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Research Article

Cobalt Chromium Bar versus Titanium in the Surgical Treatment of Idiopathic Scoliosis

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Abstract

Establishing differences between different biomaterials of rods in the surgical treatment of scoliosis and describing advantages and disadvantages.

Methods: In the 1960 the first instrumentation was in steel (Harrington system) and surgeons used this kind of biomaterial for a long time also when the instrumentation changed with progressive improvement like Harringhton Luque and Cotrel Dubousset but in the era of MRI stainless steel doesn't permit to make MRI so steel was substituted with titanium and from some years surgeons can use cobalt chromium. The difference is about resistance and strength.

Results: We studied 60 patients operated from 2008 till 2015, 30 treated with titanium rod and 30 with cobalt chromium. We noticed better correction with cobalt chromium and the capability to maintain correction after three years than titanium.

Conclusions: Comparing titanium and cobalt chromium rods in the correction and maintenance of correction in the surgical treatment of AIS.

Keywords: *Cobalt; Chromium; Titanium; Idiopathic Scoliosis*

Introduction

The history of surgical treatment of scoliosis with instrumentation was born in 1960 with Harringhton technique.

Harringhton invented an apparatus that permitted the correction of scoliosis using a steel bar with a hook at each extreme which when placed under each end of the curve corrected the deformity with distracting action. This apparatus revolutionized the surgical treatment of scoliosis and has been used around the world. It did however have some disadvantages.

Once surgery was finished it was necessary for the patient to be immobilized for 10/12 months in a plaster cast since the "Harrington" bar alone could not ensure the patient s stability until the bone fusion was complete. The French surgeons Yves Cotrel and Jean Dubousset proposed a new spinal instrumentation system in 1983. This system consisted of two parallel metal bars posed and bound via hooks and/or screws behind the section of the spinal column concerned [1-4].

All of this revolutionized surgical treatment of scoliosis. No more long periods of immobilization with plaster casts before and after surgery. The solidity of the hold guaranteed by the system allowed the patient to get out of bed 3 or 4 days after the operation. No requirement for any external protection. Discharge a few days after surgery.

Merit to the two French surgeons for placing emphasis on the need the correction not only the scoliosis but also the deformity that develops on the sagittal plane (alterations on the side profile of the column).

Methodology

Biomaterials

In spinal surgery arthrodesis is one of the most commonly used procedures and it is carried out in association with a metal instrumentation especially steel or titanium alloys and currently also cobalt and its alloys which provide a better fusion and allow to obtain immediate stability and therefore an earlier rehabilitation.

Metal biomaterials are defined as those materials of metallic nature that thanks to certain properties which they possess are used in the biomedical field including the construction of orthopaedic implants.

When we speak of these materials it is necessary to observe that in most cases they are not used in their pure state but rather in the form of an alloy that is a mixture composed of a base element (metal) and other metal and non-metal elements.

For steel it is an alloy based on iron containing up 2% of Carbon. Only a particular form of stainless steel austenitic stainless steel is used in biomedical applications.

Stainless steels whilst representing only 2% of total steel production are one of the technology classes of steel of major particularly in biomedicine.

- For the reduced cost
- For their particular resistance to corrosion
- For ease of processing

Steel disadvantages

- It's impossible to undertake MRI scans
- Some corrections performed with steel showed a junctional pathology of the underlying segments related to the rigidity of the material but also to the lack of knowledge of the importance of the sagittal plane in the period of use of steel.

Titanium

The unusual characteristics of titanium and its alloys are

- Its resistance to corrosion in a physiological environment
- Its biocompatibility
- Its mechanical characteristics
- The success of the application of titanium and its alloys in the biomedical field is indisputable
- The limit is the high cost price at least one order higher than stainless steel
- Titanium is well tolerated both by soft tissue presenting an extremely reduced toxicity
- It presents a lower resistance to mechanical stress than steel and cobalt chromium.

The noteworthy features of cobalt alloys are

- Its biocompatibility
- Its resistance to corrosion
- These metal materials are mainly used for long term implants which are subjected to very high loads
- It has a higher resistance to mechanical stress than titanium
- There are two types of alloys based on cobalt more commonly called Cobalt Chromium alloys.

