

Review Article

Influence of chronic congenital systemic disorder effects in orthodontic treatment

ABSTRACT

The orthodontic treatment of patients with medical disorders is becoming an increasing aspect of modern-day practice. Orthodontic treatment is no longer reserved for only healthy patients. With better management of serious medical problems, increased quality of life expectations, and greater ambulation, medically compromised individuals are now regular visitors to orthodontic practices. While orthodontic treatment has been historically considered to be completely noninvasive, specific orthodontic procedures may place some patients at risk for serious sequelae. Among the most common of these conditions are those associated with cardiovascular disease, bleeding disorder, respiratory disorder, neurological disorder, renal disease, musculoskeletal system, endocrine disorder, liver disease, allergies, and drug side effects. Aggressive risk assessment is the key factor in the identification and prevention of medically associated problems. Assessment and management of patients at risk for endocarditis, bleeding, and asthmatic attacks are discussed. The orthodontic treatment of patients with medical disorders is becoming an increasing aspect of modern-day practice. The influences of various systemic diseases on orthodontic treatment have been discussed and various recommendations to overcome the potential problems have been highlighted in this article.

Keywords: Bleeding disorder, cardiovascular disease, endocrine disorder, orthodontic treatment

INTRODUCTION

General systemic disturbances may seem but remotely related to the everyday problems of the clinician of orthodontia.^[1] This phenomenon is a consequence of several factors including earlier diagnosis and better medical management of serious diseases, increased expectations for quality of life and life expectancy, greater ambulation of chronically ill patients, and increased demand for all types of dental care, regardless of underlying medical conditions. Orthodontists need to be aware of the possible clinical implications of many of these diseases. In addition, orthodontists see their patients every 6–8 weeks and rapidly developing medical problems can manifest themselves at any age. This article examines the aspects of some of the systemic conditions that are of relevance to orthodontic practice. A comprehensive medical history should be taken

and regularly updated. Medical case reports should alert the clinician to the patient's medical status. All medical conditions should be accurately understood before any treatment is planned and this may involve seeking guidance from the patient's physician. Patients should be well informed of all the options and made aware that any orthodontic treatment has been planned with their best interests. It should be highlighted they are not being penalized for their

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medical condition.^[2] The importance of excellent oral hygiene should be emphasized to all patients considering a course of orthodontics. Identification of patients at risk before the initiation of treatment remains the best way to effectively manage medically compromised patients and prevent or minimize the risk of adverse outcomes. Although seemingly mundane, a thorough written medical history and verbal review is the cornerstone of risk assessment. It is the doctor's responsibility to review the medical history.

MATERIALS AND METHODS

The electronic databases PubMed, Google Scholar, Science Direct, and Cochrane Library were searched and verified all the journals till 2019. No limits and language restriction were applied during the electronic search in order to include all the relevant articles pertaining to the topic of interest. The search in PubMed yielded 256 articles, which were screened based on the relevance of the title and abstract to the topic of interest. 128 articles were excluded based on this criterion. The full texts of the 64 articles were analyzed, of which 32 were excluded based on the exclusion criteria of this systematic review. Only one relevant article could be extracted through hand search and no articles were retrieved from other databases. The inclusion criteria include *in vitro* and *vivo* studies.

Different types of systemic disorders encountered in routine orthodontic practice are as follows:

- Cardiovascular disease
- Bleeding disorder
- Respiratory disorder
- Endocrine disorder
- Neurological disorder
- Renal disease
- Musculoskeletal system
- Allergies
- Drug related side effects.

CARDIOVASCULAR DISEASE

Infective endocarditis

Infective endocarditis (IE) is a rare condition with a high mortality and morbidity.^[3] The primary prevention of IE is very important. Antibiotic prophylaxis for such patients prior to an invasive procedure that could generate a bacteremia has been a founding principle of dental practice for half a century, although the evidence of benefit is limited. Despite aggressive antibiotic intervention, endocarditis can be a life-threatening condition. In fact, the condition results in death in 3% of patients who develop it. Although most orthodontic treatment is minimally invasive, the placement and removal of orthodontic bands

has been suggested to produce bacteremias. McLaughlin *et al.*^[4] studied the incidence of bacteremias after orthodontic banding in 30 healthy adults. Elastomeric separators were placed 1 week before the placement of a single band on a permanent first molar. A Study was conducted on the impact of gingival health on bacteremias associated with band placement between individuals without gingival inflammation (0%) and those who had gingivitis associated with bleeding (32%).^[5] Based on guidelines established by the American Heart Association,^[6] patients can be placed into one of three risk categories [Table 1]. Patients at high risk are those with a prior history of endocarditis, those who have prosthetic valves or surgically corrected systemic pulmonary shunts or conduits, or those with complex cyanotic congenital heart disease (tetralogy of Fallot). The prevalence of endocarditis in the high-risk population is 300–700 cases of bacterial endocarditis per 100,000 patient-years compared with 2–5 cases per 100,000 patient-years in the general population. Patients at moderate risk are those with congenital cardiac malformations, acquired valvular dysfunction (such as that caused by rheumatic fever), hypertrophic cardiomyopathy, and mitral valve prolapse with regurgitation. Patients at negligible risk for endocarditis, defined as being no more likely to develop BE than the general population, are those with secundum atrial septal defects, surgical repair of atrial or ventricular septal defects or patent ductus arteriosus, previous coronary artery bypass grafts, mitral valve prolapse without valvular regurgitation, innocent heart murmurs, rheumatic fever without valvular dysfunction, cardiac pacemakers, and implanted defibrillators.

Orthodontic considerations in patients with cardiovascular disorders are as follows:

- The orthodontist should communicate with the patient's physician to confirm the risk of IE
- The orthodontist should offer people at risk of IE clear and consistent information about prevention
- The risks and benefits of antibiotic prophylaxis
- Aggressive pretreatment and intratreatment oral hygiene to minimize the presence of gingival inflammation
- Regular supportive therapy from a hygienist is also advisable
- The use of orthodontic bands and fixed acrylic appliances should be avoided whenever possible in high-risk patients with poor oral hygiene
- A risk of bacteremia induced by traction of unerupted exposed and bonded teeth has been suggested
- Any episode of infection in people at risk of IE should be investigated and treated promptly.

