings, works of art on leather, parchment etc. I must confess that while working on the individual projects, I was often frustrated by the lack of a procedure regulating the typology of the treatments

depending on the conservation of the remains and, above all, of the norms regulating the correct sequence of preliminary research. I sometimes participated in examinations of the bodies that risked to compromise the integrity of the remains or, worse, to further deteriorate its already poor state of conservation. In this situation I decided to apply the norms that regulate the restoration of works of art.

1. The National Board of experts for the study and cataloguing of human biological remains (The Department for the Study and Cataloguing of Human Biological remains).
2. The Regional Co-ordinator of the Study and Cataloguing of the Ancient Biological Human Biological remains.
3. The obligation for all the projects of the restoration of ancient biological human remains to obtain the approval of the regional co-ordinator.
4. The set of norms for a conservation procedure.
5. Norms on the use of substances that may or may not be applied. The criteria for the reversibility of the substances. The use of products that do not alter in time and that at any time allow the performance of cognitive analyses ( $^{14}\text{C}$ , analysis of the oligo-elements and other).

## The Body of the Blessed Margherita di Savoia: the Synopsis of the Restoration Work

The preliminary research conducted prior to the conservative restoration of the mortal remains of Saints raised to the altars for the veneration of the faithful is a primary element, of fundamental importance, in choosing the type and the successive phases of the treatment. In general, the examination has to provide the conservator with the answers to the questions that he asks himself while observing the body still in the urn, before undressing it: are the bones all in place? Does the bone tissue present signs of alteration caused by organic agents and/or signs of de-cohesion of its inorganic constituents? Does the

integument, if present, cover the skeleton entirely or only partially?

In order to verify the state of conservation of both the skeleton and the integument that may still be present, before, as we said, removing the clothing, it is necessary to perform accurate X-ray analysis using the same technique as for paintings: low voltage, long exposure, a high-quality X-ray generator with a beryllium window.

Another important part of the preliminary investigation is the micro-biological and parasitological analysis. The former can reveal possible bacterial and/or micro-fungal infections; the latter looks for parasitic infestations of worms, insects, etc.

Depending on the type of contamination, the conservator will study and decide which products to use as well as the way in which to apply them in order to definitively restore the entire body.

Another fundamental element is the identification of the external chemical-physical deteriorating agents that may have contributed to the poor state of conservation of the body.

Among the physical factors that should be considered is the relative humidity and temperature, the excessive lighting, ultraviolet and infrared radiation. Among the chemical factors to be considered is the presence of aerial chemical pollutants or other products erroneously introduced in the urn for conservation purposes. Frequently, the deterioration of the Venerable Remains is caused by the high levels of relative humidity and temperature that are not suitable for the conservation of tissues. The excessive humidity may facilitate the proliferation of spores and microfungi and, as a result, of the arthropoda.

The state of conservation of the ancient bodies, either naturally or artificially preserved, placed in the urns, in the altars for the veneration of the faithful, is never optimal. During the procedures of their recognition, that in the past were usually conducted by the public and ecclesiastical authorities, in order to verify their state of conservation, only on rare occasions was optimal state observed. Very often, the deterioration of the bodies was caused by bad climatic parameters: excessive temperature and high relative humidity. The bodies were usually illuminated by incandescent lamps placed directly above the glass urn. This augmented the temperature in the urn and accelerated the deterioration process pertinent to the bacterial and microfungi infections. The high temperature was, above all, the factor causing the dehydration of the tissues and, eventually, their pulverisation.

In my experience as the conservator of the bodies of Saints and of the Relics of the Blessed, I often observed the poor state of conservation caused by microfungi flora and, above all, by the insects similar to the ones that attack wood (Gabrielli et al, 1993; Gabrielli 1993; Gabrielli, 2002). Leaving aside the exact description of the state of conservation of the bodies (autoptic examination), including, of course, the body of the Blessed Margherita di Savoia, it can be summarised as follows:

- Disconnection of the elements of the skeletal

apparatus: observed most of all in the articulations of the long bones, the cranium, the rachis, the ribs, the sternum.

- Profound alterations of the integument: cracks in the skin with numerous perforations, detached fragments, not anchored to the underlying structure. Dry, fragile, and profoundly dehydrated integument that pulverise to touch (Fig. 1).



Fig. 1 - The state of conservation.

