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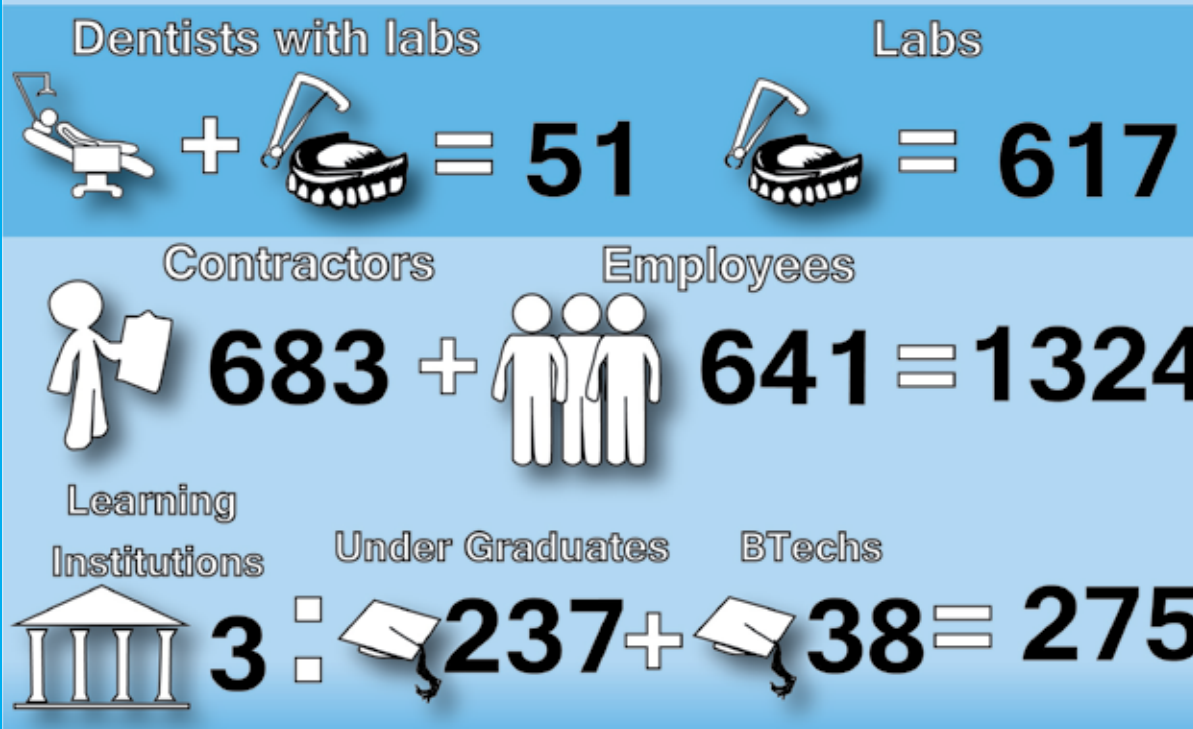
SADTJ

The Southern African Dental Technology Journal

The State of Dental Technology or Dental Technology in a state?



Be Inspired at the DENTASA Summit & AGM

1-2 August 2014

Birchwood Hotel

www.dentasa.org.za

#AGM14

Exhibiting Traders	25
Delegates Attending	400
Lectures	12
CPD/CEUs	±12

11 CEU

Invitation to write articles and case presentations

The Southern African Dental Technology Journal invites all dental technicians/technologists and dentists, who have original articles or case presentations to submit their work. The SADTJ is a peer review publication, and all original articles will be reviewed by our Associate Editors. Do not let this scare you off, you will receive constructive criticism and suggestions on how to improve your writing, should your article not be published the first time round.

Length of Manuscripts:

- Technical Article: 1500-2000 words and 15-20 photos or diagrams. These articles should be up-to-date accounts of interesting and noteworthy developments in techniques. They should be case specific and engage the intermediate and advanced-level technologies as well as new techniques. Articles should give step by step information on how to do something, but also provide insight on the why and how of a particular technique or product. Please include a 10 question, multiple choice quiz, about the contents of the article, when submitting a technical article. All technical articles submitted to the journal must be written or co-written by a Certified Dental Technician, a foreign technician with a SADTC approval to work in South Africa, or a dentist.
- Photo Technical Article (Case presentation): 1000 words maximum and 10-26 photos. These articles should be up-to-date accounts of interesting and noteworthy developments in techniques. This kind of article is usually a case presentation sharing tips or a quick technique with others. The photos should be accompanied by a written explanation (maximum 1000 words) of how the final results were accomplished.
- Research Article: 6000 words. Here the criteria of intelligibility and wider interest are strictly applied.
- Review Articles: up to 6000 words long. These articles should be up-to-date surveys of important current developments in dentistry.
- News Articles: 250-700 words, photos optional. We are interested in all news-worthy events that involved or impact dental technicians, or their laboratories. Please keep us up to date so we can share the news.

Manuscripts and Photo Requirements:

- Articles submitted should be in the proper format for scientific papers.
- All submissions should be the original work of the author/s as noted.
- Articles should be submitted in Microsoft Word.
- Images should be in JPEG format. It should have a resolution of no less than, 300dpi, should be uncompressed, be of high quality and clarity and should have no copyright. You are not allowed to reproduce any images without the proper copyright releases. If the images are not your own, please make sure that you obtain the copyright release on the images before submitting it to the SADTJ, as this remains your responsibility.
- The journal reserves the right to edit your article, for the sake of clarity.
- Articles that have been submitted to the Journal of Dental Technology in Southern Africa, may not be submitted to another publication for a period of four months.
- Include a photograph of the authors as well as a short biography.
- Include copies of the completed authors release form, conflict of interest and photo release forms with the submission, of your article.
- Include the cover page for your article.

Presentation of Content:

- Use Arial or Times Roman as font.
- Number each page clearly.
- No footnotes will be allowed.
- Keep your presentation clear and simple.
- Tables, figures and images (including photographs), should be presented on a separate page at the end of the document, separate from other documents.
- All tables, figures and images must be clearly marked using Arabic numerals.

All manuscripts must be submitted in English. Remember to include all your contact details when submitting your work. Make use of this invitation, and submit your work today, we look forward to hear from you.

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July 2014

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Feature Articles

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Lighter Side

STATEMENT OF INTENT

The Southern African Dental Technology Journal is published 3 times a year. The main objective of the Journal is to provide the professional with the opportunity to earn CEU's through completing the questionnaires, or writing articles. All papers in English, on any aspect of dental laboratory science or related disciplines, will be considered on merit and subject to the review of the editorial board and the CEU accreditation committee.

EDITORIAL, ADVERTISING AND COPYRIGHT POLICY

Axel Grabowski

JULY 2014

One month to go to the 2014 DENTASA Summit and AGM. This is where one realizes exactly how little time is left. The organising committee is at its busiest.

I have had the opportunity to work closely with the SADTC with regards to closing an illegal dental laboratory in Stellenbosch, Western Cape on the 18th June. This was a lab run by a dentist, collecting work from his colleagues and then sending the impressions to China, and on completion re-selling them to the dentists. By doing this, taking away work of S.A dental technicians. This individual was reported to SARS and Customs and Excise.

I am also in the fortunate position to be part of the task team that is busy re-writing the Dental Technicians Act. We have had our first working session, and a lot ground has been covered. There is a long way to go, and the profession will most certainly have the opportunity to give their input. Very exciting times for our profession.

I am of the opinion that the most newsworthy item is that Council has taken the decision to implement Denturism or Clinical Dental Technology as soon as is possible. It has taken many years of persistence by a few dedicated technicians to achieve this. Well done. I will keep you updated as to where and when this is to be implemented. A new era in South Africa has dawned in dentistry.

See you at the AGM, as there is a lot of information that will be made available.

Don't forget to keep the 1st and 2nd August open.

Editorially yours,
Axel

GOVERNMENT NOTICE

DEPARTMENT OF HEALTH

No. R. 356 12 May 2014

DENTAL TECHNICIANS ACT, 1979 (ACT NO 19 OF 1979) AS AMENDED
REGULATIONS RELATING TO CONTINUING PROFESSIONAL DEVELOPMENT OF DENTAL TECHNOLOGISTS AND DENTAL TECHNICIANS

The Minister of Health has in terms of Section 50 (1) (r) of the Dental Technicians Act,1979 (Act 19 of 1979) as amended, on the recommendation of the South African Dental Technicians Council, made the regulations in the Schedule

SCHEDULE

1. Definitions

In these regulations "The Act" means the Dental Technicians Act of 1979, and any expression to which a meaning has been assigned in the Act shall bear such meaning, unless the context otherwise indicates, and in addition-

"Accreditor" means the Council or an institution or body that is appointed by the Council, once it has met the criteria set out by the SADTC CPD Committee;

"Accreditation committee" means a sub committee appointed by the CPD committee for the purpose of assessing CPD activity applications;

"Audit period" means the time or period during which the CEUs will be valid;

"Compliance checks or audit" means the random selection of professionals from the register by the CPD Committee for compliance purposes;

"Continuing education units (CEUs)" means the value attached to a learning activity for Continuing Professional Development;

"Continuing professional development (CPD)" means the continuous formal and informal education and development presented in terms of these rules;

"Council" means the South African Dental Technicians Council/or SADTC established in terms of Section 2 of the Act;

"CPD category document (CPD 006)" means the document published by the council and which will apply for the prescribed cycle containing the categories and sub categories in which CEUs can be obtained;

"CPD cycle" means the term in which a registered person must obtain the prescribed number of CEUs which will constitute an audit period as determined by council from time to time;

"ethics activities" means a set of principles with regard to what is considered to be right or appropriate with due regard for one's profession and professional conduct as well as its impact on others which should include but not be exclusive to; human rights, business medical law and commercial law;

"Formal structured learning activities" means those developmental activities that have an outcome but do not constitute full year of earned CEUs. These include education, training, research and publications in professional journals, articles, authorship and co-authorship including chapters, posters, completion of a formal qualification, course, module and learning portfolio. These do not include teaching, examining or activities that constitute a person's job description;

"Individual CPD activity record" means the document that is in the possession of a person registered with the council as a record of every learning activity attended or completed;

"CPD activity data base" means the data base held by the council or its appointed agent of service providers and of persons registered as a record of every learning activity attended or completed;

"Learning activity" means the CPD activities for which CEUs are obtained;

"Measurable activities" means those activities that have a measurable outcome and include structured learning or a formal programme that is planned, recorded and presented by an accredited training institution, evaluated by an accredited assessor. Further categories will include demonstrations, hands on practical, case study presentations, educational involvement, training and publications in dental technology and related fields;

"non-compliance" means the failure of an individual to annually obtain the required CEUs for his/her continuous registration as determined by the Council;

"non- measurable activities" means those activities that do not have clearly measurable outcomes and may include advisory committee's and committee's related to dental technology, quality audits, special interest groups, programme reviewing, serving on council structures, attending formal national and international trade exhibitions, member of an appropriate accredited associations;

"Penalties" means the outcome of the actions/decisions taken by the Council or the committee delegated against a registered person who fails to comply with the CPD requirements of his/her registration;

"Registered person" means any dental technician, dental technologist, duly registered in terms of the Act;

"SADTC CPD Committee" means the committee constituted by Council to oversee matters related to CPD; and

"Service provider" means a profession-specific entity, professional or individual, accredited as per the set requirements, to present the learning activities for CPD purposes.

2. Requirements

1. Any person whose name appears on the register, under section 20, 23A and 28 of the Act, on the date to be determined by the Council, shall be required to comply with the conditions of CPD.

2. For the purpose of CPD, every registered person, shall at the date determined by the Council, be required to accumulate the required CEU's as determined by the council from time to time.

3. The CEUs as prescribed in subregulation 2 above shall be accumulated by way of different educational or developmental activities accredited by the Council in any categories and sub-categories as determined in the CPD category document (CPD 006).

3. Exemption on the basis of age

Any registered person may upon reaching the age of 70 apply to the Council for exemption from compliance with the requirements of CPD. Any dental technician or technologist shall be required to accumulate 50% of CEUs within the year they reach 70 years of age.

4. Deferment

Deferment of compliance with the requirements of CPD may only be granted by the Council on application by an individual on submission of adequate reasons and subject to such requirements as the Council may determine.

5. Non compliance

In the event of a registered person not complying with the requirements specified in regulation 2 above within the prescribed period of time, the council may impose any one or more of the following conditions, namely:

(a) grant the registered person deferment; and/or

(b) require the registered person to follow a remedial programme of continuing education and training as specified by the Council; and/or

(c) require the registered person to write an examination as determined by the Council; and/or

(d) order the registrar to:

(i) register the registered person in a category of registration which will provide for supervision regarded as appropriate by the Council;

(ii) register the registered person in a temporary category of registration for a period of time to allow compliance; or

(iii) remove the name of the registered person from the relevant register.

6. Appeals Procedure

1. Applicants of CPD activities may appeal to the CPD Committee if dissatisfied with adecision of the CPD Accreditation sub-committee in writing within 30 days (thirtydays) after receiving such decision.

2. Registered persons failing to comply as per sub regulation 5, may appeal any of the penalties and apply for a resolution from the CPD Committee.

7. Re-registration

A deregistered person may apply for re-registration on the following grounds:

(a) If deregistered due to non-compliance with CPD, this registration shall be considered in accordance with the regulations pertaining to restoration as contained in the Act.

(b) If deregistered either on own request or in terms of section 24 of the Act, the applicant shall have to comply with the requirements as listed above.

8. Fees payable in relation to CPD

The SADTC CPD Committee may subject to the approval of the Council require some fees to be paid to the Council by the service providers for approved CPD activities as provided for in clause 4(f) and section 50(1)(r) of the Act.

9. Commencement

These Regulations are called Regulations relating to the Continuing Professional Development of Dental Technologists and Dental Technicians made in terms of the Dental Technicians Act, 1979 (Act no 19 of 1979) and will commence upon the date signed by the minister.

RISK MANAGEMENT - A VITAL PART OF YOUR BUSINESS

" This article first appeared in CA (SA) Dot News and is produced with the authority from Dot News and Du Toit Mook, Registered Accountants and Auditors ''

Risk is an integral part of business. Every time we launch a new product or buy new assets there is risk involved. It has become accepted for many businesses, particularly large and multi-national corporates to consider risk as part of their governance and compliance process. In this scenario, risk is a backroom exercise with limited impact on the day to day operations of the business.

The continuous growth of globalisation and technology has brought in rapid change. This has led to new products and technologies, shorter product life cycles, more competition and less time for businesses to react to threats and challenges. In turn this means that business risk is continuing to rise.

How to respond

Best practice businesses have responded to the conundrum of increased risk by putting it at the forefront of their strategy. When planning their response to, say, a new investment, risk is incorporated into the project plan and mitigating strategies are devel-

oped to reduce each risk identified to manageable levels. Thus, instead of the risk committee considering risk in the business, it has been brought to the coal face of business operations.

Risk has also increased with new regulatory demands being placed on organisations, for example the Consumer Protection Act and the Protection of Personal Information Act. Regulatory compliance risk is now being assessed as part of a business' ongoing strategy.

Where to start?

Some of you may not have consciously considered risk but it will have been at the back of your mind.

Taking into account the above, it is well worth deciding the risk profile you want your business to adopt and then document the risks facing your business and strategies to reduce the risk. This can become an ongoing working document and every time you face an important decision, this document can be used to help in making the decision. In time you will have a valuable risk assessment of your business.

Everything is speeding up which adds to the risk in business – if you don't already formally consider risk, now is a good time to start.

FRANCHISE AGREEMENT RENEWAL: A HIDDEN TIME BOMB

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When the Consumer Protection Act (CPA) was being introduced in 2011, the intention of the legislature was that all franchisors were to be given a six month window period to bring all existing franchises into line with the CPA. After a public outcry this requirement was dropped to the satisfaction of franchisors.

What is the catch?

Most franchise agreements are subject to renewal after a certain period of time. The CPA deems that the renewal of a franchise is "a new franchise agreement" and thus falls into the ambit of the CPA. Any renewal of the agreement must therefore comply with the CPA.

As franchises were largely unregulated up to the introduction of the CPA, this is a blow for them. Franchisees get considerable protection in the CPA. Agreements are to be transparent with strong disclosure provisions and must be written in simple understandable language.

More significantly the agreement must start with the following "cooling off period" wording:

"A franchisee may cancel a franchise agreement without cost or penalty within 10 business days after signing such agreement, by giving written notice to the franchisor", and a reference to the CPA.

What it means

If the above wording is not included, then the agreement seemingly becomes void in terms of the CPA. The courts still need to rule definitely on this when a "cooling off period" case comes before them. This will remove uncertainty surrounding whether or not the agreement becomes void - until then, the risk to franchisors is a real one. Obviously this can have adverse consequences for any party trying to enforce its rights through the franchise agreement.

Until the courts decide, franchisors would be wise to ensure that renewed contracts comply with the CPA, particularly the "cooling off period" clause.

VAT REFUNDS: HOW THE NEW SYSTEM WORKS

" This article first appeared in CA (SA) Dot News and is produced with the authority from Dot News and Du Toit Mook, Registered Accountants and Auditors ''

After numerous complaints SARS implemented a new VAT refund process just over a year ago.

How does it work?

SARS commits to paying refunds within 21 business days of receiving a VAT return, subject to:

- The return being correctly filled in
- The taxpayer owes no monies to SARS and there are no outstanding VAT returns
- Banking details of the business being valid

Interest is paid to the taxpayer for non-payment after 21 business days.

A computer program analyses VAT returns and selects "high risk" refunds. Taxpayers selected will get a request for documentation (usually within 48 hours of submitting the VAT return) which needs to be submitted within 21 business days. The refund only becomes due when SARS are satisfied that the refund is due and valid. Then the commitment to paying refunds in 21 business day rule kicks in.

Taxpayers may object to the assessment by completing the Alternative Dispute Resolution form. This must be done within 30 business days. SARS aim to resolve the objection in 90 days. If taxpayers are still not satisfied they may appeal.

What to do

It becomes time consuming when taxpayers are asked to submit justifying documentation which will negatively affect the taxpayer's cash flow.

Ensure you submit your return accurately and timeously.

- Watch your account on eFiling and respond promptly to any requests for documentation (if you don't respond within the 21 business days, SARS can issue an assessment denying the input VAT claim).
- Submit the documentation on eFiling to avoid queues at SARS' offices.
- Then monitor your statement of account on eFiling as it will reflect any new assessments or refunds due.

In other words be proactive to reduce your waiting time to a minimum..

A TAX SNIPPET: ESCALATING QUERIES WITH SARS

" This article first appeared in CA (SA) Dot News and is produced with the authority from Dot News and Du Toit Mook, Registered Accountants and Auditors ''

If you are finding it difficult to resolve any problems you have with SARS, speak to your accountant. SAICA have an agreed channel to SARS whereby operational queries can be escalated for resolution.

