Dentists' Knowledge and Application of the Guidelines for the Management of Traumatic Dental Injuries in the United Arab Emirates

By:

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ABSTRACT

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Purpose/Aim

The aim of this study was to assess and to compare the level of general dental practitioners' (GDPs) knowledge within the United Arab Emirates (UAE) regarding the ways to manage traumatic dental injuries, and to compare their level of knowledge with that of paediatric dentists' (PDs).

Materials and Methods

A two-part questionnaire consisted of seven questions relating to the participants' demographic data and alongside thirteen questions demonstrating trauma case scenarios. The questionnaires were distributed among dentists' electronic mail as well as in two local conferences. A total of 296 questionnaires were received and data were statistically analysed to identify GDPs' knowledge regarding how to manage dental trauma cases, and to henceforth compare the score of GDPs' knowledge with that of PDs'.

Results

Out of a total top score of 13 the mean score for GDPs' knowledge was 4.87±1.82 which illustrated poor knowledge. This means that only 37.5% of the total of the 13 questions was answered correctly. The mean knowledge score of paediatric dentists was 5.56±1.47, which is also poor with 42.8% correct answers. However, the

difference in knowledge between GDPs and PDs was statistically significant (*p*-value =0.005).

Conclusions

This survey desmonstrates poor knowledge of dental trauma management among the surveyed GDPs as well as PDs, and highlights the need to develop strategies to improve the knowledge base in this area of dentistry.

Keywords

Traumatic dental injuries, knowledge, guidelines, general dental practitioners, paediatric dentists, United Arab Emirates.

DEDICATION

To my IT Master, my loving husband

Dr. Mohammad Shammakh.

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DECLARATION

I declare that all the content of the thesis is my own work. There is no conflict of interest with any other entity or organization

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Signature:

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LIST OF ABBREVIATIONS

TDIs: Traumatic dental injuries

GDPs: General dental practitioners

PDs: Paediatric dentists

IADT: International association of dental traumatology

PDL: Periodontal ligament

NHS: National Health Service

UAE: United Arab Emirates

CM/DE: Medical/Dental Education courses

BLS: Basic Life Support

1.0 INTRODUCTION & BACKGROUND

Owing to the multiple types of trauma that affect both the primary and the permanent dentition, the diagnosis and treatment of Traumatic Dental Injuries (TDIs) is very complex. In order to fulfil the treatment needs, the large variety of cases need multiple treatment sequences beginning with general dental practitioners and subsequently involving other dental specialities.

Majority of registered TDIs are treated in primary care centres [1–3]. In the United Kingdom (UK), the main providers of children's dental care are General Dental practitioners (GDPs), employed by the National Health Service (NHS).

Patients with TDIs who attend primary care centres may require to be referred to secondary care clinics, or specialisation clinics, usually ran by Paediatric Dentists (PDs).This, however, should not relieve the responsibility from the GDPs at the primary care centres to at least provide emergency treatments and as well as a referral to dental specialist if needed.

The GDP plays a fundamental role in treating TDIs. Adequate knowledge about the most current dental trauma management guidelines is very important for many reasons. Knowledge is essential in order to improve, the short as well as long term, prognosis and outcome of such injuries, and to reduce the stress on the dentist and the patient/or the parents/caregivers when such incident happens.

TDIs nowadays are considered a public dental health problem, and general dental practitioners should be familiar with the evidence-based guidelines, such as those of The International Association of Dental Traumatology (IADT)[4], in order to hence provide appropriate first-aid intervention and care. This would improve the success rate of TDIs management.

In the United Arab Emirates (UAE), there are no published data in regards to TDIs registration, nor GDPs level of knowledge in the management of TDIs. For this reason, this study was conducted in

order to assess the level of GDPs' knowledge in the United Arab Emirates (UAE) about how to manage traumatic dental injuries, and compare the level of knowledge with that of PDs.

2.0 LITERATURE REVIEW

2.1 International studies regarding traumatic dental injuries management among dental professionals

In order to provide the best and the most efficient care, oral healthcare professionals must be familiar with treatment guidelines relating to traumatised teeth. This awareness of suitable treatments has the potential to benefit both the patient and the dental team by reducing both levels of anxiety and stress for both [5]. To ensure the best care professionals and groups at risk must be often familiarised and kept up-to-date regarding both the prevention of TDIs and the various treatment plans to counter TDIs. The subsequent correct application of these techniques should have the effect of improving both short- and long-term outcomes[6].

