

Titanium in Orthopaedics

Titanium is traditionally seen as a “biocompatible metal” which osseo-integrates with bone so is used in orthopaedic, spinal and dental surgery. It forms the outer casing for pacemakers and is present in staples and clips used in surgery.

1. Pure titanium is composed of about 99% titanium. Very low traces of nickel may be present [1].
2. Titanium alloys consist mainly of titanium (at least 87 wt %) and either 6% aluminum and 4% vanadium, or 6% aluminum and 7% niobium [1].
3. Nitinol – titanium alloyed with nickel

Allergic potential of titanium

Generally there are fewer reports of titanium allergy than allergy to stainless steel and cobalt chromium alloys [2]. The first case of pacemaker contact dermatitis was reported in 1970; since then, a growing number of general titanium allergy cases have been documented [3].

Some researchers believe that titanium allergy does not exist but that patients are reacting to the impurities in titanium [4] including nickel, chromium and cadmium.

Failure of implants may be used as an indicator of titanium allergy once infection has been ruled out [5, 6]. Given the difficulties of diagnosing a titanium allergy, studies probably underestimate the true prevalence of titanium allergies in patients [7].

It has been shown that many patients suffer from multiple allergies [8], and that people with a history of allergy to metals or jewellery have a greater risk of developing a hypersensitivity reaction to a metal implant [2].

Impurities in titanium implant materials

Material	Analysis values in % by weight							
	Al	Co	Cr	Mn	Mo	Ni	Pd	V
Pure titanium rod, Ti-2, Timet	0.021	0.001	0.014	0.02	0.001	0.013	0.001	0.012
Pure titanium Ti-1 Plate (Deutsche Titan)	0.004	0.001	0.012	0.001	0.001	0.012	0.001	0.001
TiAl6V4	5.93	0.001	0.033	0.004	0.002	0.011	0.001	4.15
TiAl6Nb7	5.98	0.001	0.011	0.002	0.001	0.014	0.001	0.001

Data from Harloff et al [4]

MELISA testing

MELISA is an optimised lymphocyte transformation test (LTT) with improved specificity and sensitivity. LTTs are used extensively to detect type IV allergies to metals and drugs. For testing prior to implantation, a panel of the 20 most commonly found metals in orthopaedic surgery is available. Testing for hypersensitivity to some of the constituents of cements and adhesives is also possible.

The lymphocyte reaction to metals is measured by two separate methods: uptake of radioactive thymidine by dividing lymphocytes and the evaluation of cellular stimulation by microscopy.



MELISA and titanium allergy patch testing

Studies show that lymphocyte transformation tests are better suited for diagnosing possible metal sensitivity than traditional patch testing. Implant-related hypersensitivity reactions are mediated by sensitized T cells [2] and the relationship between skin hypersensitivity and systemic hypersensitivity is ill defined [2, 6]. Lack of standardization in patch testing may also contribute to reduced reliability [8,10].

The accuracy of patch testing for titanium allergy in particular seems to be variable; the Mayo clinic failed to find any positive reactions to titanium in over a decade [11], despite several published cases of titanium allergy [7,12]. Traces of other metals such as nickel and aluminium are found even in commercially pure titanium due to the production process [13,14]. Titanium has been shown to induce clinically relevant hypersensitivity which can be detected with MELISA testing [15,16]. Some surgeons suggest MELISA testing prior to surgery in patients with suspected metal allergy [17]. This allows the surgeon to choose the most compatible material for surgery.

What are the symptoms of titanium allergy?

There is a wide range, and not everyone gets all the symptoms:

- Pain and inflammation at the site of surgery
- Fatigue
- Headaches
- Generalized skin reactions including urticaria, eczema

These symptoms usually come fairly slowly, and develop over a period of several months. Unfortunately, they are also typical of other medical conditions.

References

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Testing procedure

A blood sample can be sent to any licensed MELISA laboratory. Samples are time sensitive and should arrive within 24 hrs (maximally 48 hrs).

The blood sample should be kept at room temperature and sent in tubes sodium citrate light blue vacuette tubes. The amount of blood required depends on how many antigens are to be tested.

For adults, a screening of 10 metals, 36 ml (or 4 large 9ml tubes) of blood is needed.

Taking steroids or other immuno-suppressant drugs may affect the test results.

A questionnaire which helps to identify patients who are likely to benefit from MELISA testing can also be provided and evaluated. However, patient history alone is not sufficient to diagnose metal hypersensitivity [18].