HYPERTENSION

JOINT NATIONAL COMMITTEE 7 introduced, in 2003,

the category of prehypertension, which is defined as systolic blood pressure of 120–139 mm Hg and diastolic blood pressure of 80–89 mm Hg [Table 2]^[7] Patients with prehypertension are at increased risk of developing hypertension, those with blood pressure (BP) values 130–139/80–89 mm Hg have at times greater risk of developing hypertension than those with lower values. Hypertension is a highly prevalent cardiovascular disease, which affects over 1 billion people worldwide. Although >70% of hypertensive patients are aware of the disease, only 23%–49% are treated and fewer (20%) achieving control. Hypertension prevalence varies by age, race, education, and so forth. According to the ESC-ESH guidelines in 2013, there are limited comparable data available on the prevalence of hypertension and the temporal trends of BP values in different European countries.^[8] Overall, the prevalence of hypertension appears to be around 30%–45% of the general population, with a steep increase with aging. There also appear to be noticeable differences in the average BP levels across countries, with no systematic trends toward BP changes in the past decade.^[9] A permanent high BP affects blood vessels in the kidneys, heart, and brain, increasing the incidence of renal and cardiac coronary heart disease and stroke. Hypertension is called the “silent killer” because it often affects target organs (kidney, heart, brain, and eyes) before the appearance of clinical symptoms.^[10]

Table 1: Guidelines established by the American Heart Association

High risk patients:	
• Previous endocarditis	
• Prosthetic heart valves	
• Complex cyanotic congenital heart disease (CHD)	
• Unrepaired cyanotic CHD, including	
Medium risk patients:	
• Congenital heart defects eg VSD	
• Acquired valvular disease (e.g. from rheumatic fever)	
• Hypertrophic cardiomyopathy	
Low risk patients:	
• General population	
• Repaired VSD's Isolated secundum atrial defects	
• Note that coronary artery bypass grafts are not at risk	
• Mitral prolapse with regurgitation	
• Palliative shunts and conduits	

Table 2: JNC7 classification of hypertension

Classification	SBP (mmHg)	DBP (mmHg)
Normal	<120	and <80
Prehypertension	120–139	Or 80–89
Stage I hypertension	140–159	Or 90–99
Stage II hypertension	≥160	≥100

Orthodontic considerations in patients with hypertension are as follows:

- Minimizing stress is important
- Appointments should be <1 h to minimize stress
- Maintaining periodontal health and good oral hygiene, educating the patient, and recommending specific oral hygiene aids and devices
- Calcium channel blockers can cause gingival hyperplasia in addition to the irritation caused by the fixed appliance. Depending on the condition, the patient should be referred back to his physician or cardiologist, to prescribe an alternative therapy.

BLEEDING DISORDER

Hematology and patients with bleeding problems

Effective hemostasis is the consequence of a sequence of events in which platelets and plasma proteins produce clotting. Defects in either may result in a clinically relevant coagulopathy with consequent bleeding. Bleeding disorders therefore result from qualitative or quantitative platelet deficiencies or inadequate or insufficient levels of plasma-clotting factors. Hemophilia is a common example of a clotting factor deficiency. Hemophilia A is a sex-linked disorder due to a deficiency of Factor VIII. When the Factor VIII level is <1% of normal, the condition is classified as severe.^[11] Other bleeding disorders include Hemophilia B or Christmas disease (factor IX deficiency) and von Willebrand disease (defects of von Willebrand factor), which is necessary for effective platelet aggregation. The hemophilia population was an early victim of HIV transmitted by infected blood products. For patients with a congenital bleeding disorder, probably the biggest orthodontic-associated risk is associated with extractions associated with treatment. In these cases, the administration of factor replacement along with Amicar or tranexamic acid is prudent. Amicar (aminocaproic acid) and tranexamic acid are antifibrinolytic agents that prevent the breakdown of the clot in the extraction site, allowing for better organization, and thereby decreasing the likelihood of postoperative bleeding. To minimize risk and cost to the patient, it seems most reasonable to perform all planned extractions at a single visit. Care should be used in the placement and removal of orthodontic hardware to minimize the risk of mucosal injury.

Orthodontic considerations in patients with bleeding disorders are as follows:

- Orthodontic treatment is not contraindicated in patients with bleeding disorders.^[12] A thorough history and close liaison with the patient’s hematologist, oncologist, or physician will help reduce the risk of problems occurring

- b. Patients should be encouraged to maintain excellent, atraumatic oral hygiene
- c. If extractions or surgery cannot be avoided, the management of patients with hemophilia relies on careful surgical technique, including an attempt at primary wound closure and the following regimen to:
 - Increase Factor VIII production with 1-desamino-8-D-arginine vasopressin
 - Replace missing Factor VIII with cryoprecipitate, Factor VIII, fresh frozen plasma, or purified forms of Factor VIII
 - Antifibrinolytic therapy with tranexamic acid or epsilon amino caproic acid^[13]
- d. Chronic irritation from orthodontic appliances should be avoided. Fixed appliances are preferable to removable appliances as the latter can cause gingival irritation
- e. Self-ligating brackets are preferable to conventional brackets. If conventional brackets are used, archwires should be secured with elastomeric modules instead of wire ligatures
- f. Care is required when placing and removing archwires
- g. The duration of orthodontic treatment should be kept to a minimum to reduce the potential for complications.

RESPIRATORY SYSTEM DISORDER

Respiratory disorders are common and the use of intravenous (IV) sedation and general anesthesia (GA) for elective procedures may be contraindicated. The unwanted effects of prescribed drugs can also influence the orthodontic treatment of these patients.

Asthma

Approximately 300 million people around the world have asthma, and it has become more common in both children and adults globally in recent years. The severity varies from mild to severe. In moderate cases, episodes are severe, but the patients are symptom free between attacks. In severe asthma, the attacks are severe and the child is never asymptomatic and growth and lung function can be affected. There has been a tentative link between orthodontic-induced external root resorption and patients with asthma.^[14] Asthma is most often the result of an inherited immunologic hypersensitivity (allergic) disorder. McNab *et al.* compared the incidence and severity of external root resorption following fixed orthodontic therapy between patients with asthma and a healthy population. They found that while the incidence of external apical root resorption was elevated in the asthmatic population, the severity of resorption was the same between groups.