## The conservative procedures on the body of the blessed Margerita of Savoia

### The connection of the detached bones

For the proper execution, the procedure has to start from the back of the body. In order to turn the body without causing further disconnection or damage to the integument, it is necessary to block the anterior with a "fake plaster cast" applied onto the tissues. This can be done using sheets of gauze soaked in hot paraffin and applied in several layers. The following day, the body can be turned, as the solidified paraffin blocks and contains its front like a rigid shell.

For this purpose, it is necessary to melt in a special dish, paraffin of low fusion point of 40-60°C, in petroleum ether with distillation point of 80°C (it is necessary to use ether of this point of distillation because if it were lower it would distill before the paraffin melted), in the proportion of 1:3. One by one, the pieces of gauze are soaked in the paraffin and then, still warm, are applied on the entire surface of the body. For a better fixture it is necessary to apply at least 2 layers of gauze.

After the bandaging it is necessary to wait for the paraffin to solidify before turning the body. The treatment can start after some 24 hours (Fig. 2).



Fig. 2 - The containment of the body with gauze (40 x 40) dipped in melted paraffin.

### *Restoration treatment of posterior part of the body*

#### *On the skeletal apparatus*

The Body of the Blessed Margherita, supported and fixed with the paraffin bandaging, is now turned upside-down and placed on a foam rubber bedding in which openings were made to position the head, the arms and hands, and the feet without causing pressure on the precarious articulations.

The skeletal apparatus is, unfortunately, well visible because of the numerous gaps in the integument where the bones come out, especially in the thorax. The skull is detached from the rachis. In fact, the first vertebra, the atlas, is mobile and detached from the occipital foramen. The latter is still united with the body through integument and, perhaps, through muscles. In particular through one: the sternocleidomastoid that might still, at least in part, given the age of the body, keep its articulations.

The scapular-humeral articulations appear to be in good condition. The vertebrae of the rachis seem to be firmly united. With the exception of the cervical and some of the thoracic vertebrae that are covered with integument, the processes of the other vertebrae are visible. In both the right and the left hemithorax it is possible to see some ribs. The sacrum is visible through the lacerations in the tissue. The femora appear firmly anchored in the acetabula. The fibula of the left leg has its upper part detached from the tibia, and its lower part disarticulated from the astragalus. Also the fibula of the right leg is disarticulated from the astragalus. The feet with all the bones *in situ* are mobile because scarcely anchored to the respective tibiae and fibulae.

The connection of the detached bones in their articulations is a procedure not always easy to perform, but in our case it was facilitated by the fact that the skeletal apparatus was, on this side of the body, visible and accessible in many points.

The disarticulated bones emerge through the gaps in the dermis and their points to be connected are described above.

The procedure used in the connection of the bones has to be performed before any other treatment, first of all before the hydration treatment, to avoid the oiling of the articulations that must be cemented.

About the products used, in my opinion, the polyester resin is the optimal adhesive to be used rapidly in any connection. Depending on the type of treatment it can be applied with a spatula, like stucco, or injected with a syringe and needs to be mixed with micronized silica in order to give it the desired consistence and viscosity. In order to adhere and cure the resin needs a hardener: 5% of ethyl-methyl-ketone peroxide; and of an accelerator: the naphthenate of cobalt in the proportion of 0,02%. By diminishing the quantity of the accelerator the curing time becomes longer and the resulting product is less rigid (Fig. 3).

#### *State of conservation of the integument*

The tissues on the posterior part of the body are dry, pulverized and torn. It is not easy to assess the condition



Fig. 3 - The re-attachment of some of the detached with resin Poliestere.

of the skin because it breaks and pulverizes when touched. Proceeding with the examination from the head to the sacrum, we observe that the tissues are present on the occipital and continue on the neck and, partly, on the shoulders. As far as the condition of the dorsal integument is concerned, it is difficult to evaluate due to its severe state of deterioration. It can be said that there are few areas with integument still present. The integument on the legs presents numerous gaps, holes, cracks and on the tibiae it is missing altogether.

#### *The hydrating treatment of the tissues*

The conservative treatment with the purpose to consolidate the surface of the tissues of the Bodies venerated by the faithful in the altars, have been performed for centuries. Many substances have been used. The oldest one is colophene resin, obtained through distillation of turpentine, the liquid produced by conifers, especially by the Aleppo pine. Rubber latex dissolved in alcohol was also widely used. In modern times conservators have preferred synthetic resin with cellulose base first, then resins in ethyl-methacrylic base, and others.