Titanium versus cobalt chromium

The charge of the enervation the rigidity and the flexion are the parameters that characterize a biomaterial from biomechanical tests Cobalt Chromium can be seen to have

- A Greater charge of enervation compared to titanium
- A greater rigidity compared to titanium
- A greater flexion compared to titanium

Titanium doesn't consent to

- Obtain the same corrective results when compared to Cobalt Chromium (also in line with the highlighted data).
- Obtain the original correction over time.

Results

We operated from 2008 till 2015 183 patients affected from AIS. From 2008 till 2011 with titanium bar and from 2012 till 2015 with Cobalt. We studied 30 pt of first group with titanium and 30 of the second group with cobalt. We choose similar cases like age like characteristic of scoliosis like Lenke curve. It's true that in a cases with titanium to correct Deformity we performed "derotation maneuvers " by Cotrel Dubousset concept and in a cases with cobalt we performed at first correction of the sagittal plane and secondary correction in the coronal plane of scoliosis with translation maneuvers.

In all case in selectioned cases we performed also distraction and compression. In all cases we used screws in a majority of cases at all levels and in the others we let free some vertebra but in general the instrumentation has been rich. As already said in the correction with titanium the bar was modeling in a coronal plane in scoliosis to derotate and obtain a result in coronal and sagittal plane.

In the correction with cobalt chromium we model a rod like a lateral plane to obtain a result in coronal plane with translation.

We studied in detail 5 patients operated with titanium bar and 5 operated with cobalt chromium.

Titanium

Lenke 1

aa 13 risser 2+

63 Cobb

mod B Hypo

Post op T4-L1

26 Cobb

mod A normal

Correction 59%

Lenke 1 aa 15 Risser 3+ 54Cobb mod A hypo

Post op T4-T12 24Cobb A normal

Correction 55%

Lenke 1 aa 12 risser 1+ 58 Cobb mod B hypo
Post op T3-L1 28 Cobb mod A normal
Correction 52%

Lenke 3 aa 13 risser 2+ 71 Cobbth 45 l mod B hypo
Post op T4-L3 30th 18 l Cobb mod A normal
Correction 58%th 60% l

Lenke 5 aa 14 risser 3+ 61 Cobb mod B hyper
Post op T5-L2 28 A normal
Correction 54%

After three years loss of correction between 10 and 15 degrees.

Cob chromium
Lenke 1 aa 11 risser 0 56 Cobb mod B normal
Post op T3-T12 20 Cobb mod A normal
Correction 64%

Lenke 1 aa 15 risser 3+ 61 Cobb B hypo
Post op T4-L1 21 Cobb A normal
Correction 64%

Lenke 1 aa 13 risser 2+ 51 Cobb B normal
Post op T3-T12 18 A normal
Correction 65%

Lenke 3 aa 13 risser 3+ 57 Cobbth 43 l
Post op T3-L2 22Cobb 16 l A normal
Correction 61%

Lenke 5 aa 14 risser 3+ 63 Cobb BHypo
Post op T5-L3 21Cobb A normal
Correction 66%
After three years the correction is maintained the same.

	Yield Strength	Ultimate Tensile Strength	Elongation to Fracture	Reduction in Area
	(MPa)	(MPa)	%	%
Ti-12Mo-6Zr-2Fe	1248	1312	11	43
Ti-13N1,137,	900	1030	15	45
Ti-15 Mo	655	793	22	60
Ti-30Nb	500	700	20	60
Ti-30Ta	590	740	28	58

Melting	1360 - 1385°C	1332 - 1363°C
Casting Temperature	1460°C	1454°C
Hardness	370 HV	439 HV
Tensile strength	850 MPa	824 MPa
Elongation	6,0%	3,0%
Modulus of Elasticity	230 GPa	206 GPa