Cystic fibrosis

Cystic fibrosis (CF) is the most common life-limiting,

childhood-onset, autosomal recessive disorder among people of European heritage. It affects the exocrine glands of the lungs, liver, pancreas, and intestines, causing progressive disability due to multisystem failure. The cells are relatively impermeable to chloride ions and thus salt-rich secretions are produced. The mucous is viscid and blocks glands of the respiratory and digestive systems. There is a nonproductive cough that leads to acute respiratory infection, bronchopneumonia, bronchiectasis, and pancreatic insufficiency. Diabetes mellitus (DM) may be a complication and patients may have cirrhosis of the liver. Most individuals with CF die young many in their 20s and 30s from lung failure; however, with advances in medical treatments, the life expectancy of a person with CF is increasing to ages as high as 40 or 50. Heart and lung transplantation are often necessary as CF worsens. Oral effects include hypoplastic enamel and delayed eruption. In the 1970s, there were several reports of tetracycline staining of teeth, but alternative medications are now used. A side effect of antibiotic treatment is the lower prevalence of dental disease.^[15]

Relevance of drugs in respiratory disorders

The chronic use of corticosteroid inhalers can lead to localized lowered resistance to opportunistic infections. As a result of this, oropharyngeal candida infection may occur. To avoid this complication, patients should be advised to rinse and gargle with water after the use of their inhaler, especially if wearing removable acrylic appliances. Candidiasis can be treated with topical antifungal agents such as nystatin. The need for steroid cover is discussed in the general section on drugs and orthodontic treatment. Beta-adrenergic agonist bronchodilators such as salbutamol, antimuscarinic bronchodilators, cromoglycates, and antihistamines can all produce dry mouth, taste alteration, and discoloration of teeth.

Orthodontic considerations in patients with respiratory disorders are as follows:

- The patient's physician should be contacted before treatment is commenced to evaluate the severity and prognosis of the problem. The orthodontist should ensure that the patients have their inhaler nearby
- Patients may not be comfortable in the supine position if they have difficulty breathing
- The first objective is to prevent acute asthmatic attacks. Treatment can be deferred in patients with poorly controlled asthma and with a history of multiple emergency room visits. Morning appointments when the patient is rested, short waiting, and treatment times all help ease stress and anxiety
- Orthodontic extractions should ideally be carried out under local anesthesia (LA) with or without relative analgesia (RA) and not GA. If GA is required, the patient

must be in optimal health with no evidence of a respiratory infection. RA with nitrous oxide and oxygen is favored to IV sedation since the former can be rapidly reversed^[16]

- CF also affects the salivary glands and hence salivary flow can be reduced. These patients, as well as those with drug-induced xerostomia, are at a higher risk of decalcification
- Patients with asthma should be prescribed nonsteroidal anti-inflammatory drugs (NSAIDs) with caution as many asthmatic patients are allergic to aspirin-like compounds.

ENDOCRINE DISORDERS

Diabetes mellitus

The term DM is characterized by chronic hyperglycemia. There are two main categories of DM: Type 1 DM (insulin-dependent diabetes mellitus or juvenile-onset diabetes) results from defects in insulin secretion. The onset is usually before adulthood and accounts for approximately 5%–15% of all people with DM. Type 1 DM occurs more frequently in people of European origin than non-European origin. It is life threatening if not treated with exogenous insulin. Type 2 DM (noninsulin-dependent or mature-onset diabetes) develops as a result of defects in insulin secretion, insulin action, or both. There is a link with being overweight. Type 2 DM usually appears in people over the age of 40, although in South Asian and African-Caribbean people, it often appears after the age of 25. However, recently, more children are being diagnosed with the condition, some as young as seven. This form of DM is also more prevalent in less affluent populations. It accounts for 85%–95% of all cases of DM. It is not usually life threatening, but chronic complications can affect the quality of life and reduce life expectancy. The WHO estimates that diabetes resulted in 1.5 million deaths in 2012, making it the 8th leading cause of death. However, another 2.2 million deaths worldwide were attributable to high blood glucose and the increased risks of associated complications (e.g., heart disease, stroke, and kidney failure), which often result in premature death and are often listed as the underlying cause on death certificates rather than diabetes. Until recently, India had more diabetics than any other country in the world, according to the International Diabetes Foundation. Diabetes currently affects >62 million Indians, which is >7.2% of the adult population. The average age on onset is 42.5 years. Nearly 1 million Indians die due to diabetes every year. According to the Indian Heart Association, India is projected to be home to 109 million individuals with diabetes by 2035.^[17] The high incidence is attributed to a combination of genetic susceptibility plus adoption of a high-calorie, low-activity

lifestyle by India's growing middle class. Gestational diabetes is similar to type 2 DM in that it involves insulin resistance; the hormones of pregnancy can cause insulin resistance in women genetically predisposed to developing this condition. Gestational diabetes typically resolves with delivery of the child; however, types 1 and 2 diabetes are chronic conditions. DM is progressive and has potentially harmful consequences for health. Oral complications include xerostomia, burning mouth and/or tongue, candidal infection, altered taste, progressive periodontal disease, dental caries, acetone breath, oral neuropathies, parotid enlargement, sialosis, and delayed wound healing.