In the course of my activity as a conservator of the bodies and relics of Saints, on many occasions I verified the presence of such substances and have been able to observe the effect they produced over time. I can report that the tissues that had been subjected to such treatments were dry, rigid, and broke and pulverized easily. This phenomenon was caused by the flaking of the varnish. It strongly adhered to the skin, that was obviously not elastic any more, and provoked the flaking of the entire integument.

While observing the deterioration of the matter, accelerated by the consolidating treatments with the use of varnishes, I decided that the conservation of dry tissues had to be done in a different way. I made the obvious presupposition that organic matter ages because of dehydration, and man has always tried to slow down the aging process by nourishing the tissues with substances rich in water, glycerin, oleic acids etc. Taking the above into consideration, in 1975 I experimented, for the first time, on the body of St. Ubaldo in Gubbio, an emulsion on the base of water, glycerin, and unsaturated oleic acid. The procedure produced immediate and surprising effects: the integument became softer and regained compactness and elasticity.

In 1996, some 20 years later, on the occasion of the translation of the Saint to a new urn, I was able to verify, with amazement, the successful result of the hydrating treatment performed in 1975.

The treatment on the body of Margherita of Savoia is done using an emulsion of water, glycerin and unsaturated oily acids: linoleic, linolenic and arachidonic. Many products of the pharmacopoeia contain these substances and can be used successfully (Lucas 1910, Nisseubaum 1992)

The emulsion must be applied to the tissues with extreme delicacy, making sure not to cause further damage. It is advisable not to use brushes but a spatula to spread the emulsion. Once the entire body is covered with the ointment, in order to allow it to penetrate into the tissues, it is necessary to use heat. The body can be inserted in a plastic tube with a temperature controlled current of hot air or, when it is not possible to move the body, the absorption of the emulsion can be facilitated by using a simple hair-drier.

After the hydrating period it is necessary to wait for at least 7 days for the emulsion to penetrate through the dermis and for the effect to stabilize. It is therefore useful, during that period, to close the body in its reliquary with sufficient quantity of silica gel to absorb the excess water that might be returned by the tissues (Fig. 4).



Fig. 4 - The hydrating treatment with an emulsion on the base of linoleic acid, linolenic acid, glycerin and water.

#### The treatment to fill the gaps and cracks

The treatment of the filling of gaps, cracks and numerous cribose areas in the skin is not any less important and may not be separated from the treatment to connect the articulations or from the hydrating of tissues. In fact, together with the former, that gives new stability to the skeletal apparatus, and the latter gives the tissues the necessary elasticity and softness, this treatment prevents further breaking of the gaps and eventually the deterioration of the integument.

There are a number of different substances to be used: generally the ones to be preferred are waxes, silicon rubber and, in particular cases, also polyester resins. As far as waxes are concerned, one should consider the paraffin of both low and high fusion point, carnauba wax, and synthetic microcrystalline waxes. A waxy substance suitable to repair gaps in the skin has to be resistant and elastic. Usually, virgin wax is mixed with carnauba or microcrystalline wax. The obtained product is resistant, elastic and has a high fusion point. The filling of the gaps and the reparation of the cracks can be done using a solid wax stick applied by thermocautery, or by using a solution of wax in petroleum ether and turpentine that has the thickness of a creamy stucco. When applying the stucco it is important to take into consideration the shrinking of the substance due to the evaporation of the solvents.

#### The support of the rachis and/or of the posterior part of the body

It is extremely important to insert a supporting net on the rachis in the cases with the visible, also in by means of X-Ray analysis, poor connection of the vertebrae. It is even more important to insert a supporting net on the entire posterior part of the body when the tissues appear badly deteriorated, cribriform, with numerous gaps and cracks. In such a situation, the reparation of the skin itself will not ensure a perfect conservation over time.

It is possible to use fine stainless steel nets to support the rachis, and as reinforcement the cellulose hemp or linen fabric, like an "inner skeleton", of the posterior part of the body (Fig. 5).



Fig. 5 - A thick linen canvas is applied on the canvas support on the rachis to sustain the body.

