Scoliosis and metal allergy

MELISA® is a clinically validated blood test for metal hypersensitivity and may be used in two ways:
Firstly, to check pre-operatively for specific metal allergy in patients presenting with a history of suspected metal allergy (dermal reactions to jewellery, earrings, contact dermatitis, etc). Studies have shown patients who reacted to a single metal have an increased chance of co-sensitisation to another metal. [1,2,3] Given the complexity and high rate of complications associated with removing spinal rods, allergy testing prior to surgery should be considered in patients presenting with a history of metal allergy.
Secondly, post-operatively, when patients present with increased and persistent unexplained pain, sometimes after an initial pain-free period with no evidence of infection [4,5,6], usually within six months of implantation. MELISA can be used to confirm if metal allergy is responsible for the post-surgical symptoms, and will measure the strength of the allergy to particular metals [7,8].

Metal allergy and spinal implants
In metal-on-metal total hip arthroplasty, cell-mediated hypersensitivity reactions (Type IV) are well recognized and reported and have become of increasing concern [9,10,11]. Although the frequency of hypersensitivity reactions is unknown, they are associated with poor outcomes and implant failures. Although fewer cases of hypersensitivity reactions have been reported after spinal implants, which may be down to the difficulty in diagnosis. However, the mechanisms leading to such reactions are similar to those described after hip arthroplasty [12,13,14].

Why use MELISA testing?
Studies show that lymphocyte transformation tests are better suited for diagnosing possible metal sensitivity than traditional patch testing. Implant-related hypersensitivity reactions are generally type-IV delayed hypersensitivity [15] and the relationship between skin hypersensitivity and systemic hypersensitivity is ill defined [15,16]. The accuracy of patch testing for titanium allergy in particular seems to be variable. Mayo Clinic failed to detect any positive reactions to titanium in over a decade of patch testing [17], despite several cases of titanium allergy published by others. [18,19]
Traces of other metals such as nickel and aluminium are found even in commercially pure titanium due to the production process [20,21]. Titanium has been shown to induce clinically relevant hypersensitivity which can be detected with MELISA testing [16]. Before testing, it is important to bear in mind that the screws, wires, bolts, etc. used in surgery may contain other metals than are present in the rods, and these metals should also be tested. This may be a problem for hypersensitive patients and could also lead to increased corrosion.

Corrosion in vitro
With stainless steel scoliosis implants, over 65% were found to have corroded after retrieval [22]. It is generally agreed that implants rely on an oxidative layer to prevent corrosion. When mechanical stresses are applied then this protective layer will break down and metal ions may be released. The corrosive process may accelerate once the alloys or metals are exposed to bodily fluids in vitro. Spinal implants are static, load-bearing devices and are subject to both tiny movements and to fretting – at least until fusion is finally achieved. As a consequence, metal ions are released and can be found in body fluids [23-25]. In one study 35% of patients with titanium spinal implants showed abnormal serum metal concentrations [25]. Locally, released titanium particles are taken up by macrophages and might initiate inflammation, activation of osteoclasts and cellular apoptosis as described in an animal model [26].

Life threatening metal allergy treated through “immunological camouflage” of implant
This scoliosis case report describes an innovative solution for patients with metal allergies needing implants. A young boy with syndromic scoliosis had metal rods implanted and developed severe post operative symptoms. MELISA testing showed that the boy was allergic to several metals found in the implant. Symptoms resolved after the rods were removed. Eventually the rods were “camouflaged” from the patient’s immune system by an innovative carbon coating and the boy was able to tolerate the implant.
Zielinski et al, 2014 [28]
Thus in the clinical setting, the presence of titanium debris around corroding spinal implants could serve as the impetus for both late-onset inflammatory-infectious complications and long-term osteolysis [26]. As the use of dissimilar metals in spine instrumentation has increased, eg cobalt chromium alloys with titanium alloy screws Ti-6Al-4V screws so there is an increased risk of galvanic corrosion and the need for revision surgery due to metallosis [27].

**Long term exposure to metal ions**

Whilst a short term (12 month) rise in levels of titanium, aluminium and niobium in a paediatric cohort has been reported after scoliosis/kyphosis surgery, few studies have looked at the long term effects that corrosion may have [29]. Levels of nickel and chromium remain higher than normal levels four years post surgery – even when implants showed no sign of corrosion [30]. Studies link metal allergy from spinal devices to a variety of conditions including inflammatory arthritis [31], cauda equine syndrome [32] and the development of soft-tissue mass [33].

The causes of surgical site infections in scoliosis have been discussed at great length in the literature. Some authors suggest that allergy is a risk factor on the development of infectious complications associated with surgical treatment of idiopathic scoliosis [34].

**References**

16. Campbell P; metalsensitivity.com
17. Davis MD et al. Patch testing with a large series of metal allergens; findings from more than 1,000 patients in one decade at Mayo Clinic. Dermatitis 2011;22(5):256-71
33. Guyer RD et al. Early failure of metal-on-metal artificial disc prostheses associated with lymphocytic reaction: diagnosis and treatment experience in four cases. Spine 2011;36(7):492-497

**Testing procedure**

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

For adults, a screening of 10 metals, 36 ml (or 4 large 9 ml 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].