Orthodontic considerations in patients with diabetes mellitus are as follows:

- Orthodontic treatment should be avoided in patients with poorly controlled DM as they are more likely to suffer from periodontal breakdown. Well-controlled DM is not a contraindication for orthodontic treatment
- Rigorous preventative regimes should be put in place. The patient should be made aware of the consequences of poor oral hygiene and the increased risk of periodontal disease
- Early morning appointments are least likely to interfere with the diabetes control regime. Patients should be advised to eat a usual meal and take the medication as usual prior to longer appointments
- Diabetic-related microangiopathy can affect the peripheral vascular supply, resulting in unexplained toothache, tenderness to percussion, and even loss of vitality. It has been suggested that patients with DM should be treatment planned as periodontal patients. Light physiological forces should be used in all patients to avoid overloading the teeth
- The orthodontic team should be trained to deal with diabetic emergencies. Hypoglycemia is characterized by initial signs of tremor, nausea, sweating, anxiety, tachycardia, palpitations, and shivering
- Conscious 50 g of glucose as a drink, tablet, or gel has to be given
- Unconscious 20 ml of 50% Dextrose IV or 1 mg of glucagon should be administered intramuscularly
- When the patient is cooperative, oral glucose should be given to prevent recurrent hypoglycemia. If recovery is delayed, the emergency services should be called.

Adrenal insufficiency (cortical crisis)

Acute adrenal insufficiency is associated with peripheral vascular collapse and cardiac arrest. Therefore, the orthodontist should be aware of the clinical manifestations and ways of preventing acute adrenal insufficiency in patients. There are two types of adrenal insufficiency:

1. Primary adrenal insufficiency (Addison's disease)
2. Secondary adrenal insufficiency (secondary to the use of exogenous glucocorticosteroids).

Orthodontic considerations in patients with adrenal insufficiency are as follows:

- Physician consultation to determine whether the patient's proposed treatment plan suggest a requirement for supplemental steroids
- Minor oral surgery procedures should be performed under steroid coverage^[18]
- Use of a stress reduction protocol and profound local anesthesia minimizes the physical and psychological stress associated with therapy and reduces the risk of acute adrenal crisis. Hydrocortisone 200 mg (IV/IM immediately preoperatively or orally 1 h preoperatively) and continue normal dose of steroids postoperatively.

Thyroid and parathyroid disorders

Orthodontic therapy can be carried out with minimal alterations in patients with effectively managed thyroid and parathyroid disease. Thyroid dysfunction is a relative contraindication for the use of IV sedation. Hypothyroid patients are particularly sensitive to central nervous system (CNS) depressants such as sedative hypnotic, antianxiety agents, and narcotic analgesic. Hyperthyroid patient, on the other hand, is very extremely difficult to sedate due to the high metabolism and heart rate. Atropine and scopolamine should therefore be avoided in these patients. Common oral findings in hypothyroidism include macroglossia, delayed eruption, poor periodontal health, and delayed wound healing.

Orthodontic considerations in thyroid and parathyroid disorders are as follows:

- Treatment procedures such as banding and bonding should have brief appointments and stress management is important for patients who have hyperthyroidism. Banding should be avoided especially on molars, and bondable molar tubes can be placed
- Adrenaline should be used judiciously due to the spread of infectious foci^[19]
- Treatment should be discontinued if signs or symptoms of a thyrotoxic crisis develop and access to emergency medical services should be available
- After treatment, it is important that patients continue taking their thyroid medication as prescribed
- Excessive radiation exposure should be avoided. Thyroid collar should be used while taking patient X-rays.^[20]

LIVER DISEASE

Liver disease can result from acute or chronic damage the

liver, usually caused by infection, injury, exposure to drugs or toxic compounds, an autoimmune process, or by a genetic defect. The main effects of liver disease can be categorized into coagulation disorders, drug toxicity, disorders of fluid and electrolyte balance, problems with drug therapy, and infections. Viral hepatitis is undoubtedly of importance to the orthodontist. Hepatitis B virus (HBV), hepatitis C virus, and hepatitis D are bloodborne and can be transmitted via contaminated sharps and droplet infection. Aerosols generated by dental hand pieces could infect skin, oral mucous membrane, eyes, or respiratory passages of dental personnel and patients. The main orthodontic procedures to result in aerosol generation are removal of enamel during interproximal stripping, removal of residual cement after debonding, and prophylaxis. HBV has an incubation period of 6 weeks to 6 months and a small number of infected persons can progress to the carrier state associated with chronic active hepatitis and eventually cirrhosis. Hepatitis B surface antigen (HBsAg) is the first sign of infection. Antibody to HBsAg is associated with protection from infection. Hepatitis B core antigen is detected by the development of an antibody to it.

Orthodontic considerations in patients with liver disease

General liver disease:

- Care should be taken when prescribing any medication for patients with liver disease. Hepatic impairment can lead to failure of metabolism of some drugs and result in toxicity
- Patients undergoing liver transplantation will be receiving immunosuppressive drugs that can cause gingival hyperplasia. This effect is discussed in more detail on the section on medication
- Hemostasis will be affected and this should be accounted for when planning treatment.

Hepatitis:

- All patients should be treated as though they are infected and universal cross-infection control precautions should be taken. Several studies have shown that orthodontists are more complacent than general dental practitioners (GDPs) with regard to cross-infection^[21]
- All members of the team should be immunized against HBV. A booster is required in those with anti-HBs level less than 100.

RENAL DISORDERS

Patients with kidney disorders are presenting more frequently in orthodontic practice due to improvements in medical care, resulting in reduced morbidity and mortality. The most common

renal condition to present to the orthodontist is chronic renal failure (CRF). CRF occurs after progressive renal damage. The symptoms and signs vary and can affect diverse body systems. Bone disease or renal osteodystrophy is an almost universal feature of CRF. Calcium metabolism is compromised by an elevated parathyroid hormone and by disruption in Vitamin D metabolism. This results in secondary hyperparathyroidism. Renal disease also causes anemia and marrow fibrosis leads to a reduced platelet count and poor platelet function. Hemostasis is impaired to varying degrees in patients with CRF. Initially, treatment is conservative with dietary restriction of sodium, potassium, and protein. As the disease progresses, dialysis or transplantation is required. Immunosuppressant drugs such as cyclosporine and calcium channel antagonists such as nifedipine are also taken to prevent transplant rejection. Immunosuppressants predispose the patients to infections. These drugs can also cause drug-induced gingival overgrowth as discussed in the section on drugs and orthodontic treatment. In children, CRF leads to decreased growth and sometimes delayed eruption and enamel hypoplasia.