Composition of Standard Implant Materials

Titanium	ASTM Standard	Titanium	Nitrogen	Carbon	Hydrogen	Iron	Oxygen	Aluminum	Vanadium	Yttrium
CP Titanium Grade 2	ASTM F67	99.33%	0.03%	0.08%	.015%	0.30%	0.25%	X	X	X
CP Titanium Grade 3	ASTM F67	99.21%	0.05%	0.08%	.015%	0.30%	0.35%	X	X	X
CP Titanium Grade 4	ASTM F67	98.96%	0.05%	0.08%	.015%	0.50%	0.40%	X	X	X
Titanium Alloy Ti-6Al-4V	ASTM 1472	88.07-90.32%	0.05%	0.08%	.015%	0.30%	0.25%	5.50-6.75%	3.50-4.50%	0.005%
Titanium Alloy Ti-6Al-4V ELI	ASTM F136	88.48-90.48%	0.05%	0.08%	.012%	0.25%	0.13%	5.50-6.50%	3.50-4.50%	X

Cobalt Chrome	ASTM Standard	Cobalt	Chromium	Molybdenum	Silicone	Manganese	Nickel	Iron	Nitrogen	Carbon
CoCr Alloy Co-28Cr-6 Mo	ASTM F1537	58.86-64.86%	26.00-30.00%	5.00-7.00%	1.00%	1.00%	1.00%	0.75%	0.25%	0.14%

Cobalt Chrome	ASTM Standard	Cobalt	Chromium	Tungsten	Nickel	Iron	Manganese	Silicone	Carbon	Phosphorus	Sulfur
CoCr Alloy Co-20Cr-15W-10Ni (CoCr Wires Only)	ASTM F90-09	46.38-53.48%	19.00-21.00%	14.00-16.00%	9.00-11.00%	3.00%	1.00-2.00%	0.40%	0.05-0.15%	0.04%	0.03%

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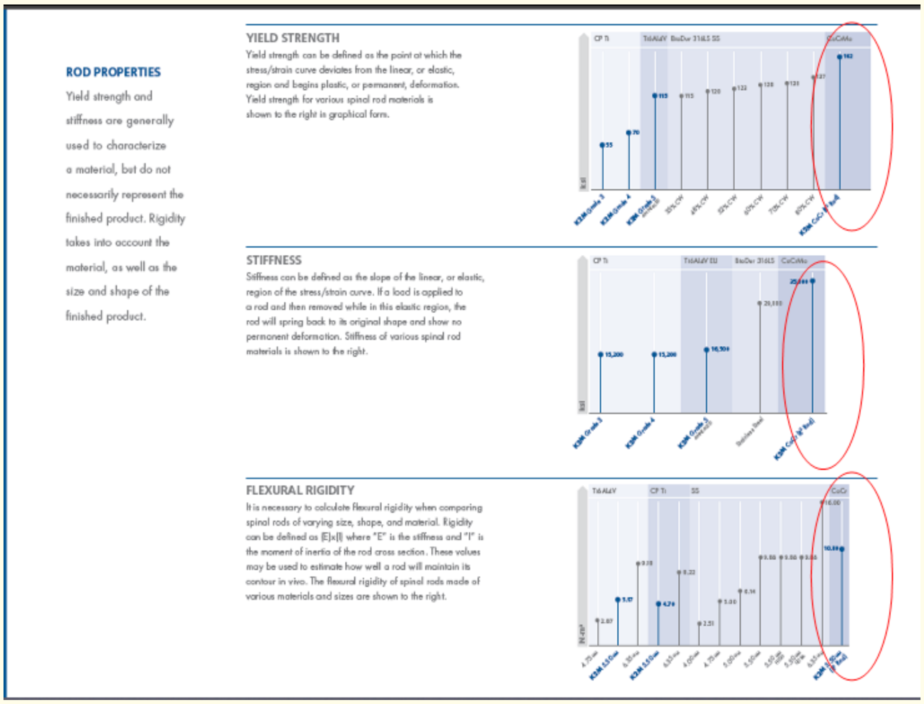

Discussion and Conclusions

During the last years of experience in the use of Cobalt Chrome bars in the treatment of AIS we had had good results in terms of better correction than titanium as percentage between 12 and 15% and specially after three years of surgery we observed the maintenance of correction while of titanium rods we observed a loss of correction of medium 8/10%.

These because Cobalt is more resistant and more rigid than titanium more or less like a steel without the problem that steel doesn't consent MRI [6-11].

Up to now there are not degenerative problem below and above but we think it's necessary to wait more time to have this kind of evaluation.

If the correction in coronal and sagittal balance is good this possibility in a young patients is too low in our mind.

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