You need to have gone through the normal query resolution processes at SARS before taking advantage of this avenue.

Considering the frustrations many people have with SARS, this is an excellent service to take advantage of should you need it.

YOU AND BUDGET 2014

" This article first appeared in CA (SA) Dot News and is produced with the authority from Dot News and Du Toit Mook, Registered Accountants and Auditors "

There were no real surprises or changes announced by Minister Gordhan in his budget speech. As an election is just over two months away, this is a positive outcome.

The budget deficit to Gross Domestic Product (GDP) for 2013/2014 came in at 4% versus over 5% predicted by many economists last year. The 2014/2015 budget deficit is also forecast at 4%. This fiscal prudence is good for the economy and interest rates as it means lower borrowings by government and a favourable response from credit rating agencies (downgrades from them result in the cost of the country's debt increasing).

This was achieved by limiting government spending increases. Steps have been taken to reduce wasteful expenditure – for example, two million "ineligible" people have been taken off the social grant roll. It also means giving only minor relief to taxpayers.

The budget is framed in terms of the National Development Plan which seeks to put South Africa on a high economic growth path. Gordhan stressed that government is moving towards stimulating investment from a previous focus on consumption expenditure.

Highlights

- R9.3 billion given to individual taxpayers to offset fiscal drag
- No changes to income tax, VAT or capital gain tax rates, although "sin" taxes (see attached table) go up.
- Tax free lump sum payments on retirement increased from R315 000 to R500 000. In addition, government is addressing taking costs out of the retirement funding chain to ensure greater benefits for retirees
- The carbon tax has been delayed to 2016
- No concrete action taken on National Health Insurance but it is on the government's radar
- Licensing and regulatory systems will be streamlined.
- Manufacturing incentives of R10.3 billion over the next three years will be introduced. Additional machinery and productivity allowances of R15.2 billion will come into effect.
- Currently, philanthropic entities (Public Benefit Organisations) are required to distribute 75% of their donations within one year. This will be relaxed and will enhance the sustainability of such organisations.
- Small business (Micro Enterprises and Small Business Corporations) were given minor increases. The Minister emphasised that additional relief would come to small business this year, including reducing the compliance burden and a reduction in the rate of turnover tax for micro businesses from 6% to 5%.
- Special Economic Zones will be allocated R3.6 billion to increase exports and job creation.

Overall, this was a conservative budget, which keeps fiscal policy on a sound footing.

SMALL BUSINESS CORPORATIONS - NEW TAX TABLE		
Taxable Income	**New SBC Tax Rates**	**Change vs Prior Year**
R0 - R70,700	Nil	Band raised by R3,589
R70,701 - R365,000	7% over R70,700	Band unchanged
R365,001 - R550,000	R20,601 + 21% over R365,000	Band unchanged
Over R550,001	R59,451 + 28% over R550,000	Band unchanged

Note 1: Benefits to taxpayers are marginal

Note 2: Consideration is being given to replacing the above table with a tax compliance credit

Note 3: Micro Enterprises turnover tax will be reduced from 6% to 5%

NEW TAX TABLES 2014/15	
Taxable Income	**Tax**
R0 - R174,550	18% of each R1
R174,551 - R272,700	R31,419 + 25% of the amount above R174,550
R272,701 - R377,450	R55,957 + 30% of the amount above R272,7000
R377,451 - R528,000	R87,382 + 35% of the amount above R377,450
R528,001 - R673,100	R140,004 + 38% of the amount above R528,000
R673,101 and above	R195,212 + 40% of the amount above R673,100

NOTES	2014/15	CHANGES FROM LAST YEAR
Rebates		
Persons under 65	R12,726	Increased by R646
Persons 65 - 74	R19,836	Increased by R1,006
Persons 75 and over	R22,203	Increased by R1,123
Tax Thresholds		
Persons under 65	R70,700	Increased by R3,589
Persons 65 - 74	R110,200	Increased by R5,589
Persons 75 and over	R123,350	Increased by R6,239
Interest Exemption		
Persons under 65	R23,800	No change
Persons 65 and older	R34,500	No change
Dividends		
Taxed at 15%	No change	No change
Medical Aid Tax Credits per beneficiary		
First two beneficiaries	R257 p.m. each	Increased R15
Third and more	R172 p.m. each	Increased R10
Business Travel - Tax free		
Up to 8,000 kilometres per annum	R3.30 per km	Increased by 6 cents per km
Travel Allowance		
Travel allowance still taxable at 80% *Logbook compulsory*	No change	No change
Other Taxes		
Capital Gains Tax - Individuals/Special Trusts	No change	No change - 13.3%
Capital Gains Tax - Companies	No change	No change - 18.6%
Capital Gains Tax - Trusts	No change	No change - 26.6%
Fuel Levy*		Increases by 12 cents a litre
Cigarettes		Increases by 68 cents a packet
Wine		Increases by 13 cents a bottle
Spirits		Increases by R4.80 a bottle
Beer		Increases by 9 cents a 340 ml bottle
Road Accident Fund (RAF)*		Increases by 8 cents a litre
* = Total increase in fuel price is 20 cents per litre from April		

TAX CLEARANCE CERTIFICATES – EASIER IF YOU FOLLOW SARS' RULES

" This article first appeared in CA (SA) Dot News and is produced with the authority from Dot News and Du Toit Mook, Registered Accountants and Auditors ''

We will all probably be required to get a Tax Clearance Certificate ("TCC") at least once in our lifetime, quite possibly on a regular basis as TCCs are only valid for 12 months.

When do you need a TCC?

- TCCs are necessary:
- For obtaining a government or parastatal tender,
- Some suppliers require them,
- If we emigrate,
- If we want to invest funds abroad.

The Tax Administration Act of 2012 requires that SARS must respond to an application (it must be done on the prescribed form) for a TCC within 21 business days. SARS have responded to this by designing a new TCC process which they have begun implementing.

The Rules

Clearly, you need to have all taxes paid up (all taxes currently administered by SARS) and all necessary submissions up to date. In addition, all your tax reference numbers must be "active and correct".

On the prescribed form, your reason for requiring a TCC must be stated.

Please note SARS will only issue a TCC in the legal name of the entity. Trading names will not be used. This is to prevent fraud or abuse of the TCC.

It is also worth bearing in mind that in cases where a company has divisions and branches, SARS will issue a consolidated TCC. This means if any branches or divisions are not compliant, then no TCC will be issued – this will have consequences for compliant divisions/branches and the main company, as they will not get a TCC.

TCCs are vital to many businesses and individuals – SARS are now bringing some clarity and certainty to this process.

To speed up the process, comply with SARS' requirements when applying.

TAKE ADVANTAGE OF THE GENEROUS RESEARCH AND DEVELOPMENT ALLOWANCES

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Innovation is seen as one of the key drivers of economic growth and employment, and significant concessions are available to taxpayers that undertake defined research and development ("R&D"). Certain of these businesses are allowed to deduct 150% of specified capital cost ("prototypes or pilot plant" which will be used only in the R&D phase) and expenditures (excluding "administrative, financing, compliance and similar costs"). Other R&D entities are allowed to deduct 100% of all of their expenditure – including capital costs.

This compares to 100% of expenditure and 50% of the capital cost (depending on the industry) enjoyed by businesses not involved in R&D.

What is R&D?

It is "systematic investigative or systematic experimental activities" aimed at creating or developing an invention, functional design or computer program, or the discovery of "non-obvious scientific or technological knowledge", or the discovery of knowledge "essential" to the above criteria. "Significant and innovative" improvements in the above areas also qualify.

The research must be done in South Africa by a taxpayer (or third party commissioned by the taxpayer).

In order to qualify for the additional 50% expenditure, prior approval is required from the Minister of Science and Technology ("MST") and it must be incurred on or after the date of the application.

What is excluded?

The main categories of exclusion are:

- Marketing and sales promotions, including market research
- Ongoing routine costs such as quality control
- The development of internal systems unless these are associated with R&D
- Oil and gas exploration including prospecting but excluding R&D to develop
- technology in this sphere
- The development or creation of financial instruments
- "The creation or enhancements of trademarks or goodwill".

Please note this is a summary of concessions and exclusions – consult your accountant before making use of these provisions.

The benefits are best illustrated by an example:

1. Assume two companies - company A and company B. Company A undertakes R&D while company B does not.
2. Each company has sales of R2 million.
3. Each company incurs R800,000 in deductible expenditure.
4. Each company spends R500,000 on capital equipment. Company A gets approval for R&D spend from the MST and of its expenditure R400,000 is in MST approved R&D spend.
5. Company B is allowed to deduct 50% of its capital spend for tax purposes.
6. Income tax rate: 28%.

Although this is purely an illustration it does clearly show the benefits of the R&D concessions.

The R&D incentives are lucrative and the definition of what constitutes R&D spend is not onerous – it does, for example, include improvements. Whilst they are complex, they are well worth considering.

A PRACTICAL EXAMPLE		
	Company A	Company B
Sales	2,000,000	2,000,000
Expenses	(800,000)	(800,000)
= Profit before tax	1,200,000	1,200,000
Tax Calculation		
Tax depreciation	(750,000) *	(250,000)
R&D extra 50%	(200,000) **	(0)
=Taxable Income	250,000	950,000
Tax charge	70,000	266,000
TAX SAVING	**R196,000**	

Notes:

* *Company A can deduct the full cost of R500,000 on capital equipment plus another 50%*

** *Company A may deduct an extra 50% of R&D spend of R400,000*

Differentiation

by Shane Palm

Posted by JDTUnbound on March 2, 2014 in Unbound Columnists

In a market where every lab produces the same types of products, how do you make yourself stand out? What makes you different from the lab down the street, on the other side of town, or across the country? The purpose of differentiation is to make your products/lab stand out amongst all the others to the point of retaining and gaining new clientele. But, how do you do that when everyone is capable of fabricating the same prosthesis? Michael Porter developed three generic strategies to gain a competitive advantage: cost advantage, differentiation, and focus.

A cost advantage strategy is the method of reducing all production costs to a level where the lab can offer an extremely low priced product. The goal is to become the low price leader and make a profit based on economies of scale. There can only be one low price leader. If cost is the biggest motivator for a customer to choose a lab, why would they send it to the second or third low price leader? This strategy is mainly used by larger labs that have a large customer base and volume.

A focus strategy targets a narrow market, a niche market. Within this niche, the strategy is to gain market share through differentiation or cost advantage. Typically there is less volume with this strategy. However, focus strategy is able to create strong brand loyalty within the market. This brand loyalty can be a deterrent for others to compete in the market.

Differentiation strategy is used to make your products more attractive than a competitor. The lab uses creativity and their knowledge of their market to offer built in value for their targeted customers. This can be accomplished through customer service, technology, expert knowledge, problem solving, accessibility, branding, etc. Laboratories utilizing this strategy are able to charge more for their work and customers are willing to pay for the built in value. This is the strategy of choice for most labs.

How do you determine which way you can differentiate your lab from another? Start by grabbing a pen and paper. Draw a line down the center of the paper from top to bottom. The left column is for your lab and the right is for the other labs. In your column, list all the products/services offered and anything else that differentiates you from the other labs. Some examples would be, excellent customer service, “x” amount years of experience, fabricates “x”, “y”, and “z” products, education, technology used. Try to stay away from opinion based statements such as “high quality”. 1. They are subjective and everyone has a different definition/standard of quality. 2. Honestly, who is going to boast they produce exceptionally mediocre or low quality work? Everyone thinks their work is high quality. In the column for the other labs, do the same. Next, cross out anything that is the same in both columns. What’s left on your side is the potential areas that can make you stand out. What’s left on the other labs side is how they are setting themselves apart. Once you know what areas you can exploit as strengths and the areas that are weaknesses, you can develop a strategy to maintain and gain market share. For help with strategy formulation, read my article, What’s your Strategy for your dental lab? Lastly, create a marketing plan that integrates your strategy and will communicate why you are the lab to use.

In a market where the products are essentially the same, you must differentiate amongst the others if you want to survive. Take some time and discover what can make your lab stand out!

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10 Ways to Protect Your Profitability

by Becky Tyre

Article Sources from: LMT Communication, www.lmtmag.com

Brand Your Restorations

Creating your own brand of restorations helps you stand out in the marketplace and conveys exclusivity. To distinguish their all-ceramic products, D&S Dental Laboratory, Inc. in Waunakee, WI, has created its "ZR" line of zirconia restorations including ZR Crowns, ZR Plus, ZR Fusion and ZR Micro. "We brand our products to differentiate our laboratory and reinforce that our products aren't available from any other lab. When doctors start to learn your brand and your name, they start asking for it," says Travis Zick, President.

Go Digital

Many laboratory owners have experienced tremendous improvement in productivity—and therefore profitability—through digital technology. By going digital with 12 CAD/CAM stations using 3Shape and Lava design software, a Straumann scanner and two 3D Systems printers, D&S Dental Laboratory has increased its unit production by about 20% in the past three years with approximately the same number of technicians. "We have about a dozen technicians who work directly with the equipment, but everyone works with it in some capacity," says Zick. "We've really gone all-in to incorporate technology anywhere we've felt it could make us more efficient."

D&S purchased the equipment over time to spread out costs, although Zick admits it was a significant outlay at first. But the laboratory calculated the ROI for each purchase, taking into account the capacity and efficiency of the product, and it has already received a full return on nearly all of the machines it purchased.

Offer Different Levels of Service

To ensure it can meet a full range of client needs, Jesse & Frichtel Dental Labs, Pittsburgh, PA, offers two levels of crowns: those made with simpler buildups and premium crowns fabricated with six to nine porcelain layers. "Part of our original business plan was to provide our doctors with options that handle all price points, and I credit our growth during these hard economic times to this plan," says President Mark Frichtel. "For example, we had a client who was doing mostly premium cases. One of his patients couldn't afford that option, but we were able to do a basic case for him. The client knew he would get the same fit as his other restorations and we'd follow his preferences, and the case didn't go to another laboratory."

Batch Your Work

Colin Gibb, the only full-time technician in his laboratory, Red Mountain Dental Arts in Mesa, AZ, preschedules cases and varies his turnaround time so he can organize his workflow in batches. For example, if he has five IPS e.max restorations to do in a week, he'll plan to work on them all the same day rather than doing one per day. "This way, I only have one workstation to setup, I only need to run the pressing oven one day and I can focus on a single type of restoration. Larger laboratories have different departments for each type of restoration; I have different days. With batching, I'm more efficient from a labor standpoint and don't spread myself too thin," he says.

This strategy also enables Gibb to order inventory on demand and better manage his material costs. By scheduling an e.max day, for example, he knows in advance what ingot shades he needs to order for that day. Even though he's paying for two-day shipping, he has better control of his inventory costs. "Why have all these shades of ingots with different opacities in stock? If I had one tube of each ingot shade, I'd have over $4,000 of inventory just sitting there," he says. "If you know what you've got coming up,

you can watch your inventory and order only what you need."

Go Lean

Lean manufacturing is a management philosophy that advocates eliminating waste from a production process thereby improving workflow and enhancing product value. D&S Dental Laboratory started implementing Lean principles several years ago and has successfully shortened production time and increased capacity as a result.

The production leadership team meets regularly to discuss the workflow and continually tweaks the process to improve it; for example, it recently moved its digital design center to a central location within the lab. "The actual time it takes to make a crown is a small fraction of the time that crown is in the lab. Anything we can do to reduce the time between production steps allows us to shorten the turnaround time and increase capacity," explains Zick.

Maintain Your Marketing Budget

When times are tough, marketing is often the first expense to be cut but just the opposite should happen. This is the time to ramp up—or at least maintain—your promotional investments to make sure they're delivering what you need most: sales revenue and customers.

Zick suggests using this opportunity to market your less well-known products. For instance, given the current prominence of all-ceramic advertising, D&S Dental Lab decided to focus some of its marketing dollars on mouthguards, partial dentures and other less visible products. "Doctors don't see a lot of advertising for products like these so it's attention grabbing because it's different," says Zick. "Plus, a doctor is more inclined to try a new lab for a mouthguard rather than a more complex case."

Get Some Facetime

Connecting with potential clients at events such as study clubs or CE courses is an invaluable opportunity to explain your services and develop new relationships face to face. "I'm staying in front of the doctors, speaking with them four to six times per month and actively attending study clubs," says Greg Sederlin, CDT, FICOI, MAAIP, President of Cal Ceram Dental Lab, and Vice President of da-Vinci Dental Studios, West Hills, CA. "By attending on a regular basis, I have become known as the implant expert. Doctors can come to me with a new case or an issue on a previous case and, by helping them, I've been able to turn some of them into full-time accounts."

Watch Your Overtime Costs

When CDA Milling Center in University Place, WA, experienced an unexpectedly busy start to 2013, Owner Mike Shelley started crunching numbers and noticed that he was paying a lot of overtime. In the waxing department alone, he was paying 40 hours of overtime each week and still had a backlog of 50 cases. Solution: a new full-time waxer. "With the overtime hours, it was as if we were paying an extra person anyway," Shelley explains. "Now, we're saving money by not paying time-and-a-half for overtime, technicians aren't getting burned out or having to come in on weekends, and we've been able to increase production because of the additional set of hands."

Offer Value-Added Services

Not wanting to compete on price, many labs are offering value-added services such as continuing education seminars, lunch 'n learns, chairside assistance, custom shade-taking and educational newsletters. These services enhance their image as a valuable resource and can keep your clients loyal to your lab if the price-cutters come knocking.

The goal of value-added services is to make your clients' lives easier. For instance, earlier this year, D&S Dental Laboratory launched a free mobile app that puts the lab's resources at the doctor's fingertips. The app includes a digital Rx form and a Crown Selector option that helps direct doctors to the appropriate restoration. "We want to be the main, trusted, unbiased resource our doctors can turn to for help or answers to any questions," says Zick. "This all adds value to the products we provide."

Share the Profits

At the beginning of 2012, Mitch Pruitt, President of Greatland Dental Laboratory, a four-person removable lab in Anchorage, AK, was optimistic about the coming year. He started a profit-sharing structure whereby instead of raising hourly wages and paying overtime, he switched everyone to a base salary plus a year-end bonus based on laboratory profits.

This new structure helped Greatland stay profitable during harder times such as the fourth quarter of 2012 when business suddenly dropped off, with clients across the board sending about 25% less work. "If we had locked in higher wages for everyone, we would've had to lay someone off last year," says Pruitt. But with profitability being averaged throughout the year, he was able to keep everyone on staff and each employee received a bonus equivalent to 16% of his annual salary just before Christmas. "The bonuses not only motivate the staff to work harder," he says, "it's also a nice way to share extra profits with employees and avoid the risk of paying higher wages when profitability is down."