Orthodontic considerations in patients with renal disorder:

- Orthodontic treatment is not contraindicated in patients if the disease is well controlled
- Treatment could be deferred if the renal failure is advanced and dialysis is imminent
- Appointments should be scheduled on nondialysis days. The day after dialysis is the optimum time for treatment for surgical procedures as platelet function will be optimal and the effect of heparin will have worn off
- Surgical procedures are best carried out under local anesthesia. The anemia and the potential electrolyte disturbances that can predispose the patient to cardiac arrhythmias can complicate GA
- Hemostasis is impaired as a result of platelet dysfunction. Impaired drug excretion leads to the need for care with drug prescriptions. The value of prophylactic antibiotics in renal transplant patients on prevention of postoperative complications is questionable or unproven, with the Working Party of the British Society for Antimicrobial Chemotherapy stating that there is no need for antibiotic prophylaxis for dental treatment^[22]
- These patients may be taking or have taken steroids, but the use of supplemental steroids in dentistry is controversial and is discussed in the section on drugs and orthodontic treatment
- Animal models have also shown that orthodontic tooth movement is accelerated in rats with renal insufficiency. This was attributed to the increase in circulating parathyroid hormone. It has been suggested that orthodontic treatment forces should be reduced and

the forces re-adjusted at shorter intervals. It has been suggested that orthodontic treatment forces should be reduced and the forces readjusted at shorter intervals.

MUSCULOSKELETAL SYSTEM

Juvenile idiopathic arthritis

Juvenile idiopathic arthritis (JIA) is a severe disease of childhood. It comprises a diverse group of distinct clinical entities of unclear etiology. The overall prevalence of JIA is estimated to be from 0.07 to 4.1 per 1000 children, with an incidence of 0.008 to 0.226 cases of JIA per 1000 children. While oligoarticular being 40% of newly diagnosed among Caucasian population, polyarticular is predominant in African, East Indian, and Indian population. JIA is classified according to the type of onset of the disease and the number of joints affected during the first 4–6 months: pauciarthritis or oligoarthritis denotes four or less joints being involved and polyarthritis when five or more joints are involved. JIA can be of varying severity with localized and/or systemic complications, including functional impairment of the affected joints. This may result in disturbances in growth and developmental anomalies. There is remission of the disease in adolescence, which happens for 70% of patients. The temporomandibular joint (TMJ) is affected in 45% of cases with JIA.^[23] The diagnosis of TMJ involvement is more difficult than the other joints as the signs and symptoms are missing or weak. This can lead to the development of condylar hypoplasia, restricting mandibular growth resulting in mandibular retrognathism. JIA patients commonly present with skeletal Class II and open bite malocclusions. Mandibular asymmetry is seen in cases with unilateral TMJ involvement. Early orthodontic intervention facilitates both the skeletal and the occlusal rehabilitation. More severe cases are prescribed a variety of medicaments such as gold, methotrexate, corticosteroids, and antimalarial drugs. These drugs have their own adverse effects, which must be reflected on during orthodontic treatment planning.

Orthodontic considerations in patients with JIA:

- The functional ability of the TMJ in JIA children should be monitored closely in order to start medical treatment as soon as inflammation begins in the joint. The TMJ in a growing child has immense potential for structural changes and growth can normalize, provided the inflammation is controlled early and mandibular growth is supported
- A bite splint can be provided to unload the joint during any acute periods of inflammation. It has been argued that functional appliances and class II elastics put increased stress on the TMJs and should be avoided;

However, it has also been suggested that functional appliances protect the joints by relieving the affected TMJ, the aim being to move the mandible into the normal anterior growth rotational pattern, thus correcting the skeletal Class II relationship^[24]

- Surgery can be considered if the problem cannot be treated orthodontically; however, it has been suggested that mandibular surgery should be avoided and instead a patient with severe mandibular deficiency should have maxillary surgery and a genioplasty.

NEUROLOGICAL DISORDERS

It is important that orthodontists have knowledge of the most common neurological conditions as some problems may manifest initially in the orthodontic chair. Most people who have epilepsy or seizure disorders can have conventional orthodontic care in the primary care setting. Patients should take their normal antiepileptic medication before appointments, eat normally before appointments, and avoid scheduling appointments when they might be tired.

Epilepsy

Epilepsy is a common symptom of an underlying neurological disorder. The seizures can take a variety of forms and epilepsy is considered to be active if a person has had a seizure within the last 2 years or is taking antiepileptic medication. Brain damage due to injury, infection, birth trauma, or a cerebrovascular accident accounts for 25% of cases. The other 75% of cases have no identifiable cause, but there is a familial trend. Epilepsy can develop in some genetic syndromes such as Down's syndrome or in Sturge-Weber syndrome.^[25]

Orthodontic considerations in patients with epilepsy are as follows:

- Most people who have seizure disorders are able to undergo conventional orthodontic care in the primary care setting. Nonetheless, the orthodontist should ensure the patient has taken his/her normal antiepileptic medication, is not too tired, and has eaten normally before each appointment
- The orthodontist should ensure the patient is receiving regular and rigorous preventative dental care to avoid/minimize dental disease
- Patients should be aware of and consented for the risk of soft tissue and dental injuries as a result of a seizure
- Gingival overgrowth associated with phenytoin is the most widely known complication of antiepileptic medication, with 50% of individuals being affected within 3 months of starting the drug. Gingivectomy is

recommended to remove any hyperplastic tissue that interferes with appearance or function

- Removable appliances need to be used with caution as they can be dislodged during a seizure. It is not always possible to avoid the use of removable appliances
- If an individual with a Class II division 1 incisor relationship experiences an aura before a seizure, he/she should carry a soft mouth guard with palatal coverage and extending into the buccal sulci, to use at such times
- The orthodontic team should be well trained in seizure management. Status epilepticus is a medical emergency and there should be given a benzodiazepine from the emergency drug kit.^[26]