Without adequate knowledge regarding TDIs and appropriate treatment plans, the injuries may be the cause of even further challenges for the patient, and the dental team alike. Inadequate knowledge may result in treatments and maintenance that are costly, time-consuming and may last a lifetime[7].

The majority of TDIs registered were treated in primary care centres [1–3]. In the UK, the main providers of children's dental care are General dental practitioners (GDPs), employed by the National Health Service.

Patients with TDIs who attend to primary care centres may be referred to secondary care clinics, or specialization clinics. This, however, should not relieve the GDPs from their responsibilities at primary care centres to provide appropriate of the emergency care.

Dentists' responses to TDIs are indicative of their knowledge in providing appropriate care for trauma cases; in any event and whatever their response, their actions will determine the clinical outcome and success of treatments.

In Australia, Yeng *et al*. 2008, found there is a split in opinion with regards to the opinions of GDPs on whether or not to refer dental trauma causes to specialists. Yeng *et al.* has found that (97.3%) had the opinion that trauma to young permanent incisors should be referred to an oral and maxillofacial surgeon for management, (87.6%) believed that they should be referred to a paediatric dentist, and (75.2%) to an endodontist[8]. On the other hand, (92%) and (81.5%) of dentists believed that it was not necessary to refer children with dental trauma to specialist clinics [8].

Various studies have highlighted that upon assessing the knowledge of general dentists regarding proper treatment for dental trauma, it is clear that some dentists have insufficient knowledge in treating dental trauma[9–12]. It has also been found that due to the fact that in treating dental trauma cases, these dentists had very little experience[13], the dentist displayed a subsequent lack of confidence with treatment and management pertaining to trauma cases[14].

After finding there to be a lacking level of knowledge among dental professionals about proper emergency management of TDIs, Cohenca *et al.* 2006, highlighted the need of better awareness, among GDPs, of the current guidelines for the emergency treatment of TDIs[7].

Rita *et al.* 2014, have found that similarly in Belgium, especially for the management of immature incisors, the awareness of Flemish dental practitioners about emergency treatment and management for complicated crown fracture is insufficient[15]. Likewise in Germany, Krastl *et al*. 2009 found that the general dentists therein hold poor knowledge regarding aspects of dental traumatology[16]. Contrary to most studies presented so far, it has been found that GDPs in Riyadh Kingdom of Saudi Arabia, were found to have sufficient knowledge on dental traumatology[14].

2.2 Dental traumatic injuries incidence and prevalence

2.2.1 Incidence

There exists a dearth in studies with regards to reporting instances of trauma. Among those few studies, Table 1 shows incidences ranging from 1 to 44 new cases per 1000 persons in a year (up to 4.5% of the population).

Worldwide, the occurrences of dental trauma does not seem to affect any more than 5% of the population. Because of the many difficulties regarding sampling, the studies that have been conducted about dental trauma in fact underestimate the very issue. When dealing with dental trauma, it is the case the patients may not appear for treatments, they may skip school and they may neglect to respond to questionnaires. With improved methods of data collection and research at large, it is probably the case that the actual severity and intensity of traumatic would turn out to be higher than previously recorded. In any event, the differences in socioeconomic, environmental and cultural differences coupled with varying study methodologies and classifications often result in variations between studies conducted between and within locales[17].

2.2.2 Prevalence

As shown in Table 2, the prevalence of dental injuries ranges from 6% to 59% of the population, depending on the context. The table highlights the fact that depending on where you are, there appears to be a large variation in the presence of dental injuries. Otuyemi *et al. 1998* [18], has postulated that because of Nigerian children having care-givers who are only a few years older than themselves, Nigerian children as a result displayed a higher prevalence of TDIs in their primary dentition (30.8%)[18]. Likewise alongside external factors, study methodologies also have an impact on prevalence rates. Two studies conducted in Brazil, one by Granville-Garcia *et al.* (36.8%) and the other

by Oliveira *et al*. (9.4%) presented a large discrepancy in the prevalence of TDIs, with (36.8%) being recorded by Garcia *et al.* and (9.4%) recorded by Oliveira *et al.*[19,20]. These studies were conducted within the same jurisdiction (Brazil), the same age group (1–5), the same dentition (primary) and during the same time (2006–2007). Despite the very similar study methodologies and approaches to the research, the results of the two studies were different. Representing the effects of different classification and inclusion criteria, this large variation may be attributed the disregard of luxation injuries in the study conducted by Oliveria *et al*. [21].