I've Got Time for That

Posted by JDTUnbound on October 15, 2013 in Unbound Columnists

Time is a non-renewable resource. Once it's gone, it's gone, and we can never get it back. This is why it is important for all of us to manage our time wisely and to the best of our abilities. With only so much time in a day, it behooves us to make the best use of every minute. So, take a few minutes of your hectic day to read and implement the following tips into your workday; you will find yourself more productive, less stressed, and enjoy more free time.

Track interruptions and activities.

For three days, keep a journal of your interruptions and the activities that consume your time. Yes, it will take some time to do this, but it will pay off in the long run. When tracking your interruptions take note of who it was, the date, what the interruption was, and if it was urgent or important. After the three days, compile all of the data to determine who interrupted you the most, for what reason, and the urgency level. Urgent tasks should be handled at that moment; however the same urgent task should not be reoccurring. This may be a symptom of another problem within the lab. Being interrupted for the same thing over and over will identify areas of additional training. Just as important as tracking your interruptions, it is important to track the activities that require your time. When tracking your activi-

ties list what you did, how long it took, and if it was urgent or important. Compile the data and determine where you spend most of your time and its urgency level. Knowing what you spend your time on will allow you to prioritize and schedule your time accurately. Also, empowering your employees to make decisions will limit the amount of interruptions.

Schedule your day.

Use the information gathered from tracking your activities to schedule your day. Group like items together, i.e. phone calls/email, and respond to them at specific times in the day. If there is a specific time of day when you do your best work (morning or afternoon), do not schedule anything but work during that time. Save remedial tasks for times when you are not as apt to perform as well. Also, remedial tasks that do not require you to complete, should be delegated to other employees. When scheduling your day, do not make the time constraints too tight. Build extra time into the schedule to ensure each task receives the attention it needs. Unused time can be utilized for getting a jump start on other tasks.

Create a To Do List.

At the beginning or end of each day, you should create a To Do list for the upcoming day. Each task on the list should be prioritized. Prioritize tasks as must be done, want to get done, and delegate. Work on less desirable must be done tasks first to avoid procrastination. Avoid working on multiple tasks at the same time. Focusing your attention in too many places at once can be counterproductive and lead to not getting anything completed. Try to complete "want to get done" tasks to achieve a sense of getting ahead. When delegating tasks, split the tasks amongst the employees who will be best suited for the task. Do not overload any one particular employee as they may become overwhelmed. Review your list and use it to create the next day's list.

Say No. Know when it is ok to tell employees and clients "no". There are times during the day you will have to tell your employees you cannot be disturbed, i.e. working on a time sensitive case. Once you have a minute, go back to the employee to see what they needed. A lot of times what was important wasn't that important or the employee figured it out on their own. If a dentist asks for a rush case and you know you can't handle it, then say "no" and explain why. Overscheduling will place undue stress on yourself and staff.

Minimize Distractions.

Non-productive distractions such as phone calls, emails, texts, social media websites, and surfing the internet should be kept to a minimum. These types of activities, if necessary to run the lab, should be scheduled into your day.

Health.

Take care of yourself! Eating correctly, getting enough sleep, and exercising will lead to being more productive. Avoid eating high fat foods (fast food) during lunch as this will slow you down and make you feel tired. Know when it is time to go home and get some downtime and sleep. Fatigue will cause you to make more mistakes and put you further behind. Exercise increases focus, concentration and re-energizes the body and mind.

Put these useful tips to work and you'll find yourself saying, "Yeah, I've got time for that".

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Milled Bar Overdentures-Protocol and Procedures

by Dennis Urban, CDT

When full implant dentures requiring a milled bar is prescribed, the proper protocol and procedure are of extreme importance. The proper impression, bite registration, verification index, denture tooth set-up, internal framework and bar design are of the utmost importance. There are too many instances where the doctor wants to take a shortcut by eliminating the verification index or the set-up. Both of these procedures are a must for a successful overdenture case.

In addition, always recommend an internal metal framework for support of the attachments to increase the strength of the overdenture. Most of the time when a framework is not incorporated into the overdenture, breakage will occur. Where does it occur? In the weakest area not supported by metal and acrylic: the attachment areas.

How many times have you had an instance where the Denturist has asked you to eliminate the metal framework just to save money? The result, a few weeks later the case is back in the laboratory for repair and will continue to come back until an embedded frame is placed in for support.

The following case was sent to the lab to be finished after the models and bite registration were completed by another laboratory. A verification index was previously made (Fig. 1) and the Denturist was sure the impression and model work was accurate.

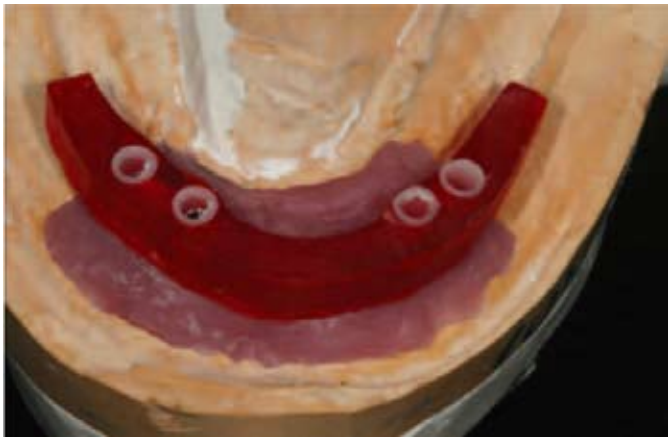

Figure 1 — Verification Index in Pattern Resin

The first step was to do a denture set-up to check the patient's occlusion so we could get an idea of how much room was available for a milled bar .

After the case consult it was decided that the best direction to take was to make a milled bar utilizing Rhein 83's OT Equator attachments. We had completed numerous cases in the past with Equator at-

tachments with complete success and this case was the perfect case for Equator attachments.

Figure 2 — Equator retentive caps with housing

Figure 3 — Rhein 83 OT Equator

The OT Equator has the lowest profile (Figs. 2 and 3) and smallest diameter available of 4.4 mm as well as a vertical height of 2.1 mm. It is compatible with all implant brands with cuff heights from 4.4mm to 7mm and includes multiple levels of retentive caps, which are retained by steel housings.

OT Equator abutments are available in three versions: implant abutment, prefabricated titanium threaded for all CAD/CAM or cast bar connections

Figure 4 — Set up for try-in

with a standard 2mm thread and castable. For this case prefabricated abutments were used.

The denture tooth set-up (Fig. 4) was verified that

Figure 5 — Implants

the bite was right on the money. The next step was to send the case out for the milled bar fabrication. Before it was sent out a putty matrix was made of the waxed set-up. The matrix and the set-up was sent along with the case. When the set-up was taken off the model and the matrix was put in place, we were

Figure 6 — Finished milled bar

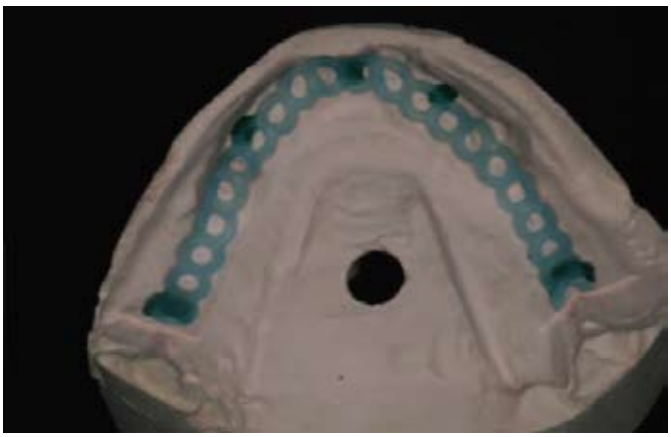

Figure 7 — Waxed framework for support

Figure 8 — Cast and finished support framework

Figure 9 — Rhein 83 housings processed to framework for try-in

Figure 10 — Lingoform teeth in lingualized occlusion

Figure 11 — Final waxed try-in

confident that we had enough room for a nicely designed bar with OT Equator attachments.

The bar was milled with four 2mm threads to accept the Rhein 83 OT Equator abutments and was made in accordance with the specific implants placed (Figs. 5 and 6). After the bar was received back at the lab, the next step was to make an internal cast metal framework. A refactory model was made and a wax-up was completed to fit over the milled bar (Fig. 7). After the framework was cast and finished (Fig. 8), another wax denture set-up with Equator housings and retentive caps in place was fabricated (Fig. 9). The abutments were screwed into place and the housings were processed to the mesh framework before the set-up was completed.

When selecting denture teeth for an overdenture

Figure 12 — Processed and finished implant overdenture

Figure 13 — Tissue side of processed denture showing Equator attachments

case, many Denturists are not aware of the various choices there are. Esthetics, wear resistance, shade integrity and the proper occlusal scheme are of the utmost importance. The ultimate choice in denture teeth for an implant overdenture case is Vita teeth . The esthetic value and shade consistency alone surpasses any tooth on the market. My recommended choice for implant overdentures are Vitapan Plus anteriors and Lingoform posteriors. Both are available in Vita classic shades and 3D Master shades. Vitapan Plus are made with MRP (microfiller renforced polyacrylic) which has the lowest abrasion levels of acrylic teeth.

Lingoform posteriors are meant to be set in lingualized occlusion. Lingualized occlusion (Fig. 10) relieves any off axis stress on the implant and is the perfect occlusal scheme for implant overdentures.

The bar and waxed denture try-in were then sent to the Denturist to ensure everything fit and that the bite was correct (Fig. 11). So far all the necessary protocol had been followed on this particular case and when tried-in, it went perfectly. The case came back to the lab for a finish and we were now ready to process the case.

The case was then processed in high impact denture acrylic. The combination of the mesh framework and high impact acrylic ensured the patient of a premium case where the fracturing of the denture base would not be a concern (Figs. 12 and 13).

Because all the protocol for an implant overdenture case was followed, this implant overdenture was a successful case. Case planning, following the correct protocol and utilizing the best materials including Rhein 83 OT Equator abutments and attachments and Vita teeth yielded to the ultimate goal - patient satisfaction.

Milled bar overdenture protocol

Choose the correct answer:

1. What can happen if a framework is not incorporated into the overdenture?
   a) Nothing
   b) Breakage may occur
   c) The overdenture will be stronger

2. where can breakage occur with overdenture treatment?
   a) At the attachment areas
   b) In the overdenture flange
   c) In the implant

3. Why are vitapan plus teeth chosen for this overdenture case?
   a) They posess highest abrasion levels of acrylic teeth
   b) They posess great aesthetic properties
   c) They posses lowest abrasion levels of acrylic teeth

4. Is it an important protocol to utilize a verification index?
   a) yes
   b) no
   c) sometimes

5. Why is a smesh framework and high impact acrylic used in the overdenture?
   a) for better aesthetics
   b) to reduce risk of denture base fracture
   c) financial reasons

Scoliosis and dental occlusion: a review of the literature

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Abstract

Background

Idiopathic scoliosis is a deformity without clear etiology. It is unclear wether there is an association between malocclusion and scoliosis. Several types of occlusion were described in subjects with scoliosis, mostly case-reports.

Objectives

The aim of this review was to evaluate the type of occluslins more prevalent in subjects with scoliosis

Search strategy

All randomised and controlled clinical trials identified from the Cochrane Oral Health Group Trials Register, a MEDLINE search using the Mesh term scoliosis, malocclusion, and relevant free text words, and the bibliographies of papers and review articles which reported the outcome of orthodontic treatment in subjects with scoliosis that were published as abstracts or papers between 1970 and 2010.

Selection criteria

All randomised and controlled clinical trials published as full papers or abstracts which reported quantitative data on the outcomes malocclusion in subjects with scoliosis.
Data collection and analysis
Data were extracted without blinding to the authors, age of patients or type of occlusion.

Main results

Using the search strategy eleven observational longitudinal studies were identified. No randomized clinical trials were recorded. Twenty-three cross-sectional studies were recorderd, and the others studies were reviews, editorials, case-reports, or opinions. The clinical trials were often not controlled and were about the cephalometric evaluation after treatment with the modified Milwuakee brace, followed by the orthodontic treatment of the class II relationship with a functional appliance. Clinical trials also included the study of the associations between scoliosis and unilateral crossbite, in children with asymmetry of the upper cervical spine. This association was also investigated in rats, pigs and rabbits in clinical trials. The other associations between scoliosis and occlusion seems to be based only on cross-sectional studies, case-reports, opinions.

Authors' conclusions

Based on selected studies, this review concludes that there is plausible evidence for an increased prevalence of unilateral Angle Class II malocclusions associated with scoliosis, and an increased risk of

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lateral crossbite, midline deviation in children affected by scoliosis. Also, documentation of associations between reduced range of lateral movements and scoliosis seem convincing. Data are also mentioned about the association between plagiocephaly and scoliosis.

Introduction

Idiopathic scoliosis is a deformity without clear etiology. Depending on the age of presentation it has been classified into 3 types: infantile (presenting from birth to 3 years), juvenile (presenting from 3 to 10 years) and adolescent (presenting from 10 years to skeletal maturity) [1]. Eighty percent or more of idiopathic scoliosis is of the adolescent variety [2]. The most infantile curves present in the first six months of life are left thoracic apex, and males are more frequently affected, whereas the most common juvenile curves are right thoracic apex and females are more frequently affected, as in the adolescent group [3]

In the case of the most common form of scoliosis, adolescent idiopathic scoliosis, there is no clear causal agent and it is generally believed to be multifactorial. Genetics are believed to play a role [4]. There is often a positive family history but the pattern of inherited susceptibility is not clear [5]. Adolescent idiopathic scoliosis is defined as a spinal curve or curves of ten degrees or more in about 2.5% of most populations [5]. However, in only about 0.25% the curve does progress to the point that treatment is warranted [5].

Some hypothesis exists in the possible underlying pathophysiological mechanism leading to this deformity. The major types of non-idiopathic scoliosis are congenital scoliosis due to malformation or faulty segmentation of the vertebrae and neuromuscular scoliosis due to muscular imbalance.
The scoliosis can be due to malformation or faulty segmentation of the vertebrae or can be due to muscular imbalance [1].

Different factors have been suggested as causal. Among these, the following should be highlighted: deviation from the standard growth pattern, neuromuscular or conjunctive tissue alterations, asymmetric growth of the limbs and trunk, alterations in the sagittal configuration of the spine; and environmental factors [6,7].

Non-congenital scoliosis has many etiologies. The hereditary musculoskeletal disorders, such as osteogenesis imperfecta, Marfan syndrome, Stickler syndrome, Ehlers-Danlos syndrome, and the muscular dystrophies, can each include scoliosis as a manifestation. Neuromuscular diseases, such as cerebral palsy and myelomeningocele, are associated with the development of scoliosis secondary to muscle imbalance. Paralytic disorders resulting from polio or spinal trauma may lead to a progressive scoliosis [1].

In dentistry, the study of the relationship between occlusal problems and the spine are of increasing interest. This is the result of a greater incidence of pain in the muscles of the neck, trunk, the upper and lower limbs, and in the temporomandibular joints (TMJ) of patients with occlusal dysfunction [5]. There are several conditions that impede normal trunk alignment in the frontal plane, and it appear interesting to investigate whether such conditions also affect dental occlusion.

Since '70 Fonder, [8] a dentist, presented case history evidence to evidence a causal relationship between occlusion and scoliosis, and vice-versa, as he underlined the relationship of dental malocclusions to various skeletal problems such as scoliosis, kyphosis, and other postural defects. He showed full spine radiographs, both lateral and frontal, before and after dental treatment for malocclusions in three patients. Case I exhibited noticeable scoliosis and other "defects of posture" notably excess thoracic kyphosis, in the pre-treatment films. Following a course of dental treatment for a bite defect, the post-treatment radiograph revealed a non scoliotic spine with normal lateral and antero-posterior curvatures. Case 2 was similar except that the scoliosis and kyphosis before the treatment were less marked, described as being only a case of bad posture. After orthodontic treatment for deep overbite related to posterior malocclusion, the post-treatment x-ray revealed a normal appearing spine. Fonder described the patient as having greatly improved posture. In the third case, a woman with similar abnormal scoliotic and kyphotic curves in the spine also complained of general ill health with headaches, backaches and limited range

of motion of the back. Following prosthetic and other standard dental work, all of these symptoms were said to disappear and the spine on post-treatment x-ray examination appeared more normal.

The purpose of this review is to summarize what is known about the data in literature regarding the association of scoliosis with altered teeth occlusion, hereditated or acquired, and possibly to evidence the natural history of idiopathic scoliosis after the malocclusion treatment, as well as the long term effects of treatment, if investigated (Table 1).

Table 1. Principal papers showed in this review.

Table 1

Principal papers showed in this review.

Paper	Type	Main topic	Sample	Age	Main result
McMaster J (1965) Reference [7]	3 clinical cases	Casual relationship between malocclusion and scoliosis, and viceversa	3 adolescents	10-15 years	After orthodontic treatment, the author observed the improvment of posture
Paper	**Type**	**Main topic**	**Sample**	**Age**	**Main result**
Rock and Baker (1972). Reference [9]	Case-report	Class II due to the weared cast	A girl	14 years old	to recommend the use of a removable appliance to prevent the malocclusion before the surgeon operation and during the period of the wearing the cast.
Paper	**Type**	**Main topic**	**Sample**	**Age**	**Main result**
Dayan et al. (1977). Reference [10]	Transversal Case-control study	To compare facial morphology of children affected with scoliosis and treated with brace, with health children	15	5-19 years (mean 10 years)	Children treated with braces (for their scoliosis) showed all vertical measurements of face significantly lower than the control group, and more protruted maxillary and mandibular bases
Paper	**Type**	**Main topic**	**Sample**	**Age**	**Main result**
Hotchcock HP (1969). Reference [8]	Observational study on prevalence	Plagiocephaly in subjects with scoliosis	144		The study suggested the existence of an association between infantile scoliosis and plagiocephaly

Objectives

Primary objective

Our primary objective was to systematically review the literature to determine the incidence of malocclusion in adult and adolescents with scoliosis.
We did not consider other postural orthopaedic problems since scoliosis is a well defined pathology in literature.

Secondary objectives

Our secondary objectives were to:

Table 1. Principal papers showed in this review.