Multiple sclerosis

Multiple sclerosis (MS) is a complex neurological condition that occurs as a result of damage to the myelin sheathes within the CNS. The damaged areas result in inflammation and interference in both sensory and motor nerve transmission. In the USA and UK, the frequency is about 90–150/100,000. In contrast, calculations based on the hospital data in the 1970s suggested an approximate prevalence rate of only 0.17–1.33/100,000 in different parts of India^[27] With increased awareness, a significant increase in the number of neurologists and relatively easy availability of magnetic resonance imaging the current estimate stands at about 7–10/100,000. The etiology of MS is not understood and various environmental factors such as viruses and climatic factors have been implicated. Subtypes of MS are categorized in Table 3. The main symptoms relevant to oral care include pain and numbness of varying severity in the facial and oral tissues. The arms and hands can also be affected, challenging the patient's ability to carry out effective oral hygiene. Trigeminal neuralgia is atypical in younger patients. Pain is bilateral and unstimulated. Indeed, trigeminal neuralgia in people under 40 can be indicative of MS. Orthodontists should be aware of this and refer affected individuals for a neurological assessment. The focus of treatment is on the prevention of disability and maintenance of quality of life. Drugs, physical treatments, and psychological techniques are used. Steroids are often used to help a person over a severe relapse.

Orthodontic considerations in patients with MS are as follows:

- Treatment should involve a multidisciplinary approach including the patient's physician, neurologist, MS specialist nurse, and care worker^[28]
- Preventative regimes should be based on the nature of the individuals MS. Custom-made toothbrush handles to improve grip and the use of electric toothbrushes

to compensate for the loss of manual dexterity and coordination have been recommended

- It is important to discuss with every patient with MS how he/she prefers to manage his/her symptoms. Appointments should be at their convenience, the environment kept at a comfortable temperature. Patients with spasms should be allowed to get out of the dental chair and move around to relieve them. Individuals with dysphagia should be treated in a semireclined position
- Treatment objectives should be tailored to the patient's condition. Patients with severe MS may be best treated to a compromised result. Removable appliances may not be tolerated well. In patients with poor coordination, the use of intermaxillary traction may be contraindicated.

ALLERGIES

The two key allergic reactions are; Type I hypersensitivity reactions are an immediate antibody mediated allergic response, occurring within minutes or hours after direct skin or mucosal contact with the allergen. This reaction ranges from contact urticaria to full-blown anaphylaxis with respiratory distress and or hypotension. A delayed hypersensitivity reaction (Type IV) usually presents with localized allergic contact dermatitis. It presents with diffuse or patchy eczema on the contact area and may be accompanied initially by itching, redness, and vesicle formation. The reactions are not life threatening, but can cause permanent damage if not treated. The face, especially the lips and mouth, is more commonly affected in dental patients who develop a latex allergy. Orthodontic staff should be trained in how to deal with an anaphylactic shock. Figure 1

Table 3: Subtypes of Multiple sclerosis

Benign	20% of people with MS. Mild attacks followed by complete recovery and no permanent disability
Relapsing/remitting	25% of confirmed cases. Remissions occur spontaneously, relapses unpredictable, some residual damage
Secondary progressive	40% of cases. Follows on from relapsing/remitting phase and then remissions cease to occur. Usually 15–20 years from onset of symptoms
Primary progressive	15%. Symptoms worsen and disability progresses

Table 4: Commonly prescribed bisphosphonates, brand names and dosage

Mode of Administration	Common third Generation Bisphosphonates	Dosage
Oral bisphosphonates	Alendronate (Fosamax, Merck)	70 mg per week
–osteoporosis, Pagets disease, osteogenesis imperfecta	Risedronate (Actonel, Aventis) Ibandronate (Boniva, Roche)	35 mg per week 2.5 mg per day
IV bisphosphonates	Pamidronate (Aredia, Novartis)	90 mg per month
– cancer	Zoledronate (Zometa, Novartis)	4 mg per month

illustrates the sequence of steps that have been outlined by the Resuscitation Council (UK).^[29]

Nickel allergy

Orthodontists are sometimes required to treat patients with an allergy to nickel and nickel is present in a number of orthodontic materials, notably nickel–titanium (Ni-Ti) archwires. The immune response to nickel is usually a type IV cell-mediated delayed hypersensitivity reaction. The first phase or sensitization to nickel is increasing with the increasing use of jewelry containing the metal. The prevalence of nickel allergy is estimated 11% in women and 2% in men. Re-exposure to nickel can result in contact dermatitis or mucositis and develops over a period of days or up to 3 weeks. Re-exposure to nickel can result in contact dermatitis or mucositis and develops over a period of days or rarely up to 3 weeks. Fortunately, most individuals with nickel allergy do not report reactions to orthodontic appliances containing nickel.^[29] Nickel leaching from orthodontic bands, brackets, stainless steel, or Ni-Ti archwires has been shown *in vitro*

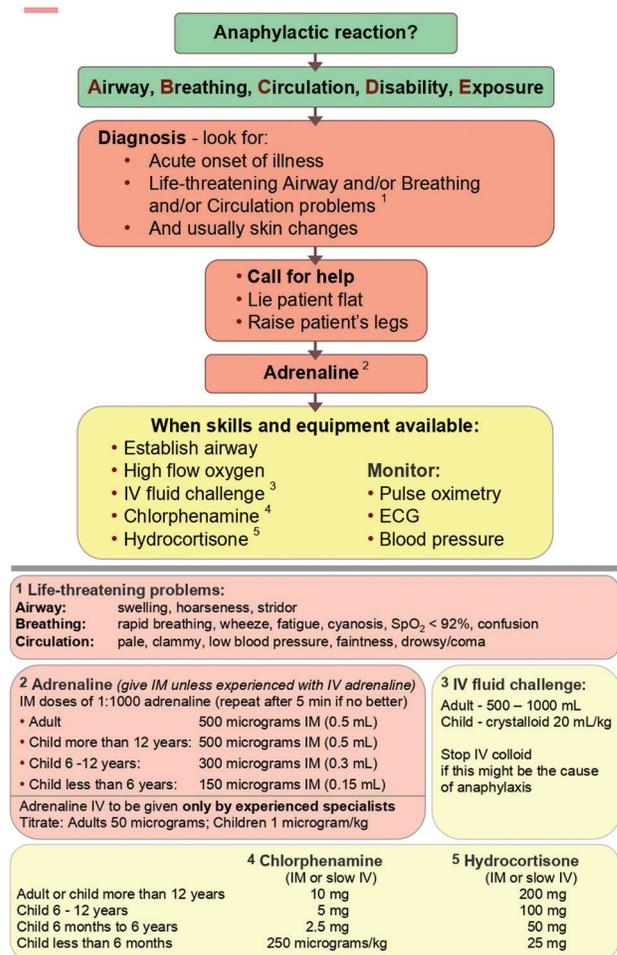


Figure 1: Anaphylaxis treatment algorithm – adapted from Resuscitation Council UK guidelines 2008 (Google scholar)