Factors such as age, circumstance, geography, behavior and culture impact the risks associated with sustaining dental trauma. There is an inherent need for a globally recognized approach to both the reporting as well as the registering of trauma; if this is not possible, it is very difficult to quantify factors and studies may not be compared to one another.

Over half of all physical traumas involve the head and neck region[22,23]. Following from this, Gassner *et al*. has suggested reports that place 48% of facial injuries as involving the oral cavity as an understatement[22]. The affect on the oral cavity is representing through a general trend indicating "that one-third of all pre-school (primary teeth) and one-quarter of adolescents and adults (permanent teeth) experienced dental trauma at least once during their life" [23]. As the oral cavity comprises a mere 1% of total body area, this is indeed noteworthy[23].

Region	Author	Country	Year Study	Age (years)	Sample size	Incidence (1000/year)
Australia	Stockwell [24]	Australia	1988	6–12 Years	66,500	17
Europe	Hamilton, Hill and Holloway [9]	UK	1997	11–14 years	2022	34
	Skaare and Jacobsen [25]	Norway	2005	1–8 years	20,000	13
	Skaare and Jacobsen [26]	Norway	2003	7–18 years	U/S	18
	Ravn [27]	Denmark	1974	7–16 years	50,000	30
	Glendor, Halling, Andersson, Eilert-Petersson [28]	Sweden	1996	0–19 years	U/S	13
	Borssen and Holm [29]	Sweden	1997	1–16	3007	28
	Oldin, Lundgren, Nilsson, Noren, Robertson [30]	Sweden	2015	0–17	889	28
	Andreasen and Ravn [31]	Denmark	1972	0–14	487	40
Asia	Basha, Mohammad and Swamy [32]	India	2015	13 years	782	30.1
South America	Ramos-Jorge*et al*. [33]	Brazil	2008	11–13 years	208	1.2
		Brazil	2008	11–13 years	208	5.72
	Cecconello and Traebert [34]	Brazil	2007	U/S	176	44

Table 1 Incidence of dental injuries worldwide adapted from R .Lam 2016 [17]

Region	Author	Country	Year Study	Age (years)	Sample size	%
Australia	Burton, Pryke, Rob and Lawson [35]	Australia	1985	12–15	12,287	6.0%
				6–20	3337	18.4%
	Kaste, Gift, Bhat and Swango [36]	US	1996	21–50	4232	28.1%
North America				6–50	7569	24.9%
				6–20	6558	16.0%
	Shulman and Peterson [37]	US	2004	21–50	8806	27.1%
				6–50	15364	23.4%
Central America	Aldrigui, Jabbar, Bonecker, Braga Linares, and Wanderley [21]	Central American Countries	2014	12 years (mean age)	2436	15–20%
	Bendo, Paira, Oliveria, Gorsand, Linares,Torres and Pordeus [38]	Brazil	2010	11–14	1612	17.1%
	Francisco, Filho, Pinheiro, Murrer Linares,and Soares [39]	Brazil	2013	9–14	765	16.5%
	Goettems, Torriani, Hallal, Correa Linares,and Demarco [40]	Brazil	2014	8–12	1210	12.6%
	Filho, Jorge, Paiva, Ferreira, Linares,Ramos-Jorge and Zarzar [41]	Brazil	2014	14–19	687	26.6%
South America	Soriano, Caldas, Carvalho and Filho [42]	Brazil	2007	12	1046	10.5%
	Nicolau, Marcenes, Sheiham [43]	Brazil	2001	13	652	20.4%
	Marcenes, Zabote and Traebert [44]	Brazil	2001	12	652	58.6%
	Granville-Garcia, de Menezes, Linares,and de Lira [19]	Brazil	2006	1–5	2651	36.8%
	Oliveira, Marcenes, Ardenghi, Linares,Sheiham Linares,and Bonecker [20]	Brazil	2007	0.5–5	892	9.4%
Europe	Mendoza-Mendoza, Iglesius-Linares,Yanex-Vico and Abalos-Lubruzzi [45]	Spain	2015	1–7	879	21.7%