Paper	Type	Main topic	Sample	Age	Main result
Ben-Bassat Y et al. (2006) Reference [16]	Observational study on prevalence	Prevalence of scoliosis in patients with ereditated malocclusion	202 adolescents	10-15	The detection of hereditary orthodontic anomalies in young children allows the identification of a group of children who have a high risk of developing scoliosis in later years.
Paper	**Type**	**Main topic**	**Sample**	**Age**	**Main result**
Segatto et al. (2008) Reference [17]	Cohort study	Malocclusion in subjects with idiopathic scoliosis	98 subjects with scoliosis and 705 controls	6.2 - 25.3; mean age 13.9 +/- 3.5	a significant higher prevalence of unilateral Angle class II (asymmetric class II malocclusion) was evident among the patients with scoliosis (21.9%) compared with the control group (8.5%). The differences between the two groups in the prevalence of the midline deviation were statistically significant both in the upper and the lower dental arches.
Paper	**Type**	**Main topic**	**Sample**	**Age**	**Main result**
Lippold C et al. (2003). Reference [18]	**Case-control study**	**To evaluate the differences in occlusion**	**28 with scoliosis and 68 health children**	**Mean age 14.7 +/- 2.3**	In the group of adolescents with scoliosis, infacts, the unilateral Angle class II relationship showed a significant higher prevalence respect to the control group
Paper	**Type**	**Main topic**	**Sample**	**Age**	**Main result**
Lippold et al. (2007) Reference [19]	**Observational**	**To compare**	**53 adult patients with Class II and Class III, but withut scoliosis**	**24.6 +/- 9**	an orthopedic examination can be considered for patients undergoing an orthodontic-operative therapy, also when they don't show scoliosis.

1) Assess the clinical consequences for the malocclusion, after the treatment of scoliosis (clinical symptoms).

2) Assess the clinical consequences for the scoliosis, after the orthodontic treatment (clinical complications and symptoms associated with scoliosis, and severity of complications and symptoms among patients).

Methods

Criteria for considering studies for this review
Types of studies

We looked for randomized clinical trials (RCTs), cohort and case-control studies, and case reports.

Types of patients

We included adolescent subjects with malocclusion and scoliosis. For our secondary objective we included patients if they were children/adolescents treated for their scoliosis or malocclusion.

Type of studies

We included studies that reported incidence and desciption of malocclusion associated with scoliosis.

Types of outcomes

Table 1. Principal papers showed in this review.

Paper	Type	Main topic	Sample	Age	Main result
Korbmacher H. et al. (2007). **Reference** [22]	**Case-control study**	**Prevalence of scoliosis in subjects with jaw deformity**	**85 patients with jaw deformity and 20 control subjects**	**adults**	Of the 85 patients with jaw deformity, 23 (27.1%) had a Cobb angle exceeding 10°. None of the control group had scoliosis exceeding 10°.
Paper	**Type**	**Main topic**	**Sample**	**Age**	**Main result**
Pedrotti et al. (2007). **Reference** [23]	**Case-control**	**To assess the congruence of the laterality of cross-bite and the orthopaedic asymmetry**	**55 children with unilateral cross-bite, and 55 children with asymmetric cervical spine (and no cross-bite)**	**3-10**	among the children who revealed an asymmetric upper cervical spine, the unilateral crossbite was not necessarily combined with a pathological orthopaedic variable,
Paper	**Type**	**Main topic**	**Sample**	**Age**	**Main result**
Lippold et al. (2000) **Reference** [24]	**A prevalence stuydy**	**Prevalence of bilateral crossbite in subjects with scoliosis**	**428**	**9-14**	an incidence of scoliotic attitudes of 9.5%, with a statistically significant relationship among that disorders of posture, and the presence of ogival palate with bilateral crossbite
Paper	**Type**	**Main topic**	**Sample**	**Age**	**Main result**
Azuma Y et al. (1999); **D'Attilio M et al. (2005);** **Poikela A et al. (1997);** **Nerder PH et al. (1999).** **References** [34-37]	**Animal studies**	**The appearence of scoliosis after an imbalance of occlusion**	**animals**	**/**	these experimental studies revealed a high level of asymmetry in craniofacial structures, temporomandibular structures and muscle functions after an experimentally induced crossbite

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Our primary and first secondary outcome of interest was incidence and description of malocclusion in subjects with scoliosis.

Our secondary outcomes of interest were the clinical consequences associated with treatments of malocclusions or scoliosis.

Electronic searches and data retrieval

We searched MEDLINE and EMBASE without language restrictions in September 2010. We also manually searched reference lists from recent review articles. All randomised and controlled clinical trials identified from the Cochrane Oral Health Group Trials Register, a MEDLINE search using the Mesh term scoliosis, malocclusion, and relevant free text words, handsearching the British, European and American journals of orthodontics and Angle Ortho-

dontist, and the bibliographies of papers and review articles which reported the outcome of orthodontic treatment in subjects with scoliosis that were published as abstracts or papers between 1970 and 2010.

Study selection and Data Extractiones of interventions

Two reviewers (ST and MS) independently reviewed the abstracts for potential eligibility and subsequently full text publications for eligibility. Disagreements were resolved by discussion.

We extracted a number of variables on study design and methodological characteristics, patient and intervention characteristics, and outcomes from all eligible studies (see Table 1). Data extraction was done independently by two reviewers (ST and MS) and disagreements were resolved by discussion.

Methodological Quality Assessment

No Randomized clinical trials were recorded for this argument.

For the observational longitudinal studies we noted the presence of control groups only in a few studies. The great part of transversal studies showed a control group.

Results

Using the search strategy eleven observational longitudinal studies were identified. No randomized clinical trials were recorded. Twenty-three cross-sectional studies were recorderd, and the others studies was reviews, editorials, case-reports, or opinions. The clinical trials were often not controlled and were about the cephalometric evaluation after treatment with the modified Milwuakee brace, followed by the orthodontic treatment of the class II relationship with a functional appliance. Clinical trials also included the study of the associations between scoliosis and unilateral crossbite, in children with asymmetry of the upper cervical spine. This association was also investigated in rats, pigs and rabbits in clinical trials. The other associations between scoliosis and occlusion seems to be based only on cross-sectional studies, case-reports, opinions.

Scoliosis and Plagiocephaly

In literature, the association between plagyocephaly and scoliosis was observed during ‘80 decade in premature infants. The existence of an association is based on clinical case-reports, opinins and cross-sectional studies.

In a study performed on 144 infantile patients who attended the Edinburgh Scoliosis Clinic between 1968 and 1982, [9] plagiocephaly was present in 124 infants (86%) and absent in nine (6%), all with resolving curves; no clinical records had been made in the remaining 11 infants (8%). In the patients with progressive curves, either single or double curves, the “recessed” side of the plagiocephaly always corresponded with the convex side of the thoracic or thoracolumbar curve, suggesting the existence of an association between infantile scoliosis and plagiocephaly [8]. (Figure 1)

Figure 1. Left sided plagiocephaly with controlateral bat ear. Tracted by the paper referenced in [3].

Also in the patients affected by scoliosis and plagiocephaly, who showed a resolving scoliotic curve, the “recessed” side of the head corresponded with the

convex side of the curve [8,9].

The association between these two conditions has been explained by the nature of plagiocephaly, that is a plastic deformation of the skull. It was hypothesized that when an immobile infant habitually lies towards one side (the case of premature babies) the action of gravity on the plastic skull could cause the uppermost side of the face and head to flow backwards and become recessed, while the lower ear is pushed forwards producing the commonly associated contralateral "bat ear". Associated with this immobility, plagiocephaly, however, rarely persists and once the child becomes mobile, it usually resolves by the age of six years. The scoliosis in these infants was rarely noted at birth but, like the plagiocephaly, developed within the first six months of life in 70% of subjects. In the cited sample, the convex side of the curve corresponded with the recessed side of the head in all except four infants with resolving curves. This close association between the presence, time of presentation and side of the two deformities (both plagiocephaly and infantile idiopathic scoliosis) suggested a possible common pathogenesis.

The Milwuakee brace and malocclusion

A lot of studies made on 60' and 70' years on the use of the original Milwuakee brace in scoliosis therapy demonstrated the damageable effects on teeth occlusion.

About this argument, longitudinal clinical trials were recorded, in addition to clinical cases and observational studies.

In 1969, a clinical case was published about the orthodontic treatment of a class II malocclusion in a patient, probably caused by the cast worn after the surgeon operation to reduce the scoliosis, in a fourteen year old girl who received the Harrington operation in 1963 [10]. This article suggest the great attention given to the association between class II malocclusion (Figures 2, 3, 4 and 5) and the use of this type of orthopedic brace, due to the presence of a force on the chin (Figure 6); the correction of the class II malocclusion requested the wearing of only a removable appliance (a positioner). The patient was treated soon after the operation and, for a year later, with a positioner, after which the malocclusion resulted corrected. For this, the conclusion of that article was to recommend the use of this removable

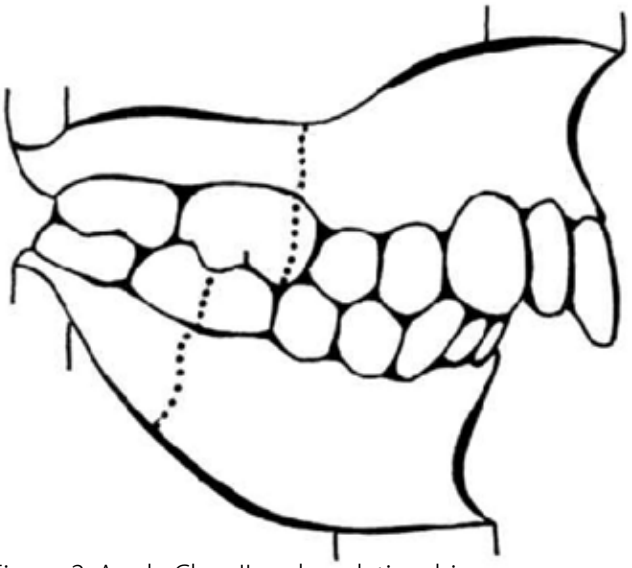

Figure 2. Angle Class II molar relationship.

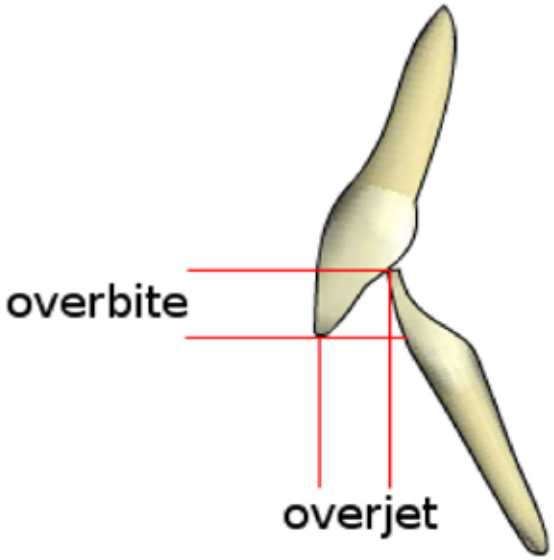

Figure 3. Overjet and overbite.

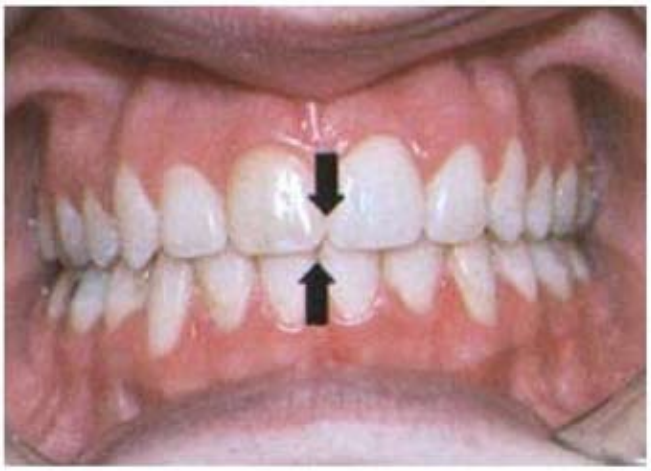

Figure 4. Dental midline deviation. Tracted by the paper referenced in [52].

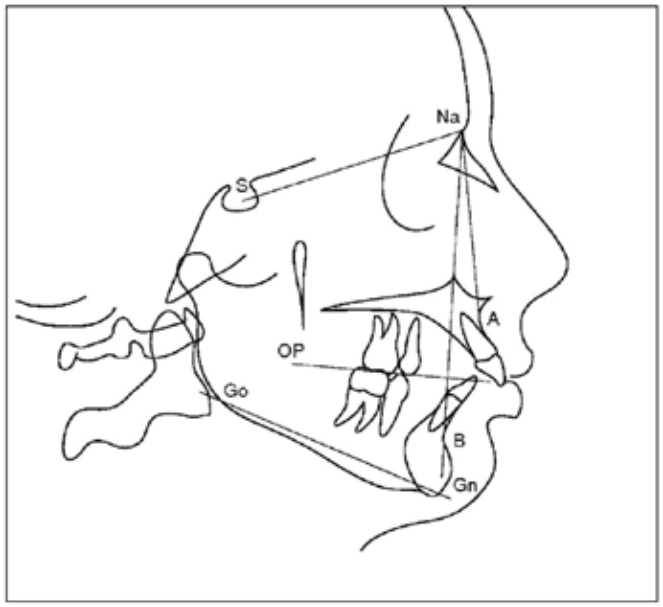

Figure 5. Protrusion of maxilla - SNA angle - and retrusion of manibula - SNB angle - in a cephalometric tracing.

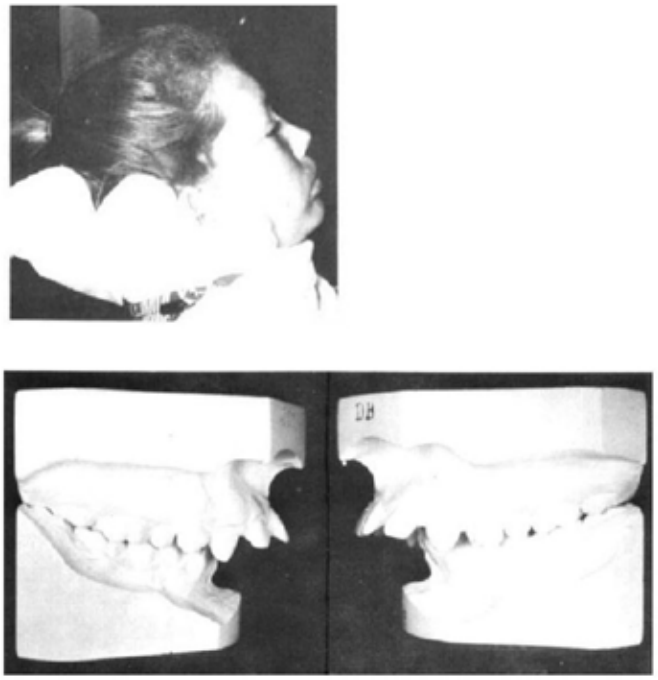

Figure 6. a-b. (a)The cast was relieved under the chin. (b) The class II malocclusion associated to the cast. Tracted by the paper referenced [9].

appliance to prevent the malocclusion before the surgeon operation and during the period of wearing the cast.

In the April of 1972, the effect of the Milwaukee brace upon dentofacial growth was investigated in a longitudinal clinical trial in a large sample and compared with a control group [11]. Measurements of facial morphology at different age of subjects affected by scoliosis and treated with this device, were compared of a health matched sample. The age range was about 5 to 19 years, with a mean of 10 years. The differences were associated to the wearing of the brace (Figure 7). All vertical measurements of face were significantly lower than the control group. The mandible and the maxilla were significantly more protruted in the study group than in the control one. The suggestion was to wear a teeth positioner during the therapy. However, as no pre-treatment data were available, it is not sure that these characteristics were caused by the brace, although it is evident that the brace can reduce the vertical dimension of the face. The Milwaukee brace has undergone many modifications since its creation. The chin pad in the original brace was replaced by a plastic throat piece in a lower position and closer to the neck. In this new design, its posture was underneath the body of the mandible just above the thyroid cartilage, so that the patient would not be able to rest the mandible on the throat piece, as was previously done with the chin pad. The rigid occipital pad was changed into flexible plastic uprights to allow the patient to tip his head backwards. This modified brace was more comfortable to wear with less pressure under the mandible. Also the use of a removable splint was suggested to avoid dental consequences when the patient did not show permanent teeth, and wore the brace for more than 24 months [12]. The effect of an orthodontic device was also evidenced in clinical case-reports [13,14]. Bracing is normally done when the patient has bone growth remaining and is generally implemented to hold the curve and prevent it from progressing to the point where surgery is recommended. Braces are also sometimes prescribed for adults to relieve pain. Bracing involves fitting the patient with a device that covers the torso; in some cases it extends to the neck. Today, the most commonly used brace is a TLSO, a corset-like appliance (Figure 8) that fits from armpits to hips and is custom-made from fiberglass or plastic. It is usually worn 22-23 hours a day and applies pressure on the curves in the spine. The effectiveness of the brace depends not only on brace design and orthotist skill, but on patient compliance and amount of wear per day. The latest standard of brace construction is with CAD/CAM technology. With the help of this technology it has been possible to standardize the pattern specific brace treatment. Severe mistakes in brace construction are largely ruled out with the help of these systems. A more recent development is the

SpineCor Dynamic brace. It was developed by a research team at the St. Justine Hospital in Montreal Canada, as part of a research project funded by the Canadian government. The brace was first used in

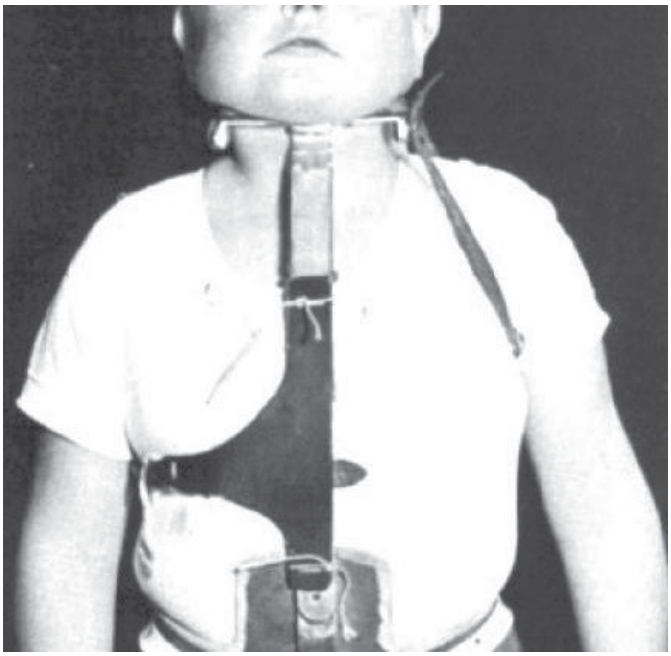

Figure 7. A patient wearing the Milwuakee brace. Tracted by the paper referenced in [9].