#### Restoration treatment of the anterior part of the body

The connection of the detached bones in their articulations  
No points have been observed where the connection has to be performed.

#### The hydration treatment of the tissues

The procedure and the products used to carry out the treatment are described in the paragraph regarding the posterior part of the body (Fig. 6).



Fig. 6 - After the treatment of the back, the body is turned again; the paraffin bandaging is removed to start the hydrating treatment.

#### The reinforcement of the natural mummification

The hydration treatment of the tissues that gave softness and elasticity to the integument may have altered their natural state of mummification. Besides, certain products like water or glycerin might, over time and in unfavorable climatic conditions, facilitate the settling and proliferation of microfungi.

Therefore, it is necessary to carry out a special treatment on the body of Blessed Margherita in order to stabilize the state of mummification of the tissues and to inhibit the proliferation of bacteria and/or microfungi.

The solution to be used was elaborated in the 1980's, and was applied many times in the mummification of the bodies of saints. The components of the solution, whose concentration may vary depending on the state of conservation of the tissues, are the following: alcohol 42-50%, phenol 8%, creosote 3-5%, benzoic acid 10%, turpentine essence 25%, nitrobenzene 5%, and/or paradichlorometacresol 5%.

In the mummification procedures carried out on bodies immediately after death or after exhumation, this solution is applied about one month after the first treatment with the solution of 25% formaldehyde FU in 90° alcohol. Usually, the treatment is performed by immersing the body in the solutions using a special closed stainless-steel tub. In our case, instead, it is sufficient to soak the tissues to saturation, then close the body of the Blessed Margherita in the reliquary and wait for some 15 – 20 days for the solution to produce the desired effect.

#### *The disinfection and disinfestation of the entire body*

After the treatment the body of the Blessed Margherita is placed in the urn and is disinfected with formaldehyde obtained from the reaction of formaldehyde – potassium permanganate.

#### *The filling of the gaps and cracks*

The products and the methods used to carry out the treatment are described in the chapter on the conservation of the posterior part of the body (Fig. 7).



Fig. 7 - Filling in the big and small gaps in the skin with: wax, carnauba, microcrystalline wax, acrylic resin.

#### *The final protection of the integument*

Having allowed time necessary for the substances used to repair the skin to stabilize, it is useful to apply on the integument a protective layer of microcrystalline wax and minimum quantity of acrylic resin. The preparation is the following: microcrystalline wax is melted with turpentine essence. Usually, for 100 g. of wax 400 cc of turpentine are added.

Then, acrylic resin “paraloid B72” (ethyl-methacrylate) is diluted in toluene, xylene or nitro solvent, at 5%.

The solution is prepared by mixing 3 parts of the

turpentine – wax suspension with 1 part of the acrylic resin “paraloid B72”. (Fig. 8)



Fig. 8 - The protection against external agents with single-component, acrylic resin and microcrystalline wax.

### **The Project of the Urn to Ensure the Lasting Conservation of the Body of Blessed Margherita di Savoia**

In order to ensure the lasting conservation of the Blessed, the urn in which the body is deposited must not contain products or materials that are subject to alterations. All the materials that can be attacked by insects or microfungi have to be removed, because such infections may invade the body of the Saint. In particular, wooden supports, woolen mattresses, and woolen and silk clothing have to be removed. Besides, in order to preserve the elasticity of the integument it is strictly necessary for the body to be kept in the environment with the relative humidity of about 30%. The appropriate quantity of silica gel (20 kg for cubic meter) placed under the body of the Blessed, conditioned to the relative humidity of 30%, can give or take water from the tissues when the parameter drops below or exceeds the optimal level.

Regarding illumination, the parameter to be taken into consideration is lighting of some 100 lux. The bulbs, that may not produce heat, will be placed outside the urn. Optical fiber or low potency fluorescent lamps can be used, with the reactors at a suitable distance from the urn. The mattress supporting the body is made from perforated plexiglass covered with linen.

Placed under the “mattress” is a *lexan* container with the necessary quantity of silica gel, which in our case is 6 kg, considering the 300 liter capacity of the urn.

To ensure the optimal conservation of the tissues and to avoid the development of the spores of microfungi that may have entered the urn during the deposition of the body, the urn has been saturated with nitrogen. The remaining quantity of oxygen is of 0,2% to avoid the proliferation of anaerobes

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