to occur within the 1st week and then decline thereafter. Oral fluids, certain foods, and fluoride media can corrode and accelerate the leaching process. Oral clinical signs and symptoms of nickel allergy can include the following: a burning sensation, gingival hyperplasia, angular cheilitis, labial desquamation, erythema multiforme, periodontitis, stomatitis with mild-to-severe erythema, loss of taste or metallic taste, numbness, and soreness of the side of the tongue.

Orthodontic considerations in patients with a nickel allergy are as follows:

- A dermatologist should confirm a true nickel allergy
- Patients with a defined history of atopic dermatitis to nickel-containing metals should be treated with caution and closely monitored during orthodontic treatment
- In patients with diagnosed nickel hypersensitivity and where intraoral signs and symptoms are present, the orthodontist should replace Ni-Ti archwires with one of the followings
- Stainless steel archwires with a low nickel content:
 - Titanium molybdenum alloy which is nickel free
 - Fiber-reinforced composite wires
 - Pure titanium- or gold-plated wires.
- If the allergic reaction continues, all SS archwires and brackets should be removed. If the allergic reaction is severe, the patient should be referred to a physician. Alternative nickel-free bracket materials include ceramic, polycarbonate, titanium, and gold. Fixed appliances may be substituted with plastic aligners in selected cases.

Latex allergy

The increase in allergic reactions to natural rubber latex over the past two decades has been accredited to the increased use of latex-based gloves and universal precautions. Disposable medical gloves, particularly powdered gloves, are the main reservoir of latex allergens. Orthodontic elastics used to apply intermaxillary forces are another potential source of the latex protein. Both type I and type IV hypersensitivity reactions can occur. The prevalence of potential type I hypersensitivity to latex is lower than 1% in the general population and between 6% and 12% among dental professionals. For the purpose of this review, only risks to patients will be discussed. Patients at risk of allergy are those with a history of atopy such as hay fever, asthma, eczema, contact dermatitis, and those with spina bifida. Allergies to certain fruits such as banana, avocado, passion fruit, kiwi, and chestnut can also indicate a potential latex allergy. They have proteins that are capable of cross reacting with latex proteins and hence help sensitize the person to latex.^[30] Multiple testing is recommended for increased accuracy of diagnosis. Definitive diagnosis should

be based on the medical history and a positive skin reaction to specific chemicals present in natural rubber latex.

Orthodontic considerations in patients with latex allergy are as follows:

- The goal is to significantly reduce exposure to patients routinely. This can be done by cleaning more frequently with a protein wash, cleaning or changing the air filter more regularly
- Latex-free goods should be stored in a 'latex-screened' area to avoid prior contamination with latex products
- Patients with a diagnosed allergy can be offered early morning appointments to reduce the exposure to airborne latex particle
- The diagnosed patient should be monitored for signs of adverse reactions. The team should be capable of instigating prompt emergency care
- The emergency drugs and resuscitation equipment should be free from latex

Prediagnosis

If a reaction to latex is suspected, patients should be referred to an allergist, clinical immunologist, or dermatologist for testing.

Postdiagnosis

The orthodontic team including radiographers should be aware of the implication of treating latex allergy patients.

SIDE EFFECTS OF MEDICATION

Nonsteroidal anti-inflammatory drugs

Pain control during orthodontics is an important aspect of patient compliance. In addition, patients may be on pain relievers for a chronic illness. The effects of these medications on tooth movement have been studied. Prostaglandins are important mediators in tooth movement and it has been suggested that the use of over-the-counter NSAIDs can affect the efficiency of tooth movement. A study to determine the effect of aspirin, acetaminophen (paracetamol), and ibuprofen on orthodontic tooth movement in rats showed that acetaminophen did not affect movement, whereas there was a significant difference between the control group and the aspirin and ibuprofen group. Paracetamol is the analgesic of choice in orthodontic patients. Their results suggested that NSAIDs reduce the number of osteoblasts by inhibiting prostaglandin synthesis. This led to the use of cyclooxygenase-2 inhibitor (COX-2) drugs, but the effects of these drugs on tooth movement can be very variable. The effects of three different COX-2 inhibitors on tooth movement in male Wistar rats showed that tooth movement was inhibited in rats treated with rofecoxib. There was, however,

no significant difference in tooth movement between the control group (saline) and the other two COX-2 inhibitor groups, celecoxib and parecoxib.^[31]

Corticosteroids

These drugs are used for many inflammatory and autoimmune diseases. There are two main issues to consider when patients present with a history of corticosteroid use. First, the use of supplemental steroids prior to dental surgery in patients at risk of an adrenal crisis is a contentious issue. The UK Medicines and Healthcare Products Regulatory Agency and the Committee of Safety of Medicines together published recommendations in which appear not yet to have been superseded, that include 'Patients who encounter stresses such as trauma, surgery or infection and who are at risk of adrenal insufficiency should receive systemic corticosteroid cover during these periods. Patients on long-term steroid medication do not require supplementary 'steroid cover' for routine dentistry, including minor surgical procedures, under LA. Instead, the BP should be monitored throughout the procedure with IV hydrocortisone available in the event of a crisis. 106 patients undergoing GA for surgical procedures may require supplementary steroids depending on the dose of steroid, duration of treatment, and severity of the planned surgery. Kalia *et al.* studied the effect of acute and chronic corticosteroid treatment in rats.^[32] Their results indicate that bone turnover is reduced in subjects on acute corticosteroid treatment and increased in patients on chronic corticosteroid therapy.