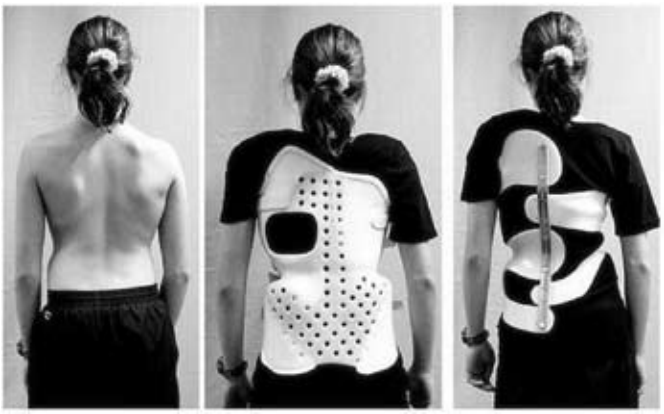

Figure 8. Orthopaedic braces used today. Tracted by the paper referenced in [15].

clinical application in Montreal in 1992 and is currently used in many countries throughout the world. This brace works using a different treatment approach to rigid bracing. Rather than trying to force the spine straight using three points of pressure, SpineCor uses a corrective movement. The regions of the body -- shoulders, rib cage, lumbar spine and pelvis -- are guided to a postural position that is the inverse of the scoliotic posture. As the spine is connected to the body it must move with the body when it is repositioned by the corrective movement. Hence, through the coupling of postural and spinal position, it is possible to affect the geometry of the scoliotic curve. The advantages of SpineCor are that it is flexible and allows dynamic movement, thereby eliminating the muscle weakening side effects seen with rigid bracing. It is also very easily concealed under clothing. The fact that it works as both a rehabilitation device and a brace, means that corrections made in the brace are sustained over the long term in 95.7% of cases [15]. In view of the postural approach to correct the scoliosis, the contemporary correction of occlusal deviations can be considered in line with the actual principles, based on the postural correction, of scoliotic treatment. Typically, braces are used for idiopathic curves that are not grave enough to warrant surgery, but they may also be used to prevent the progression of more severe curves in young children, to buy the child time to grow before performing surgery, which would prevent further growth in the part of the spine affected. The Scoliosis Research Society's recommendations for bracing include curves progressing to larger than 25 degrees, curves presenting between 30 and 45 degrees, Risser Sign 0, 1, or 2 (an x-ray measurement of a pelvic growth area), and less than 6 months from the onset of menses in girls [16].

Scoliosis and Angle class II molar relationship (unilateral class II malocclusion)

This relationship was investigated mostly through case-control studies and clinical case reports. Among the orthodontic problems associated with scoliosis, attention was given to hereditary orthodontic anomalies (class III, crowding, ogival palate). Hereditary orthodontic anomalies were found at a significant level in a group of 202 adolescent patients diagnosed with idiopathic scoliosis, with a Cobb angle from 20° to 50°, [17] compared with a matched control health group, while acquired orthodontic anomalies occurred in both groups at about the same rate of frequency, suggesting that the detection of hereditary orthodontic anomalies in young children allows the identification of a group of children who have a high risk of developing scoliosis in later years.

In 2006, the occlusions (Figure 12, 3, 4 and 5) of patients with idiopathic scoliosis were clinically examined in a group of 96 consecutive orthopedic patients with idiopathic scoliosis (79 females and 17 males: mean age, 13.9 y; SD: 3.5 y; range, 6.2-25.3 y) [18].

Occlusal features of a random group of 705 children served as the control. In the considered sample, the interarch relationships in the antero-posterior dimension (Angle classification) were similar in the 2 groups for the frequency distributions for normocclusion and Class I malocclusion, but they were significantly different when concerned the Angle class II malocclusion (Figure 2, 3 and 5).

The distribution of the Angle class II malocclusion was significantly different in the scoliotic patients respect to the orthopedic health group.

Specifically, taking in consideration the group of subjects with Class II malocclusion, (Figure 2) with a high overjet (Figure 3), a significant higher prevalence of unilateral Angle class II (asymmetric class II malocclusion) was evident among the patients with scoliosis (21.9%) compared with the control group (8.5%), indicating that the asymmetry in the antero-posterior relationships seems a clinical sign associated with scoliosis.
In particular, while the frequency of asymmetrical molar relationships was identical in the scoliosis and the control groups, great differences in the frequency of asymmetrical canine relationships were encountered; the scoliosis patients were more asymmetric in this regard. In addition, in the same sample, the prevalence of upper midline deviation (Figure 4) (this is a clear clinical sign of occlusal asymmetry) was 21% in the group of scoliosis and 9.5% in the control group; at the same time, the prevalence of lower midline deviation was 53.7% in the study group and 32.9% in the control group. The differences between the two groups in the prevalence of the midline deviation were statistically significant both in the upper and the lower dental arches. No association was found between site, side, or severity of scoliosis and the appearance or site of the malocclusion features examined.

Later, the severity of scoliosis was related to the occlusal relationship again, but no significant relationship was observed between the severity of scoliosis and the occlusal characteristics.

In 2008, in facts, the scoliosis was related again to the Angle class malocclusion, [19] with the analysis of 28 children with scoliosis at various degree of severity (mean age: 14.7 y; SD: 2.3 y) matched with a control group of 68 orthopedically healthy children (mean age: 14.8 y; SD: 0.11 y). In the group of scoliotic subjects, the indication of the corset was represented by the values of Cobb angle > 20° measured at the level of main curvature, so these children belonged to the severe group. In the analyzed sample, nine children were wearing corset because of the severity of their orthopedic malformation. The moderate subgroup consisted of children with malformations requiring no constant posture correction, namely wearing corset. Besides the clarified different orthopedic situation, the selection criteria of the two groups were: similar age, no previous orthodontic treatment, as well as no missing teeth, carious lesions, or pathologic periodontal status. In this sample, when analyzing the sagittal deviations in the molar region, the incidence rate of the bilateral deviation, being present as a sign of symmetry, as well as of the unilateral occlusal deviation, related to the asymmetry, revealed a significant importance. In the group of adolescents with scoliosis, in fact, the unilateral Angle class II relationship showed a significant higher prevalence respect to the control group (Figure 2). Specifically, in the group of subjects with scoliosis, the 57.12% showed a normal bilateral occlusion, but the 28.56% showed a unilateral Angle class II malocclusion, with a significant higher frequency respect to the health group. This unilateral deviation (unilateral Angle class II malocclusion) was characteristic for almost one-third of scoliotic subjects, while in the control health group its incidence rate was hardly 8.82%. In the group of scoliotic subjects, the unilateral class II relationship was significantly higher frequent then the bilateral class II relationship, pointing on the importance of the asymmetry of malocclusion, in relation to the scoliosis.

These studies are in accordance with what affirmed by Lippold et al. (2003), [20] that the scoliotic curves occur in the frontal plane and - through the head posture that is tilted sideways -play an important role in the development of the different dentofacial asymmetries. Results of several studies, as seen, confirm a potential correlation between scoliosis and unilateral Class II malocclusion.

Unilateral Class II malocclusion is not the only type of malocclusion significantly associated to the scoliosis.

Segatto et al. (2008) [18] analyzed also other occlusal characteristics of the frontal region of dental arch and found some other significant differences between the scoliotic and the health groups.

In particular, the subjects with scoliosis showed a significant higher overjet (see Figure 3 for details on this variable) and a higher midline deviation (Figure 4) (Table 2) respect to the control group. Then, the

Table 2

Frequency of the sagittal occlusal anomalies on the molar region, according to the study by Segatto et al. (2008).

Parameters		Scoliosis group	Control group
Normal molar occlusion (Angle Cl.I) frequency (%) (health occlusion)	unilateral	**28.56**	**16.17**
	bilateral	57.12	64.68
Distal molar occlusion (Angle Cl.II) frequency(%) (pathological occlusion)	unilateral	**28.56**	**8.82**
	bilateral	10.07	16.17

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Table 2. Frequency of the sagittal occlusal anomalies on the molar region, according to the study by Segatto et al. (2008).

Table 3

Comparison of the occlusal characteristics of the frontal region, according to the study by Segatto et al. (2008).

Parameters	Scoliosis group	Control group	
	severe type	**moderate type**	
Overjet			
mean ± SD (mm)	2.74 ± 1.851	2.55 ± 1.509	2.21 ± 1.201
Overbite			
mean ± SD (mm)	2.58 ± 2.168	2.78 ± 1.715	3.10 ± 1.585
Midline deviation			
mean ± SD (mm)	2.08 ± 1.121	1.76 ± 0.972	1.47 ± 0.898

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Table 3. Comparison of the occlusal characteristics of the frontal region, according to the study by Segatto et al. (2008).

scoliotic group was characterized by lower overbite (Figure 3 for details on this variable) compared to the determined mean values (3.10 mm) of the control health group (Table 3) [18].

Finally, on the basis of the evaluation of cephalograms in the same sample, a slightly protrusive maxilla and a slightly retrusive mandibula (Figure 5), characteristic of a class II skeletal discrepancy, resulted more pronounced in the scoliotic group than in the control group [19].

In addition to the studies that compared scoliotic to healthy subjects, other investigations underlined a relation between the occlusion and the vertebral column alignment, also in not scoliotic subjects [20,21].

These studies thus suggest a multidisciplinary orthodontic and orthopaedic approach to patients who do not show any clinical evidence of scoliosis or malocclusion.

For example, in 2007, Lippold et al. noted [21] a relationship between the pelvic tilt and pelvic torsion (Figure 9a-b) and the facial shape (facial axis and facial depth), variables which affect the occlusion of teeth and influence the orthodontic treatment.

positive if the normal to the right dimple points lower than the normal to the left dimple, indicating the DR to be rotated backward whereas the DL is rotated forward. Tracted by the paper referenced in [11].
The study was performed on a group of fifty-three adult patients (32 women and 21 men; mean age 24.6 years, SD 9.0 years) with skeletal malformations (Class II and III malocclusion) who came to medical center for a consultation regarding an orthodontic treatment, without anamnestically established motor or neurological findings and/or previous internal or orthopaedic illnesses.
In the sample, some correlations were observed with the facial depth (mesial/distal) and the facial axis (vertical/horizontal).
Patients with a vertical value on the facial axis and a skeletal distal value in the facial depth (long face) had a slight pelvic torsion (Figure 9b) where the DL (left crista iliaca posterior superior) was rotated backward with respect to the DR (right crista iliaca posterior superior), while patients with a horizontal facial axis and mesial relation of facial depth (short face) revealed a slight rotation of the DR rotated backward regarding the contralateral side. Although the investigation was performed on subjects without a diagnosed scoliosis, and on the base of a rasterstereographic surface reconstruction of the back profile of a patient (and not a radiographic evaluation of scoliosis), it suggested an extension of the interdisciplinary concepts within the sense that an orthopedic examination can be considered for patients undergoing an orthodontic-operative therapy.

This relationship was investigated mostly through case-control studies and clinical case-reports. In general, it was stated that left-right asymmetries are among the most common anomalies in patients with scoliosis [22].

As seen in literature, these anomalies seem to be also evident in the craniofacial complexes of patients with certain malocclusions, as unilateral crossbites (Figure 10), lower midline deviations, and facial asymmetries. Because some asymmetric malocclusions are difficult to correct fully, it was hypothesized that generalized body asymmetry might underlie these malocclusions in some patients [17].

In a group of subjects controlled from April 2002 through July 2003, [23] the posteroanterior cephalometric radiographs and chest X-rays from 85 patients with jaw deformities and a control group of 20 patients with no jaw deformities were controlled. To measure the lateral shift of the mandible, a horizontal baseline (X axis) was drawn on the cephalogram connecting the intersection of the external margins of the orbits and the most lateral points of the greater wings of the sphenoid. A vertical baseline (Y axis) was then marked perpendicular to the × axis, intersecting the ethmoid crista galli. Then, the lateral displacement of the mandibular mentum from the Y axis was measured. Displacement to the right was designated positive; that to the left was designated negative. Cobb's method was used to measure scoliosis curves on chest X-rays; the direction of the curve was designated similarly. Of the 85 patients with jaw deformity, [23] (27.1%) had a Cobb angle exceeding 10°. None of the control group had scoliosis exceeding 10°. No correlation was found between the direction of mandibular displacement and

the direction of scoliosis.

In 2008, in the analysis of 28 children with scoliosis (mean age: 14.7 y; SD: 2.3 y) compared with a control group of 68 orthopedically healthy children (mean age: 14.8 y; SD: 0.11 y), three children in the scoliotic group were registered with a unilateral crossbite (Figure 8) while there was only a bilateral crossbite case. In the control group two bilateral crossbite cases matched the three unilateral crossbite cases [18].

In the same sample, also the degree of the midline deviation (Figure 4), that is a clinical sign associated with the unilateral crossbite, was recorded. The severe type of scoliotic group was characterized by significantly higher prevalence of midline deviation, compared to the control group [18]. Also, this scoliotic group was found to have higher midline deviation values respect to the control group (Table 2).

In 2006, in a group of 96 orthopedic patients with idiopathic scoliosis 17 (79 females and 17 males: mean age, 13.9 y; SD: 3.5 y; range, 6.2-25.3 y), compared with a control group of 705 children, the prevalence of upper midline deviation was 21% in the group of scoliosis and 9.5% in the control group; while the prevalence of lower midline deviation was 53.7% in the study group and 32.9% in the control group. In the same sample, the prevalence of unilateral posterior crossbite was 28.1% and 18.1% respectively in the study and the control group; the prevalence of anterior crossbite was 16.6% in the study group and 9.3% in the control group.

An increased occurrence of orthopaedic alterations in the frontal plane was also observed in children with a unilateral crossbite in another recent study [24]. More specifically, among the children who revealed an asymmetric upper cervical spine, the unilateral crossbite was not necessarily combined with a pathological orthopaedic variable, but statistically, children with a unilateral crossbite showed more often an oblique shoulder, scoliosis, an oblique pelvis, and a functional leg length difference than children with symmetry. No correlation was found between the laterality of the crossbite side and any orthopaedic asymmetry. The study was conducted comparing fifty-five children aged 3-10 years (22 girls and 33 boys) with a unilateral crossbite and 55 gender- and age-matched children with asymmetric upper cervical spine, but no crossbite, who served as the control group, selected from an orthopaedic cohort of 240 patients. The certain asymmetry of the upper cervical region was confirmed in all the subjects by radiographs and palpation.

Also, in 2008, in the analysis of 28 children with scoliosis (mean age: 14.7 y; SD: 2.3 y) compared with a control group of 68 orthopedically healthy children (mean age: 14.8 y; SD: 0.11 y), 18 the clinical examination of the Temporo-mandibular joint (TMJ) at almost a quarter of the scoliotic group revealed a pathological symptom: the mandibular lateral movements showed a reduced range in only one side. More specifically, only half of the patients in the scoliotic group were able to make the same range of bilateral movements. On the contrary, this rate was 82.32% in the control group.

The results of all these cited studies suggest that dental asymmetries correlate with orthopaedic asymmetries in the frontal plane, when the analysis is conducted in a sample of young boys and girls.

However, it must be noted that also the bilateral crossbite was related to the scoliosis. In 2007, also a correlation between scoliosis and bilateral crossbite was reported: in a study on 428 subjects (211 females and 217 males), aged 9 to 14 years, 25 a 2.8% scoliosis incidence has emerged, and an incidence of scoliotic attitudes of 9.5%, with a statistically significant relationship among that disorders of posture, and the presence of ogival palate with bilateral crossbite.

Among the studies on the association between asymmetric occlusion and trunk asymmetry, a few studies must be cited, that have investigated these co-relationship in health subjects without any pathological orthopaedic condition [25-28]. They reported deviating findings: Lippold et al. (2000) [25] found a statistically significant correlation between midline deviation and oblique pelvis as well as leg length differences, considered in the limits of physiology. The other two studies [26,27] showed that moderate trunk asymmetry (not pathological condition) did not affect facial asymmetry or vice versa. With regard to the study design and the investigated patients, the three studies can hardly be compared: one

[26] compared 29 children with a right-sided midline shift with 28 children with a symmetric occlusion; Lippold et al. (2000) [25] investigated midline discrepancies in 50 patients, aged 4-55 y, who were recruited from physiotherapy appointments, while Zepa et al. (2003) [27] analyzed frontal cephalograms and compared them with rib hump or lumbar prominence and spinal posture.

In order to investigate the possible effects of orthopaedic asymmetric disorders on dentofacial development and head posture, other clinical studies have been previously conducted on patients with scoliosis, and the results given by this previous literature are very similar to the more recent cited studies.

In general, in the previous literature on this field, the statistically recorded prevalence of unilateral crossbites in subjects with scoliosis amounted to 26-55 per cent [28-31].

Prager (1980) [30] interpreted the crossbite as a transmission of the asymmetry of the body, whereas Hirschfelder and Hirschfelder (1983) [32] considered, although they had not yet clarified transmission, the crossbite to be a new compensatory curvature of a scoliosis. Independent of the different offered explanations of the high prevalence of crossbite in those patients, an interdisciplinary treatment approach to alleviate facial asymmetry and to stabilize head posture, initiated as early as possible, has been unanimously recommended since '60 decade [28,33,34].

But it must be underlined that several studies about the association between unilateral crossbite and scoliosis were also conducted on animals, and the obtained results tended to confirm the observations recorded on humans.

In general, the results from experimental animal studies suggested that alterations in the occlusion evoke changes in many other regions of the body [35-37].

For example, teeth occlusion seems to have an impact on head position, spinal column alignment, and masticatory muscles which control posture and modulate cardiac function via the trigeminal system. After unilateral occlusal destruction, a postural abnormality in terms of inability of head maintenance, T-wave inversion on electrocardiograph, hair loss, changes in tongue mobility, and eating disorders as well as pathologies of the eye have been observed [35]. Then, a scoliotic curve has been developed after induction of a unilateral crossbite in rats [34,36]. In these studies, the evoked changes were observed within 1 week of unilateral manipulation and normalized after harmonization of the occlusal plane (Figure 11)

Experimental studies also tried to explain the origin and the mechanism for the occurrence of an asymmetric growth of the head due to a unilateral crossbite: [38] more specifically, this experimental study in rabbits revealed a high level of asymmetry in craniofacial structures, temporomandibular structures and muscle functions in rabbits after an experimentally induced crossbite [37]. Moreover, in patients with a unilateral malocclusion, asymmetric condylar position with an asymmetric condylar path was observed, [28,39] and this seems to reduce the mandibular condylar growth, [40] causing an asymmetric mandibular ramus length, that has been observed shorter in the crossbite side [41,42]. Based on the findings that asymmetric facial structures can be corrected only after early correction of a unilateral crossbite [28,41,43] it was suggested that a persisting asymmetric occlusion results in growth restriction that leads to mandibular and facial asymmetry [40,44-47] and later also to a vertebral column asymmetry. For this type of correlation, the role of the cervical column, as a link tract between the head and the vertebral column has been underlined.
In this field, it has been demonstrated in health subjects, without evident orthopaedic disorders, that craniofacial growth is strongly associated with cervicovertebral anatomy [29,48]. It has been shown that the upper cervical region reveals a high potential for adaptation to craniofacial growth [29]. This may possibly be due to its important role: the cervical spine provides the morphological basis for an extensive freedom of head movement; then, it serves as a bridge for numerous blood and lymphatic vessels and nerves, linking head, trunk, and upper limb. The mechanism of transmission of an imbalance from the occlusion to the vertebral column may be related to the consequential tilt of the first cervical vertebra that affects the tilt of the adjacent vertebra, so destabilizing the vertical alignment of the cervi-

cal spine, also changing the functionality of each cervical muscle; finally, the asymmetrical distribution of loads could then affect the orientation of the other dorsal and lombar vertebrae, contributing to the functional deformity of the spine, finally the scoliosis [49].