	Oldin, Lundgren, Nilsson, Noren, Linares, Robertson [30]	Sweden	2015	0–17	889	37.6%
	Al Majed, Murray and Maguire [46]	Saudi Arabia	2001	5–6	354	33.0%
Asia	Al Majed, Murray and Maguire [46]	Saudi Arabia	2001	12–14	862	34.0%
	David, Astrom and Wang [47]	India	2009	12	838	6.0%
	Patel [48]	India	2012	8–13	3708	8.8%
	Adekoya-Sofowora, Adesina, Linares,Nasir, Linares, Oginni and Ugboko [49]	Nigeria	2009	12	415	12.8%
Africa	Otuyemi [50]	Nigeria	1994	12	1016	10.9%
	Otuyemi, Segun Ojo Linares,and Adegboye [18]	Nigeria	1996	1–5	1401	30.8%

Table 2 Prevalence of dental injuries worldwide adapted from R .Lam 2016 [17]

2.3 Dental outcomes and prognosis of traumatised teeth

Traumatic dental injuries are categorized into two groups:

(1) Injuries to dental hard tissue and pulp, (2) and injuries to periodontal tissues

(1) Injuries to dental hard tissue and pulp are divided into the following categories: [51]

- Enamel infraction "An incomplete fracture of the enamel not involving any loss of tooth structure"[51]
- Enamel fracture "A fracture confined to the enamel with loss of tooth structure"[51]
- Enamel and dentine fracture "A fracture confined to enamel and dentin with loss of tooth structure, but not involving the pulp" [51]
- Enamel dentin pulp fracture "fracture involving enamel and dentin with loss of tooth structure, and exposing the pulp" [51]
- Uncomplicated crown root fracture "A fracture involving enamel, dentin and cementum with loss of tooth structure, but not involving the pulp" [51]
- Complicated crown fracture "A fracture involving enamel, dentin, and cementum with loss of tooth structure, and involving the pulp" [51]
- Root fracture "A fracture involving cementum, dentin, and the pulp. Root fractures can be further classified by whether the coronal fragment is displaced"[51]

(2) Injuries to periodontal tissues are divided into the following categories: [51]

- Concussion “An injury to the tooth-supporting structures without increased mobility or displacement of the tooth, but with pain to percussion” [51]
- Subluxation “An injury to the tooth supporting structures with increased mobility, but without displacement of the tooth. In acute trauma, bleeding from the gingival sulcus confirms the diagnosis” [51]
- Extrusion “Partial displacement of the tooth out of its alveolar socket; An injury to the tooth characterized by partial or total separation of the periodontal ligament resulting in loosening and displacement of the tooth. The alveolar socket bone is intact in an extrusion injury as opposed to a lateral luxation injury. Apart from axial displacement, the tooth will usually have an element of protusion or retrusion. In severe extrusion injuries the retrusion/protrusion element can be very pronounced. In some cases it can be more pronounced than the extrusive element” [51]
- Lateral luxation “Displacement of the tooth other than axially Displacement accompanied by comminution or fracture of either the labial or the palatal/lingual alveolar bone” [51]
- Lateral luxation injuries “similar to extrusion injuries, are characterized by partial or total separation of the periodontal ligament. However, lateral luxations are complicated by a fracture of either the labial or the palatal alveolar bone and a compression zone in the cervical and sometimes the apical area. If both sides of the alveolar socket have been fractured, the injury should be classified as an alveolar fracture (alveolar fractures rarely affect only a single tooth). In most cases of lateral luxation the apex of the tooth has been forced into the bone by the displacement, and the tooth is frequently non-mobile” [51]

- Intrusion “Displacement of the tooth *into* the alveolar bone. This injury is accompanied by a comminution or fracture of the alveolar socket” [51]
- Avulsion “Complete displacement of the tooth out of its socket” [51]

As because of the inherent nature of dental trauma in that it is unpredictable, it is subsequently difficult to correctly verify the prognosis of injuries. Due to the differences in the circumstances causing the injury, the successes of the treatments are varied. The success rate of a given treatment has an obvious and poses various implications on the quality of life. A need for epidemiological studies is recognized as these studies take into account large data sets that may hence adequately consequences after trauma.

Treatment plans of some dental trauma injuries lead to more favorable results, compared to other treatment plans. Through using repair or regeneration, the main purpose of treatment is to manage damaged pulp or periapical tissue. The successes and the results of treatment depend on the extent to which the vitality of pulp is maintained, albeit it in the presence of various hindrances that limit pulp recovery and cause complications- such as a reduced vascular supply (ischaemia), the loss of tooth substance and the presence of bacteria. It has been estimated that, dependent on the type of dental injuries, 26-76% of injuries result in permanent loss of dental hard tissue [49,52]. Beside the loss of a tooth, other complications may include disruptions to aesthetic appearance, teeth misalignment, discoloration, discomfort and difficulty in eating.