Bisphosphonates

These drugs are commonly prescribed to manage osteopenia and osteoporosis or to treat hypercalcemia caused by bone metastasis in cancer patients [Table 2]. About half of the BP that is resorbed is excreted unchanged by the kidneys; the remainder has a high affinity for bony tissues and a reported half-life of 10 years. BPs inhibit the resorption of trabecular bone by osteoclasts and hence preserve bone density. Although their medical benefits have been proven, there are increasing numbers of side effects that can affect orthodontic treatment including delayed tooth eruption, inhibited tooth movement, impaired bone healing, and BP-induced Osteonecrosis of the jaws (Maxilla and Mandible) of the jaws.^[33] The pathogenesis of BP-associated ONJ is not fully known. One suggestion is that hypodynamic and hypovascular bone is unable to meet an increased demand for repair and remodeling due to physiological stress (mastication), iatrogenic trauma (tooth extraction), or odontogenic infection. This can be exacerbated by the following factors: corticosteroid treatment; chemotherapy; medical comorbidities such as DM, the presence of dental disease, dental extractions, and oral bone surgery; poorly

fitted dental appliances; smoking; and alcohol abuse. Radiographic signs include widening of the periodontal ligament space at the molar furcation areas and mottled bone consistent with osteolysis.

Orthodontic considerations in patients taking bisphosphonates:

- Amend the medical history form to identify patients who are taking BPs
- Orthodontic treatment can only be considered after discussion with the patient's physician and other medical specialists they may be under the care of. Ascertain why the patient is on BPs. Assess the risk of osteoradionecrosis via the route of administration, duration of treatment, dose, and frequency [Table 4]
- If possible, treatment should be carried out prior to BP treatment. In patients at high risk of ONJ, it may be better to accept the malocclusion and consider the benefits of cosmetic dentistry
- The clinician should look for signs of ONJ and the patient should be advised to have regular dental checkups
- Some clinicians suggest that one should try to avoid invasive laser therapy or temporary anchorage devices in treatment plans
- This suggests that patients who take oral BPs are no more at risk of implant or temporary anchorage device failure than other patients.

DRUG INDUCED GINGIVAL GROWTH (DIGO)

DIGO affects a proportion of patients on medication for hypertension, epilepsy, and the prevention of organ transplant rejection. The clinical signs can vary in severity from minor overgrowth to complete coverage of standing teeth. These effects are compounded by poor oral hygiene, but can occur in the absence of plaque. Drifting of teeth can also occur resulting in further esthetic and functional problems for the patient. The main drugs that cause DIGO are phenytoin, cyclosporine, and calcium channel blockers including nifedipine, diltiazem, and amlodipine.^[34] There are a few alternatives for reducing gingival overgrowth. One possibility is to have the patient placed on a different drug. There is usually spontaneous regression of the gingival hyperplasia, provided the oral hygiene is excellent. Nonsurgical techniques can limit the occurrence of DIGO, reduce the extent of plaque-induced gingival inflammation, and reduce the rate of recurrence. In some patients, however, the drug is critical to control either their epilepsy, transplant, and cardiac condition. In these cases, intensive periodontal treatment with excision of the hyperplastic tissue is necessary.

Orthodontic considerations in patients with DIGO are as follows:

- Patients at risk of DIGO require a team approach with the patient, his or her physician, GDP, periodontist, hygienist, and the orthodontist
- Treatment should be aimed at reducing the risk of DIGO occurring or at least preventing the DIGO worsening. The recurring message is to ensure that patients have excellent oral hygiene in order to reduce the risk of DIGO. A rigorous oral hygiene program should be instigated from the outset and reinforced during treatment
- A nonextraction approach is preferred in case treatment has to be terminated due to medical problems or exacerbation of the DIGO. In addition, space closing mechanics including nickel titanium closing springs, elastomeric power chain, or active ties can impinge on the hyperplastic gingival tissue. Archwire loops could have a similar effect and be displaced buccally, altering the direction of force
- Small, low profile brackets are recommended and the excess composite around the margins should be removed. Bands should be avoided if possible as they have been associated with significantly more gingival inflammation than bonded molars
- Essix-based retainers should be relieved around the gingival margins to maintain alignment. Bonded retainers should be avoided in patients at risk of DIGO.

Limitations and future research

The search of literature was restricted to English-language publications, which might introduce citation bias and jeopardize the evidence synthesis. The search process was only limited to electronic databases. Due to the ambiguity in the definitions of expectations and related concepts, selection bias is not unlikely, although effort has been taken to minimize it through the methodology and the utilization of two reviewers. With the heterogeneity in study designs, the results were extracted with an inevitable degree of subjectivity. The evidence to support the need for orthodontic dentists to clarify patients' expectations and whether this might assist them in achieving better treatment outcomes and patient satisfactions is weak. Future studies should address this better and consider specific situations the patients may encounter, the kind of expectations they may form, and how these expectations would be influenced by subdeterminants such as previous experiences, personal characteristics, and social and psychological factors. For example, Bandura's self-efficacy model is now popular as the theoretical framework in research of patient expectations.^[35] To conclude, there is a need for future studies to:

- Construct the theoretical model of how patients

form expectations from orthodontic treatment and demonstrate its determinants and contributing factors both theoretically and experimentally. Stratified or multivariate analysis is recommended

- Investigate the nature, extent, and clinical implications of the relation between expectations and subsequent treatment outcomes, including evaluations of intervention effectiveness
- Investigate the changes or different roles of expectations at different clinical stages, through a longitudinal study design.

CONCLUSION

The number of medically compromised patients seeking orthodontic care is increasing. This trend is likely to continue. While orthodontic therapy is typically viewed as being of low risk compared with more invasive dental procedures, specific orthodontic manipulations, associated with fixed therapy, are potentially harmful to certain patient populations. In addition, the potential for increased plaque accumulation resulting from orthodontic appliances might adversely impact gingival health, and predispose patients at risk for advanced periodontal disease. Prevention is the most important aspect of risk management. A good medical history, communication with the patient's physician, and clinical vigilance are critical in the medically compromised patient population.

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