Also, a close relationship among the masticatory muscles and the cervical muscles supporting the head has been demonstrated in patients requiring stomatognathic treatment [50]. In addition, it has been shown that occlusal interference can cause dysfunction of both the cervical spine and the sacroiliac joint [51]. Consequently, all these authors recommended that the cervical spine and lumbar and pelvic regions should also be investigated in patients with craniomandibular dysfunction. In this field, the intimate developmental relationship between the atlas and the cranial base was also underlined [52].

In a study previously cited, [23] in facts, an oblique shoulder was diagnosed in 30.9% of the total group, and in 70.6% of them a unilateral crossbite was observed, suggesting a link among occlusion, cervical spine adaption and occurrence of scoliosis, although no causal relationship was demonstrated.

All the interdisciplinary studies on scoliotic patients are in accordance with the fact that no lateral correlation exists between the side of crossbite and the side of the curvature of the scoliotic spine [30,31,49].

Finally, in the analysis of the orthopedic literature, Floman [53] indicated a possible connection between thoracic scoliosis and restricted head motion in a report of 6 patients. However, it has not been clarified whether such a restriction in head motion had a secondary influence on occlusion.

Discussion and conclusion

As seen, no randomized clinical trials were recorded. The observations were mostly based on case-control studies and clinical case-reports.

Longitudinal cllinical trials with a control group evidenced the association betweeh the first type of brace and the occurrence of a class II relationship induced by the brace; consequently, the clinical controlled trial suggested the use on orthodontic treatment during the treatment of scoliosis with a brace. The maiority of other studies were case-control studies that evidenced the presence of unilateral class II, midline deviation, increased overjet and unilateral cross-bite in a higher percentage in subjects with scoliosis respect to health subjects.

As seen in this review, there are only few articles which describe the orthodontic examination as an opportunity for the early detection of scoliosis or which emphasize the necessity of early orthodontic check-ups for children with diagnosed scoliosis, highlighting the application of minimal-invasive methods of screening the affected population [54]. Based on their results, however, a dominancy of the dentofacial asymmetry (mostly unilateral crossbite) in the scoliotic group, can be expected, [48,55] as well as unilateral Angle class II malocclusion and midline deviation. As seen in this review, the data in literature prove also the existence of other dentofacial anomalies in children with scoliosis (ogival palate, increased overjet, reduced overbite, reduced range in lateral movements in one side), although these studies did not analyzed the orthopaedic sample on the base of the scoliotic angle, or the presence of one or more curves, and on the location of the curvature, which may affect the gravity and the type of scoliosis.

Some hypothesis to explain the correlation between the occlusion and the scoliosis can be made, although without certain conclusions.

The assumption on which the hypothesis on this correlation is based is that there is an anatomical and functional relationship between the stomatognathic apparatus and the spinal column. This relationship was hypothesized by several authors, based upon various observations [56].

Neurophysiological principles of convergence and sensitization: a constant input, such as a nociceptive input, on second-order neurons may increase the sensitivity of these neurons. Then, non-nociceptive neural impulses from other areas within the same segment, which converge onto these neurons, may give rise to altered sensations from these areas. For the craniocervical region, for example, a constant nociceptive input from, the upper part of the trapezius muscle can lead to an increased sensitivity

of the spinal trigeminal nucleus and, consequently, non-nociceptive stimuli from the masticatory system would then lead to painful sensations from the trigeminal region [55]. This occurs as the different input converges onto the nucleus caudal portion of the trigeminal spinal tract nucleus [55]. As a consequence, for example, a significantly higher prevalence of cervical spinal pain was observed in a group of patients with craniomandibular pain than in a matched control group without craniomandibular pain, thus causing postural disease, and affecting in final the whole vertebral column.

2. Anatomical details: There is an anatomical relationship between the mandible and the cervical column, since the cranium and the mandible have muscular and ligament attachments to the cervical area. The function of the head, neck, and jaws is closely interrelated, forming a combined functional system [55,56]. observed a significant correlation between mandibular length and cervical lordosis angle on lateral skull radiographs (in natural head position) in Caucasian adult women with a skeletal class II malocclusion. The longer the mandibular body was, the straighter the cervical column appeared to be [56]. In a group of 50 Caucasian adult women with internal derangement, compared with a control group of 50 Caucasian women without internal derangement, cephalometric tracings on lateral skull radiographs in natural head position showed a significantly lower cervical lordosis angle. Beyond possibly causing TMJ diseases, dental malocclusions could, by the same mechanism, be linked to a functional asymmetry of trunk muscles. We suggest that one pathway is through the atlas. The atlas is linked to occipital condyles and thus affect the rest of the spine alignment, leading to further profound compensatory chenges, that may become pathological.

In conclusion, from a clinical point of view, if the asymmetry underlying idiopathic scoliosis and asymmetric malocclusion originates from the same etiology, it might be difficult to fully correct all features of the malocclusion or maintain the correction. This difficulty was observed, for example, in patients with posterior crossbites in whom relapse of lower midline deviations or tendency toward crossbites was evident also after orthodontic treatment. To clarify this point, the possibility of a connection between the reverse cycle in masticatory movements and asymmetrical posture should be evaluated.
In conclusion, all the observed frequent and severe dentofacial deviations in the scoliotic group draw the attention to the necessity of the early examination of this patient group from an orthodontics and orthopaedic point of view.

However, whether scoliosis affects mandibular dentoalveolar symmetry (whether there is a causal relationship) needs further elucidation.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

ST and MSare the Principal Investigator of this review. They 1) have made substantial contributions to conception and design, acquisition of data, analysis and interpretation of data; 2) have been involved in drafting the manuscript or revising it critically for important intellectual content; and 3) have given final approval of the version to be published. ST and MS contributed in the same way, as principal investigators, to this research. LT participated in drafting the manuscript. SM helped in the revision of the manuscript. AP helped in the first revision of the manuscript. FF participated in drafting the manuscript. All authors read and approved the final manuscript.

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Scoliosis and dental occlusion: a review of the literature

True or false:

6. Parker was the dentist who provided evidence for the relationship between dental assymatries and orthopaedic assymatries.
   a) True
   b) False

7. Increased overjet, midline deviation, and unilateral crossbite can be associated with scoliosis.
   a) True
   b) False

8. In the overall case studies , the patients posture deteriorated post dental treatment.
   a) True
   b) False

9. Orthopeadic spinal braces are used to guide the shoulders, ribcage, lumbar spine and pelvis.
   a) True
   b) False

10. Milwaukee braces still have chin pads.
    a) True
    b) False

Heat Treatment of Dental Alloys: A Review

William A. Brantley and Satish B. Alapati

1. Introduction

Metallic materials have widespread use in dentistry for clinical treatment and restoration of teeth. Major areas of usage are: (1) restorative dentistry and prosthodontics (dental amalgam and gold alloy restorations for single teeth, metallic restorations for multiple teeth, including metal-ceramic restorations, removable partial denture frameworks, and dental implants), (2) orthodontics (wires which provide the biomechanical force for tooth movement), and (3) endodontics (rotary and hand instruments for treatment of root canals). Heat treatment of the metal can be performed by the manufacturer, dental laboratory, or dentist to alter properties intentionally and improve clinical performance. Heat treatment of the metal also occurs during the normal sequence of preparing a metal-ceramic restoration, when dental porcelain is bonded to the underlying alloy substrate. Moreover, intraoral heat treatment of some metallic restorations occurs over long periods of time. There is an enormous scientific literature on the heat treatment of metals for dentistry. A search of the biomedical literature in May 2012, using PubMed [http://www.ncbi.nlm.nih.gov/pubmed/] revealed nearly 450 articles on heat treatment of dental alloys. The purpose of this chapter is to provide a review of the heat treatment of metallic dental materials in the foregoing important areas, describing the important property changes, with a focus on the underlying metallurgical principles.

2. Restorative dentistry and prosthodontics

2.1. Dental amalgams

Dental amalgams are prepared in the dental office by mixing particles of a silver-tin-copper alloy for dental amalgam that may contain other trace metals with liquid mercury. The initially mixed (termed triturated) material is in a moldable condition and is placed (termed condensed) directly by the dentist into the prepared tooth cavity, where it undergoes a setting process that produces multiple phases and can require up to one day for near completion. Extensive information about the several different types of dental amalgams are provided in textbooks on dental materials [1,2]. Particles of the alloy for dental amalgam are manufactured by either lathe-cutting a cast ingot or directing the molten alloy through a special nozzle. Both the machining of the lathe-cut particles and the rapid solidification of the spherical particles create residual stress. In addition, the microstructure of the solidified silver-tin-copper alloy has substantial microsegregation. Consequently, manufacturers of the alloy powder for dental amalgam perform a proprietary heat treatment to relieve residual stresses and obtain a more homogeneous microstructure. This heat treatment is of considerable practical importance since it affects the setting time of the dental amalgam after the powder is mixed with mercury. Subsequently, the dental amalgam restorations undergo intraoral aging, which can be regarded as heat treatment, and detailed information about the microstructural phase changes for prolonged intraoral time periods has been obtained from clinically retrieved dental amalgam restorations [3].

2.2. Gold alloys for all-metal restorations

Gold alloys are principally used for all-metal rest rations (inlays, crowns and onlays) in single posterior teeth. These alloys are cast by a precision investment process, and the restorations are cemented by the dentist into the prepared tooth cavity. The original gold casting alloys contained over approximately 70 wt.% gold, but the very high price of gold has led to the development of alloys that contain approximately 50 wt.% gold. These alloys also contain silver, copper, platinum, palladium, zinc, and other trace elements, including iridium for grain refinement. Information about the dental casting process and the gold alloys is available in dental materials textbooks [1,2]. Detailed compositions and mechanical properties of specific alloys are available on the website of the major manufacturers. Another valuable reference is the current ISO Standard on metallic materials for fixed and removable dental appliances [4], which stipulates mechanical property

requirements. In the normal dental laboratory procedure, gold castings for allmetal restorations are water-quenched after solidification, following loss of the red heat appearance for the sprue. This results in formation of a disordered substitutional solid solution and leaves the alloy in the soft condition, which is preferable since adjustments are more easily made on the restoration by the dental laboratory or dentist. The gold alloy casting can also be placed in the soft condition by heating at 700°C for 15 minutes and water-quenching. The quenched gold casting may be placed in the hard condition by heat treatment at 350°C for 15 minutes and air-cooling. This heat treatment results in formation of ordered AuCu or AuCu3 regions in the disordered matrix of the high-gold or lowergold alloys, respectively. Examples of changes in clinically important mechanical properties from heat treatment are shown in Table 1 for two gold alloys, where (S) and (H) represent the soft and hard conditions.

In practice, dental laboratories do not perform heat treatments on the cast gold restorations because of the time involved. However, it appears to be fortunate that the gold alloys that contain sufficient copper to undergo ordering will undergo age hardening in the mouth.

Figure 1 compares the intraoral aging behavior of a traditional high-gold dental alloy (Type lV) and a special gold alloy containing gallium (AuCu-3wt%Ga) [5].

restorations involving multiple adjacent teeth (fixed prostheses or crown-and-bridgework). An alloy is cast using the precision investment procedure in dental laboratories to fit accurately to the prepared tooth or teeth, and to form a substrate (termed the coping) for the porcelain. After an initial oxidation step that forms a native oxide on the metal surface, one or two layers of opaque porcelain are bonded to the metal, followed by the application of a layer of body porcelain and a surface glaze [1,2]. In order to have a strong bond between the porcelain and metal, which is essential for clinical longevity of the metal-ceramic restoration, the coefficients of thermal contraction for the metal and porcelain must be closely matched, and a difference not exceeding 0.5 ppm/°C is generally desired. Mechanical property requirements for the alloys are stipulated in ANSI/ADA Specification No. 38 (ISO 9693) [6], and the minimum value of 250 MPa for the 0.2% offset yield strength is important, since the thin coping must withstand intraoral forces without undergoing permanent deformation. The metal-ceramic bond strength (termed the bond compatibility index) is measured with a three-point bending test that uses thin cast alloy strip specimens having a centrally located area of sintered porcelain, and a minimum bond strength (shear stress) of 25 MPa is stipulated.

Both noble and base metal alloys are used for bonding to dental porcelain. The current American Dental Association classification has four alloy groups for fixed prosthodontics [7]: (1) high-noble (gold-

Alloy	Vickers Hardness		0.2% Offset Yield Strength		Percentage Elongation	
Firmilay (74.5% Au)	121 (S)	182 (H)	207 MPa (S)	276 MPa (H)	39% (S)	19% (H)
Midas (46% Au)	135 (S)	230 (H)	345 MPa (S)	579 MPa (H)	30% (S)	13% (H)

Table 1. Summary of property changes resulting from heat treatment of two gold alloys for all-metal restorations. [http://www.jelenko.com/, accessed August 15, 2012]

2.3. Alloys for fixed prosthodontics (metal-ceramic restorations)

Metal-ceramic restorations are in widespread clinical use for restorative and prosthetic dentistry, and are employed for single-tooth restorations and for

platinum-palladium, gold-palladium-silver and gold-palladium); (2) noble (palladium-silver, palladium-copper-gallium, and palladium-gallium); (3) predominantly base metal (nickel-chromium and cobalt-chromium); (4) titanium and titanium alloys. Information about these alloys for metal-ceramic bonding is summarized in a textbook on fixed prost-

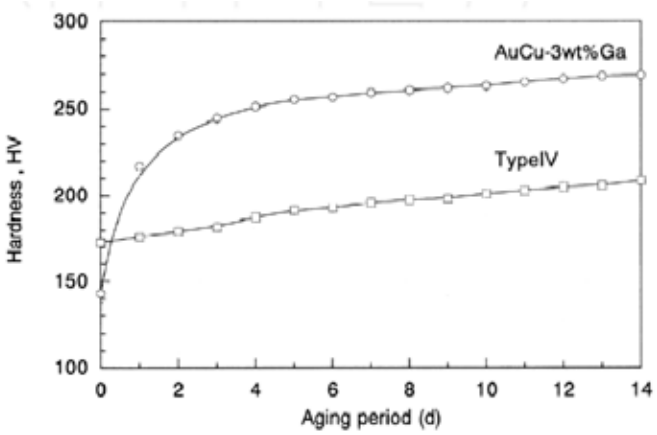

Figure 1. Comparison of the two-week aging behavior at 37°C for a high-gold dental alloy and a dental gold alloy containing gallium that was designed to undergo intraoral aging. From [5] and reproduced with permission.

hodontics [8]. The principal mechanisms for metal-ceramic bonding are (a) mechanical interlocking from the initially viscous porcelain at the elevated sintering temperatures flowing into microirregularities on the air-abraded cast metal surface and (b) chemical bonding associated with an interfacial oxide layer between the metal and ceramic. These two mechanisms are evident from photomicrographs, found in numerous references [8], of the fracture surfaces for metal-ceramic specimens prepared from a wide variety of dental alloys. This native oxide forms on the cast alloy during the initial oxidation firing step in the dental porcelain furnace. Noble alloys for bonding to dental porcelain contain small amounts of secondary elements, such as tin, indium and iron, which form the native oxide and also increase the alloy strength. However, Mackert et al [9] found that during initial oxidation heat treatment, metallic Pd-Ag nodules formed on the surface of a palladium-silver alloy for metal-ceramic restorations and only internal oxidation occurred for the tin and indium present in the alloy composition. They concluded that porcelain bonding arose predominantly from mechanical interlocking with the nodules. Internal oxidation has also been reported for high-gold [10] and high-palladium [11] alloys forbonding to porcelain, but both alloy types also formed surface oxides [10,12].

The initial oxidation step and subsequent sintering (also termed baking or firing) of the dental porcelain layers causes the alloy to experience substantial heat-treatment effects. Under normal dental laboratory conditions, the porcelain firing sequence is performed rapidly. For example, in one study heating of high-palladium alloys in the dental porcelain furnace was performed at approximately 30°C/min over a temperature range from 650°C to above 900°C, and the total heating time for the several firing cycles at these elevated temperatures was about 45 minutes [11]. Studies [13-15] have shown that the as-cast microstructures of noble metal alloys for bonding to porcelain are highly inhomogeneous in the initial as-cast condition, presumably from substantial elemental microsegregation that occurs during the rapid solidification involved with casting into much cooler investment [1,2]. After simulation of the dental porcelain firing sequence, the noble metal alloy microstructures become substantially homogeneous, and there are accompanying changes in the mechanical properties, as shown in Table 2.

Alloy Type	Vickers Hardness		0.2% Offset Yield Strength		Percentage Elongation	
Au-Pd-Ag (Neydium)	199 (C)	218 (P)	420 MPa (C)	490 MPa (F)	6% (C)	8% (F)
Au-Pd (Olympia)	213 (C)	225 (P)	500 MPa (C)	540 MPa (F)	13% (C)	20% (F)

Table 2. Mechanical properties for two noble metal alloy types used with dental porcelain, comparing the as-cast condition (C) and simulated porcelain firing heat treatment (F) [13].

Peaks in Vickers hardness for heat treatments at temperatures that span the porcelain-firing temperature range indicate that influential precipitation processes can occur in some noble alloys for fixed prosthodontics [13,16]. For the gold-palladium-silver alloy in Table 1, heating an as-cast specimen to 980°C caused a pronounced decrease in Vickers hardness, and subsequent heat treatments at temperatures from 200° to 980°C revealed a pronounced peak in Vickers hardness at approximately 760°C. The absence of substantial changes in Vickers hardness for similar heat treatments of the gold-palladium alloy in

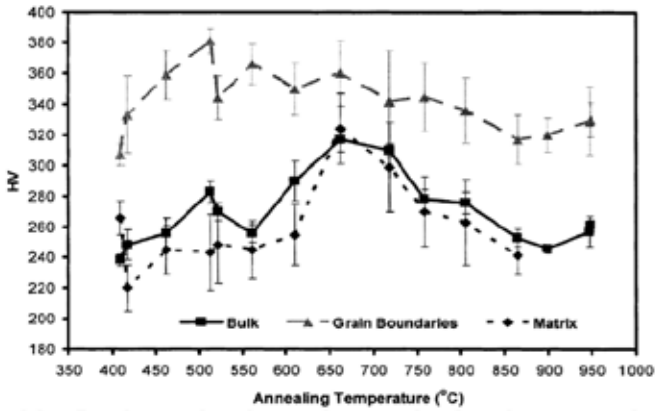

Figure 2. Annealing behavior of a palladium-silver alloy for fixed prosthodontics, showing changes in Vickers hardness for a heat treatment temperature range that spans the porcelain firing cycles. Reproduced from [16] with permission.

Table 2 arises from differences in the precipitates that form in the two complex alloy compositions. Figure 2 presents the age hardening behavior of a palladium-silver alloy, where specimens were subjected to isothermal annealing for 30 minute time periods at temperatures from 400°C to 900°C that span the range for the porcelain firing cycles [16]. Bulk values of Vickers hardness were obtained with 1 kg loads, and 25 g loads were used to obtain hardness values for specific microstructural regions. In contrast, research suggests that microstructures of popular nickel-chromium base metal alloys used with dental porcelain are not changed substantially during dental laboratory processing [17].

2.4. Alloys for removable prosthodontics

Base metal casting alloys (nickel-chromium, cobalt-chromium and cobalt-chromium-nickel) are popular for fabricating the metallic frameworks for removable partial dentures because of their lower cost [1,2]. Once an active area of dental metallurgy research, studies have found that these alloys have dendritic microstructures in the as-cast condition, because of the absence of suitable grain-refining elements, and that heat treatment is ineffective for producing improved mechanical properties [18]. A more recent publication shows the dendritic microstructures of some current alloys and their mechanical properties [19].

Removable partial denture frameworks have clasps that engage the teeth. These clasps can be cast as part of the entire framework, or alternatively wire clasps can be joined to the cast framework in the dental laboratory [1,2]. Both noble metal and base metal wires for clasps are available [20]. Because of their superior strength compared to the cast base metal alloys, wire clasps with smaller cross-section dimensions can be used with the frameworks, but caution is required during joining in the dental laboratory to avoid overheating that will cause loss of the wrought microstructure. Wire clasps are used in the as-received condition; heat treatment is not recommended before joining to the framework.

2.5. Dental implant alloys

Dental implants in current widespread clinical use are manufactured from CP (commercially pure) titanium or Ti-6Al-4V, and some implants have a thin bioceramic surface coating (typically hydroxyapatite, the principal inorganic constituent of bone and tooth structure). Proprietary heat treatments [21] are performed on Ti-6Al-4V by manufacturers to obtain optimum microstructures for the implants; minimal information is currently available about these microstructures in the dental scientific literature.

Recently, there has been considerable research interest in the development of new titanium implant alloys for orthopedic applications that have improved biocompatibility compared to the Ti-6Al-4V alloy in widespread current use. There is particular interest in the beta-titanium alloys which have lower elastic modulus than Ti-6Al-4V to minimize stress shielding and subsequent loss of the surrounding bone which has a much lower elastic modulus. Stress shielding does not seem to be of concern for dental implants, presumably because of the threaded designs. Biocompatible titanium-niobium-zirconium beta alloys have been investigated, and oxide nanotubes can be grown on the alloy surface by an anodization technique, and subsequent heat treatment can be employed to modify the structure of the nanotubes [22]. In another exciting research area, titanium oxide nanowires have been recently grown on both CP titanium and Ti-6Al-4V using special elevated-temperature oxidation heat treatments in an argon atmosphere with low oxygen concentrations [23]. Both of these special types of surface oxide layers may prove to be useful for dental and orthopedic implants, but future testing in animals will be needed to examine their efficacy.

3. Orthodontics

3.1. Background

Orthodontic wires engaged in brackets that are bonded to teeth, after being deformed elastically during initial placement, provide the biomechanical force for tooth movement during unloading. There are four wire types in current clinical practice: stainless steel, cobalt-chromium, beta-titanium and nickel-titanium [24]. The clinically important mechanical properties are (a) elastic modulus, which is proportional to the biomechanical force when wires of similar dimensions are compared; (b) springback, which is generally expressed as the quotient of yield strength and elastic modulus (YS/E), and represents the approximate strain at the end of the clinically important elastic range; and (c) modulus of resilience, expressed as YS2/2E and representing the spring energy available for tooth movement. (The permanent deformation portion of orthodontic wire activation is ineffective for tooth movement.) Round orthodontic wires are manufactured by a proprietary drawing sequence that involves several stages with intermediate annealing heat treatments. Rectangular orthodontic wires are manufactured by a rolling process utilizing a Turk's head apparatus. The wire drawing process with the heat treatments greatly affects mechanical properties.

3.2. Stainless steel orthodontic wires

A recent study that investigated stainless steel wires used in orthodontic practice found that most products were AISI Type 304 and that AISI Type 316L (low carbon) and nickelfree ASTM Type F2229 were also available [25]. While standard physical metallurgy textbooks consider the elastic modulus to be a structure-insensitive property, research has shown that the permanent deformation and heat treatments involved with the wire drawing process can substantially affect the elastic modulus of stainless steel orthodontic wires [26,27]. X-ray diffraction has revealed that conventional orthodontic wires manufactured from AISI Types 302 and 304, while predominantly austenitic structure, can contain the α□ martensitic phase, depending upon the carbon content and temperatures involved with the processing [28]. The presence of this martensitic phase accounts for the reduction in elastic modulus for some conventional stainless steel orthodontic wires. In addition, when fabricating complex stainless steel appliances, it is recommended that orthodontists perform a stress-relief heat treatment to prevent fracture during manipulation; a heating time up to 15 minutes and a temperature range of 300° to 500°C appears to be acceptable [29-31]. Heating austenitic stainless steel to temperatures between 400° and 900°C can result in chromium carbide precipitation at grain boundaries and cause the alloy to become susceptible to intergranular corrosion, and heating of austenitic stainless steel wires above 650°C should not be done because loss of the wrought microstructure causes degradation of mechanical properties.

3.3. Cobalt-chromium orthodontic wires

The cobalt-chromium orthodontic wire (Elgiloy) marketed by Rocky Mountain Orthodontics (Denver, CO, USA) contains 40% Co, 20% Cr, 15.81% Fe, 15% Ni, 7% Mo, 2% Mn, 0.15% C carbon and 0.04% Be beryllium (https://www.rmortho.com/, accessed August 15, 2012). Four different tempers (spring quality) are available, and the soft Blue temper is favored by many orthodontists because the wire is easily manipulated in the as-received condition, and then heat treated to increase the yield strength and modulus of resilience. Heat treatment (not recommended for the most resilient temper) is conveniently performed with the electrical resistance welding apparatus commonly used in orthodontic practice, and the manufacturer provides a special paste that indicates when the heat treatment is complete. Alternatively, furnace heat treatment performed at 480°C for 5 minutes has been found to give satisfactory results [32]. An extensive study employing furnace heat treatment (480°C for 10 minutes) for three tempers and numerous sizes of the Elgiloy wires observed increases of 10% – 20% in elastic modulus and 10% – 20% in 0.1% offset yield strength, which resulted in substantial improvement of the modulus of resilience [27]. These changes in mechanical properties arise from complex precipitation processes during heat treatment that are not understood. Many other companies now market cobaltchromium orthodontic wires, but studies of their mechanical properties and the results of heat treatment have not been reported.

3.4. Beta-titanium and other titanium-based orthodontic wires

Beta-titanium orthodontic wires have the advantages of: (a) known biocompatibility from the absence of nickel in the alloy composition; (b) lower elastic modulus than stainless steel and cobalt-chromium wires, which provides more desirable lower orthodontic force for tooth movement; (c) higher springback than stainless steel and cobalt-chromium wires, which is desirable for the archwire to have greater elastic range; and (d) high formability and weldability, which are needed for fabrication of certain appliances [24]. A recent study [25] of commercially available titanium-based orthodontic wires revealed that most products are Beta III alloys [21] containing approximately 11.5 Mo, 6 Zr, and 4.5 Sn, similar to the original beta-titanium wire introduced to orthodontics [33,34]. Beta C [21] and Ti- 45Nb beta-titanium and Ti-6Al-4V (alpha-beta) wire products are also available [25]. Heat treatment is not performed by the orthodontist on these wires, but care with the wire drawing and intermediate heat treatments by the manufacturer are essential for obtaining the desired mechanical properties. These processes must be conducted under wellcontrolled conditions because of the highly reactive nature of titanium.

3.5. Nickel-titanium orthodontic wires

Following the pioneering work of Andreasen and his colleagues [35,36], near-equiatomic nickel-titanium (NiTi) wire was introduced to orthodontics by the Unitek Corporation (now 3M Unitek) [37]. This wire had the advantages of a much lower elastic modulus than the stainless steel and cobalt-chromium wires available at the time and a very large elastic range. The clinical disadvantage is that substantial permanent deformation of this wire is not possible to obtain certain orthodontic appliances that can be fabricated with the three preceding, highly formable, alloys. The original nickel-titanium wire had a work-hardened martensitic structure and did not exhibit the superelastic behavior (termed pseudoelasticity in engineering materials science) or the true shape memory characteristics displayed by subsequently introduced NiTi wires [1,38-41]. These nickel-titanium wires have been a very active area of research.

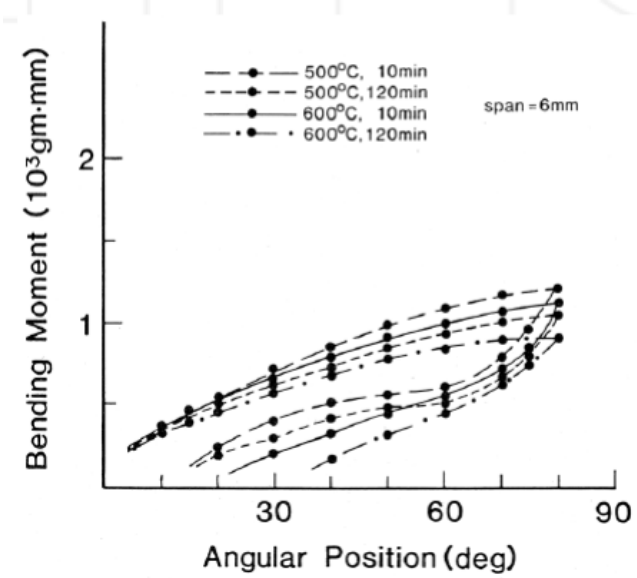

Figure 3. Effects of heat treatments on cantilever bending plots for 6 mm test spans of a superelastic nickel-titanium orthodontic wire. Reproduced from [40] with permission.

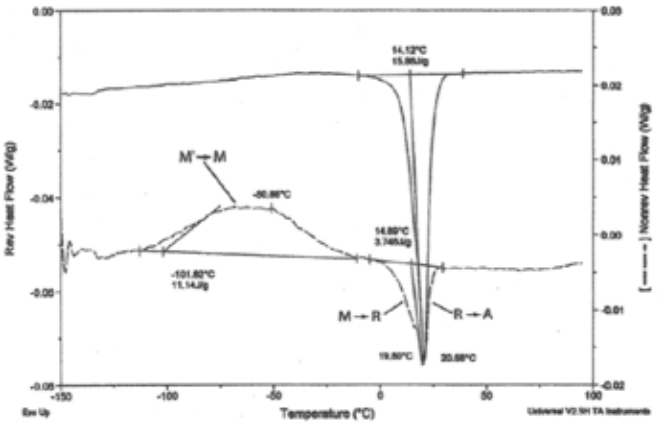

Figure 4. Heating temperature-modulated DSC plot for a shape memory nickel-titanium orthodontic wire. Reproduced from [46] with permission.

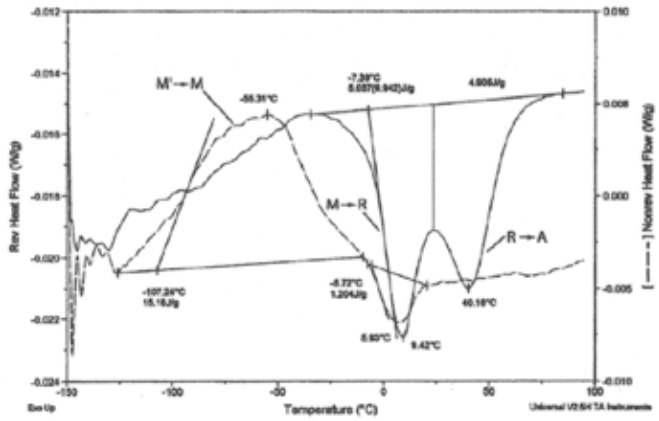

Figure 5. Heating temperature-modulated DSC plot for a superelastic nickel-titanium orthodontic wire. Reproduced from [46] with permission.

The mechanical properties of the nickel-titanium orthodontic wires are determined by the proportions and character of three microstructural phases: (a) austenite, which occurs under conditions of high temperature and low stress; (b) martensite, which occurs under conditions of low temperature and high stress; and (c) R-phase, which forms as an intermediate phase during the transformation between martensite and austenite. Very careful control of the wire processing and associated heat treatments, along with precise compositional control, by the manufacturer are needed to produce nickel-titanium wires with the desired superelastic, nonsuperelastic, or shape memory character [42,43].

Heat treatments have been exploited by manufacturers to control the orthodontic force ranges produced by nickel-titanium archwires [39]. Heat treatment temperatures have ranged from 400° to 600°C with times from 5 minutes to 2 hours [39,40]. Effects of heat treatment on cantilever bending plots for two sizes of a round superelastic nickel-titanium wire are presented in Figure 3 [40].

Loss of superelastic behavior occurs for the 2 hour heat treatment at 600°C, evidenced by the large decrease in springback (difference between the original deflection of 80 degrees and the final angular position on unloading). Heat treatment at 500°C for 10 minutes had minimal effect, while heat treatment for 2 hours caused a decrease in the average superelastic bending moment during the unloading region of clinical importance. Bending properties for nonsuperelastic wires were only slightly affected by these heat treatments. In addition to the use of furnace heat treatment, electrical resistance heat treatment [44] has also been exploited by one manufacturer to produce archwires where the level of biomechanical force varies with position along the wire [24].

Microstructural phases at varying temperatures in nickel-titanium orthodontic wires and their transformations are conveniently studied by differential scanning calorimetry (DSC) [45]. Temperature-modulated DSC provides greater insight into the transformations than conventional DSC [46]. Figures 4 and 5 present temperature-modulated DSC heating curves for shape memory and superelastic nickel-titanium orthodontic wires, respectively. The transformations involving austenite (A), martensite (M) and R-phase (R) are labeled. The austenite-finish (Af) temperature for completion of the transformation from martensite to austenite on heating is determined by the intersection with the adjacent baseline of a tangent line to the peak for the final transformation to austenite [47].

The Af temperature is below body temperature (37°C) for nickel-titanium wires that exhibit shape memory in the oral environment. The superelastic nickel-titanium wires have Af temperatures that are greater than mouth temperature and have more widely separated peaks for the successive transformations from M □R and R □ A. The nonsuperelastic wires have much weaker transformations (lower values of enthalpy [ΔH]) and Af temperatures that are also greater than mouth temperature [45]. Examination of x-ray diffraction patterns for nickel-titanium orthodontic wires revealed the effects of heat treatment on the Ms temperature for the start of the cooling transformation to martensite as well as the occurrence of stress relief and perhaps some recrystallization [24,48].

Transformation of a low temperature martensite phase (M□) to the higher temperature form of martensite (M), shown in Figures 5 and 6, is readily detected as a large exothermic peak on the nonreversing heat flow curves from temperature-modulated DSC. Transmission electron microscopy has revealed that this transformation arise from low-temperature twinning within the martensite structure [49].

4. Endodontics

4.1. Stainless steel instruments

Traditionally, endodontic treatment was performed with stainless steel hand files and reamers to remove the injured or diseased dental pulp from the root canals of teeth. While conventional elevated-temperature heat treatment is not recommended for these instruments, they are subjected to sterilization procedures before being using again with a different patient. One study found that dry heat sterilization (180°C for 2 hours) and autoclave sterilization (220 kPa pressure and 136°C for 10 minutes) slightly decreased the flexibility and resistance to torsional fracture of the instruments but they still satisfied the

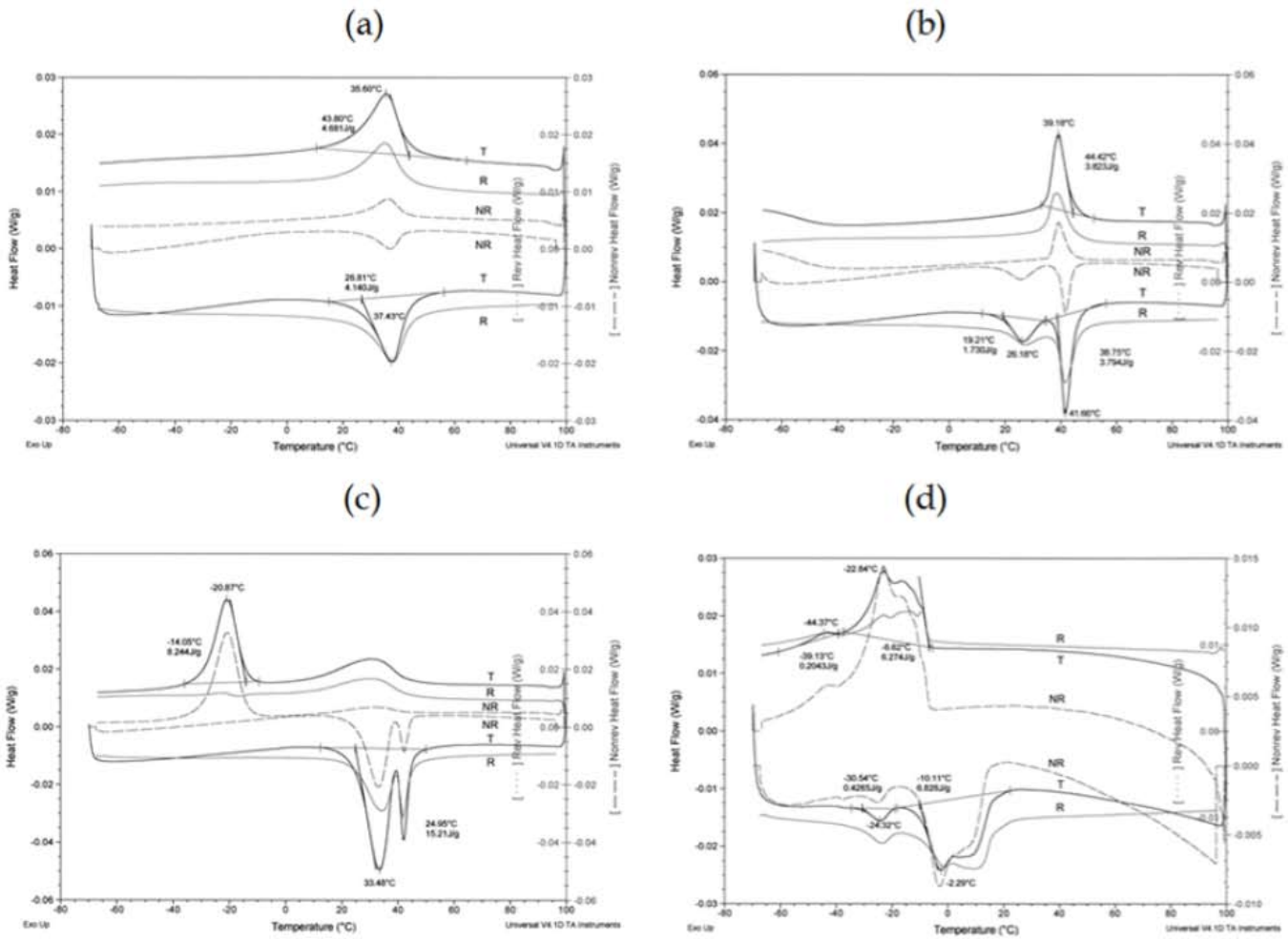

Figure 6. Temperature-modulated DSC reversing (R), nonreversing (NR) and total (T) heat flow curves for specimens from conventional rotary endodontic instruments after heat treatment in flowing nitrogen for 15 minutes at (a) 400°, (b) 500°, (c) 600° and (d) 850°C. From [55] and reproduced with permission.

requirements for minimum angular deflection in the ISO standard [50]. Further research is needed to gain insight into the metallurgical origins of the property changes.

4.2. Nickel-titanium instruments

Following the pioneering work of Walia et al that introduced the nickel-titanium hand file to the endodontics profession [51], engine-driven rotary instruments were introduced that enable rapid instrumentation of root canals. These instruments are in widespread clinical use, and research on the nickel-titanium files has been a highly intensive area of research.

The major mechanical property of the equiatomic nickel-titanium alloy that led to replacement of the traditional austenitic stainless steel files was the much lower elastic modulus of NiTi, which enabled curved root canals to be negotiated with facility. An excellent review article [52] describes the manufacturing process for the nickel-titanium files, which are generally machined from starting wire blanks. The conventional nickeltitanium rotary instruments have been fabricated from superelastic nickel-titanium blanks.

Defects caused by the machining process and metallurgical flaws in the starting blanks, along with inadvertent overloading by the clinician, can result in fracture of the file within
the root canal, which causes considerable patient anguish since the broken fragments often cannot be easily retrieved [53,54].

A recent study investigated the effect of heat treatment on conventional nickel-titanium rotary instruments, using temperature-modulated DSC and Micro-X-ray diffraction [55]. Results are shown in

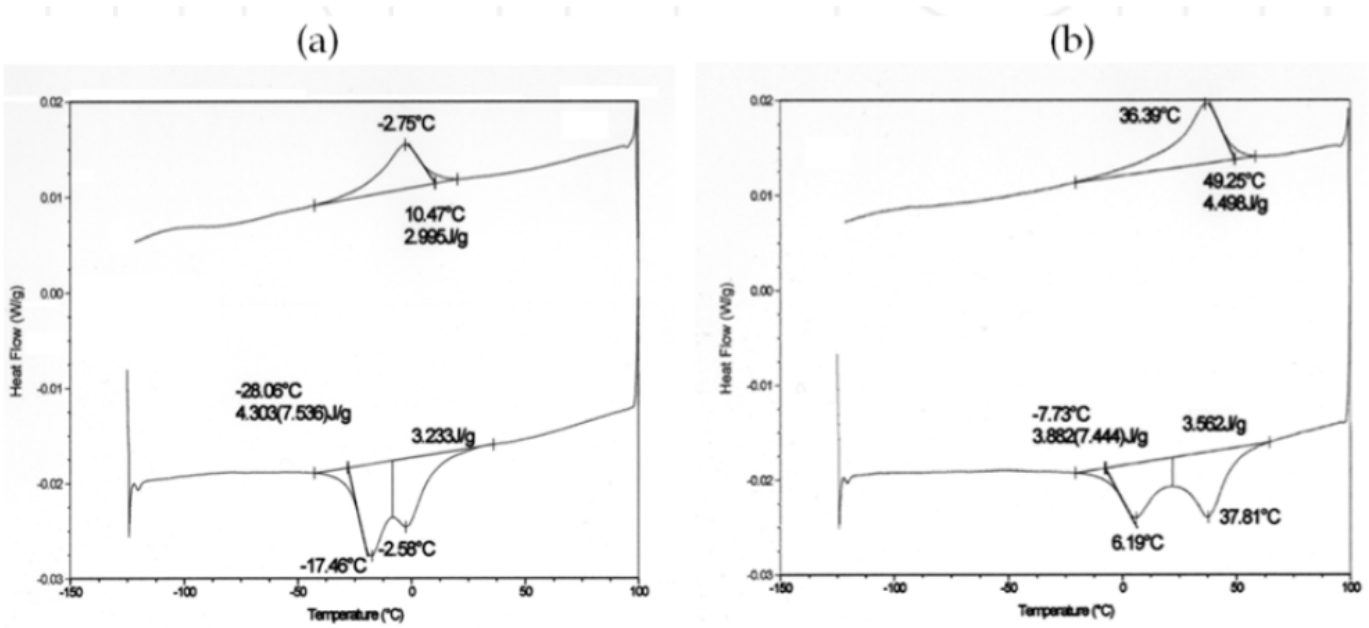

Figure 7. Comparison of temperature-modulated DSC total heat flow for (a) conventional superelastic wire and (b) Type 1 M-Wire. Lower curves are the plots for the heating cycles. Reproduced from [58] with permission.

Figure 6 (a) – (d) for heat treatment at temperatures from 400° to 800°C in a flowing nitrogen atmosphere.

Heat treatment between 400° and 600°C increased the Af temperature for as-received conventional NiTi rotary instruments to approximately 45° – 50°C, and the transformations between martensite and austenite were changed to a more reversing character than nonreversing character [55]. Heat treatment in a nitrogen atmosphere might lead to a harder surface from the formation of nitrides [56], which is beneficial for cutting efficiency of the rotary instrument. This research suggested that heat treatment at temperatures near 500°C in a nitrogen atmosphere might yield the optimum microstructure and mechanical properties, with improved resistance to deformation and fracture for conventional NiTi rotary instruments. Heat treatment at temperatures exceeding 600°C should not be performed, since the superelastic behavior is lost along with potential degradation of the wrought microstructure [24]. Another study has reported that heat treatment at 430° and 440°C greatly improved the fatigue resistance of one conventional rotary instrument product [57].

New nickel-titanium rotary instruments have been marketed, for which the wire blanks were improved by special proprietary processing techniques, including heat treatment. The first notable example was M-Wire, named for its stable martensitic structure [58]. Previous conventional rotary instruments were fabricated from superelastic wire blanks with evident transformable austenite detected by conventional DSC [59]. However, when the conventional instruments were cooled far below room temperature to attain the fully martensite condition, the enthalpy changes for transformations from martensite to austenite were far below those for superelastic orthodontic wires [44,45], indicating that these instruments contain a substantial proportion of stable martensite in their microstructures.

Two different batches of M-Wire (termed Type 1 and Type 2), with unknown differences in proprietary processing, were obtained for characterization by temperature-modulated DSC and Micro-X-ray diffraction [58]. Figure 7 shows the differences in the temperaturemodulated DSC plots for (a) conventional superelastic wire and (b) Type 1 M-Wire.

The general appearances of the temperature-modulated DSC plots in Figure 7 (a) and (b) are similar. However, the approximate Af temperatures for the conventional superelastic wire and Type 1 M-Wire were approximately 15°C and 50°C, respectively. The approximate Af temperature for the Type 2 M-Wire was 45°C. The proportions of the different NiTi phases were quite different for Type 1 and Type 2 M-Wire, as shown in Figure 8.

The Micro-X-ray diffraction pattern indicated that

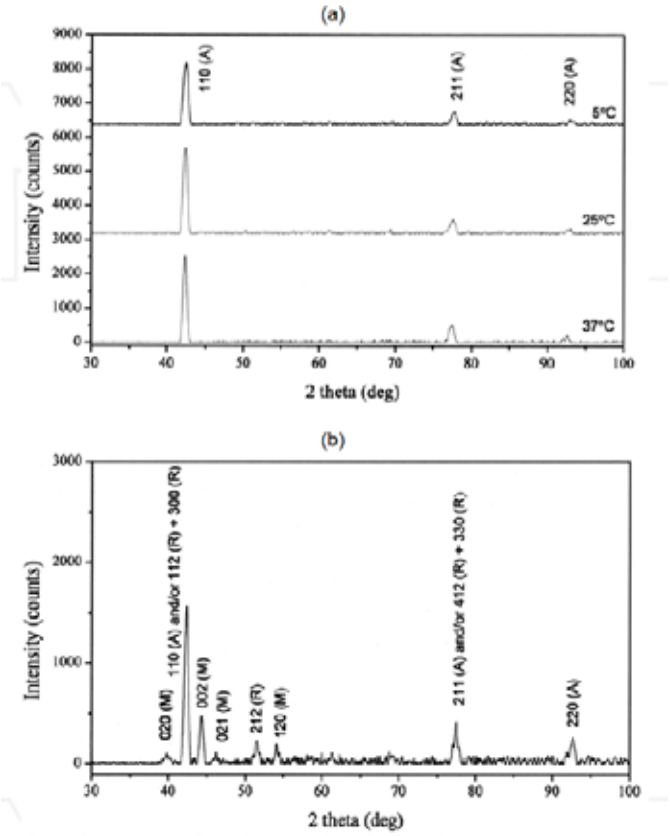

Figure 8. Micro-X-ray diffraction patterns for (a) Type 1 M-Wire and (b) Type 2 M-Wire. Peaks for austenite (A), martensite (M) and R-phase (R) are labeled. Reproduced from [58] with permission.

Type 1 M-Wire had an austenitic structure, and the Micro-X-ray diffraction pattern from the conventional superelastic wire was similar. In contrast, the Micro-X-ray diffraction pattern from Type 2 M-Wire contained additional peaks for martensite and R-phase, along with peaks for austenite. However, when M-Wire was examined by transmission electron microscopy, a heavily deformed martensitic structure was found [58]. The explanation is that the DSC peaks only reveal NiTi phases that are capable of undergoing transformation and that (stable) heavily deformed martensitic NiTi only produces weak x-ray diffraction peaks. Rotary instruments fabricated from M-Wire have been found to have similar Af values, microstructures and Vickers hardness, so the machining process and other proprietary fabrication steps do not appear to markedly alter the inherent structure and properties of the starting blanks [60].

Recently, new nickel-titanium rotary instruments have been introduced, in which the wire blank is heated to an appropriate temperature for transformation to the R-phase and twisted, along with repeated heat treatment and other subsequent thermal processing; instruments have been characterized by conventional DSC and cantilever bending tests [61]. Another recent study has characterized several new nickel-titanium rotary instruments by DSC and conventional x-ray diffraction, along with optical and scanning electron microscopic examination of their microstructures, including use of energy-dispersive x-ray spectroscopic analyses (SEM/EDS), to investigate the martensitic microstructures and composition of precipitates [62]. Because of the potentially great commercial importance, development of new rotary instruments with improved clinical performance is expected to remain an area of intensive research, along with study of the role of heat treatment [63].

It is essential to appreciate the complexity of the physical metallurgy of the nickel-titanium alloys and the effects of the severe thermomechanical processing of the starting wire blanks, along with heat treatments and machining of the wire blanks, on the metallurgical structure. Transmission electron microscopy and electron diffraction remain the best techniques to gain insight into the instrument microstructures and elucidate the relationships with mechanical properties and clinical performance.

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Heat treatment of dental alloys

True or false:

11. Heat treatment can be done by the manufacturer, dental laboratory or dentist?
    a) True
    b) False

12. The aim of heat treatment is to improve the mechanical properties of metal?
    a) True
    b) False

13. Propriatory heat treatment is performed on Ti-6Al-4V to obtain minimal microstructure.
    a) True
    b) False

14. The mechanical properties of orthodontic wire can be affected by the wire drawing process.
    a) True
    b) False

15. Stress shielding is necessary for implants?
    a) True
    b) False

INTERNET 101: ONLINE SHOPPING IN SOUTH AFRICA - THERE'S OPPORTUNITY OUT THERE

" This article first appeared in CA (SA) Dot News and is produced with the authority from Dot News and Du Toit Mook, Registered Accountants and Auditors ''

"There is a tide in the affairs of men. Which, taken at the flood, leads on to fortune. Omitted, all the voyage of their life is bound in shallows and in miseries. On such a full sea are we now afloat. And we must take the current when it serves, orlose our ventures."
(William Shakespeare, Julius Caesar)

For the past five years online shopping has grown at over 30% per annum and is the fastest growing segment in retail. Online shopping in South Africa accounts for less than 1% of total shopping (compare that with 10-12% in developed countries) but will continue to show high growth due to "the experience curve" - it takes up to five years for people who are Internet users to get comfortable with online shopping. Once they get comfortable they allocate more of their monthly spend to online shopping at the expense of traditional retail expenditure. In South Africa, there has been rapid growth in Internet users over the past several years, due primarily to the number of smart phones and tablets coming to the market.

This means that although overall retail spend is tailing off, online shopping will double in the next three years.

Other factors

Broadband is becoming more accessible driven by mobile networks. Social media is sending greater numbers of people to online retail outlets whilst the relentless growth of technology is making the Internet cheaper and easier to use. It may seem confusing to unravel what this ongoing change means for our business but many corporates, such as Woolworths and Mr Price, have successfully increased their business by online shopping. Naspers' Internet subsidiary in China (Tencent) has just purchased 15% of JD.com – an online shopping company - for R2.3 billion.

Take the opportunity

Now is the time for small and medium businesses (SMEs) to take advantage of this distribution channel which can increase both your business and your exposure. Think of a unique way to get to your clients on the Internet and you stand to successfully exploit the opportunities Internet shopping offers. The market is still relatively new and experts believe there is space for several new players to become dominant businesses in online shopping.

Once you are working in digital media, it is easy to build up a data base on your clientele such as their preferences, the promotions they favour etc. All this becomes valuable information in further growing your business.

Time and cost

As with any new investment, there will always be costs and the required focus of management time in planning and implementing a new strategy. Remember the traditional retail channels are growing very slowly and the Internet is growing very quickly.

Also remember, there is still space for businesses to get a commanding position on online shopping but this window of opportunity will not last.

Who Put the "d" in Pennyweight Anyway? A Brief History of Scientific Weights and Measures

by John Maguire, President, Maguire Refining, Inc.

History, language and scientific weights make strange bedfellows.

The unit of grain arrived from agrarian society and is still used in dentistry today.

A grain was a unit of mass based upon the weight of a single seed or grain from wheat or barley at the middle of the ear. These amber grains were the legal foundation of the traditional English weight system. 1 A troy ounce is 480 grains.

The troy weight likely takes it name from the French town of Troyes, France. English merchants traded in Troyes from at least as early as the 9th Century.2

The precious metal industry no longer works in troy pounds. However, there are 14.583 troy ounces to an avoirdupois pound.

The troy ounce is used to weight precious metals and gemstones. Everything else is weighed in the avoirdupois system or converted to metric systems.

The English troy ounce was officially adopted for in the Coinage Act of 1527 to weigh gold and silver. The English pennyweight was now the troy pennyweight. The British monetary penny was 1/20th of a troy ounce. Precious metal prices are listed in tory ounces.

The U.S. too followed suit in adopting the troy ounce as the official weight for coinage by Act of Congress in 1828.

An avoirdupois ounce is abbreviated avoir. or simply av. There are 16 av. ounces to a regular postal or av. pound.

Avoirdupois derives its name from the French avoir de pois, which translates as goods of weights or property.

Precious metals and gemstones are weighed in troy ounces. Everything else is weighed in the avoirdupois system or metric systems. So, who put the d in pennyweight anyway? How did dwt. become the abbreviation for pennyweight?

Early Roman currency included the gold aureus, the silver denarius and the brass sestertius. The gold aureus and silver denarius would circulate throughout the Roman Republic and Empire for 400 years. The denarius would become the latter day British penny.

The early common abbreviation for penny was d, from the Roman denarius. Thus the d became a measure of weight as d weight or abbreviated as dwt. There are 20 pennyweight or 20 dwt. to a troy ounce. Thus, the answer to the title question is that intertwined Roman and British history, language and traditions of weight nestled together to put the d in pennyweight (dwt.).

The pennyweight bears no relation to the weight of current penny coins.

The literal Latin translation for libra was scales or balances. The Roman word libra came to be known as the pound and would be shortened to simply lb. Libra also spawned the currency symbol £ for pound sterling in the United Kingdom.

The French proposed a revolutionary metric system during the French Revolution of the 1790's. The metric system sought to bring order to European weights and measurements.

The metric system, used for scientific purposes, is the universal measurement system for countries. Many countries have converted to the metric system, whereas the U. S. has not.

Which weighs more, an ounce of feathers or an ounce of gold?
To answer, one needs to compare in the metric system. Only precious metals and gemstones are weighed in troy oz.
1 oz. feathers = 28.35 grams = 1 avoir. oz.
1 oz. gold = 31.1 grams = 1 troy oz.
Thus, a troy ounce of gold is almost 10% heavier than an avoirdupois ounce of feathers.

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2. Oxford English Dictionary. Oxford, England: Oxford University Press. June 2012. The received opinion is that it took its name from a weight as the fair of Troyes in France.

The DENTASA executive has, after many requests from its members, decided that as from 2012 the questionnaires in the SADTJ, regarding the CEU'S will be available for DENTASA members only.

PLEASE NOTE:
All questionnaires MUST be completed and submitted online from the DENTASA Website: www.dentasa.org.za > Members Only > SADTJ VOL5 Q1 (eg.)

Participation in CEU activities on our web site is completely free and can be used by students and practitioners to update and improve their professional knowledge and skills without acquiring credits. A very reasonable fee is, however, charged for the issuing and processing of CEU credits.
Please note an 70% pass rate is required.

You will receive your marks once proof of payment has been received and your questionnaire marked. Please use this code to identify the questionnaire: Vol 5 Q1
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