The prognosis for TDIs is dependent upon early and correct treatment. Regardless of the injury, the initial objective of a dental practitioner should be to reduce the impact of

the above factors affecting TDIs. In any event, as opposed to pulp without adequate blood supply, a healthy pulp has a better prognosis[52–54] as they are more resistant to bacterial invasion through the dentinal tubules and have more defensive mechanisms, available through the neurovascular supply [53]. This underscores the importance of conservative therapeutic pulp and restorative procedures in dentistry for controlling the entry of a bacterial attack.

Table 3 represents the outcomes of teeth affected by different types of TDIs. The prognosis is worse when concomitant injuries occur on the same teeth. Studies reported success rates should be considered carefully, as there is a wide range of clinical treatment techniques and materials. For example, the choice of medication (corticosteroids pastes, calcium hydroxide, mineral trioxide aggregate or mixtures), root canal therapy after avulsion, bonding technique, or the type and duration of splinting all impact healing. There are also patient factors affecting the success rates such as the time of injury and presentation, the stage of root development, compliance, behavior and previous dental history.

As such, the assessment of prognosis requires individualized based case using literature as a guide evaluation. Although beyond the scope of this discussion, it is important to be aware of the different treatment modalities and to be careful when selecting the right direction for each case.

Injury type		Reference	Prognosis
Injuries to dental hard tissues and pulp			
Enamel infraction	favourable outcomes	Borssen and Holm [29]	PN: 2–5%
	Incidence of pulpal necrosis rare	Wang [55]	PN: 0–3.5%
Enamel dentine fracture	favourable outcomes	Cavelleri and Zerman [56]	PN: 5–15%
	Exposed dentine have a higher tendency to result in pulpal necrosis	Wang *et al*. [55]	PN: up to 13.7%, up to 40% without dentine protection
	Outcome is case sensitive and depends on age, severity and management	Viduskalne and Care [57]	Pulp survival 98%
	Losing pulp sensibility has been observed in 72% cases. Teeth treated with conservative pulp therapy methods have preserved the pulp in 98% of cases		
Complicated crown fracture	Partial pulpotomy has more favourable outcomes compared to direct pulp capping	Borssen and Holm [58]	Conservative pulp therapy without further treatment 75–95%
	Cvek partial pulpotomy has one of the highest success rates	Cvek [59]	Cvek showed 94–96% success rates.
	No other concurrent injuries	Lauridsen *et al*. [60]	In the absence of a concurrent luxational injury, the prognosis of an exposed pulp is good
Crown root fracture	Prognosis is dependent on the level of root fracture	Andreasen *et al*. [61,62]	PN: 20–40%
	Less favourable outcome the more cervical the level of fracture	Welbury *et al*.[63]	PCC: 69–23%
	The likelihood of healing by calcified tissues is poorest in the cervical third	Malhotra[64]	PN = 25%
Injuries to the periodontal tissues			
Concussion	Low risk of complications. If occurred, mainly in teeth with completed root development	Andreasen and Pedersen [65], Andreasen [66]	PN = 3%, RR = 5%, PCC=5%, TAB = 1.5% (permanent dentition)
Subluxation	Low risk of complications. If occurred, mainly in teeth with completed root development	Andreasen and Pedersen [65], Andreasen [67]	PN = 6%, RR = 2%, PCC = 10–26%, TAB = 1.5% (permanent dentition)
Extrusive luxation	Moderate risk of complications	Andreasen and Pedersen [65], Andreasen [67]	PN = 26%, RR = 9%, IR = 9%, PCC=26–45% (permanent dentition)
		Lee, Barrett and Kenny [68]	PN = 43% (permanent incisors)
		Andreasen [66]	TAB - 11.3%
Lateral luxation	Relatively high risk of complications	Andreasen and Pedersen [65]	PN = 58%, RR = 27%, IR =3% PCC = 28% (permanent dentition)
		Nikoui, Kenny and Barrett [68]	PN = 40%, PCC = 40% (permanent incisors)
		Andreasen [66]	TAB = 12.3%

Intrusive luxation	Intrusive luxation is the most serious type of luxation injury	Andreasen and Pedersen [65], Andreasen [67]	PN = 85%, RR= 66%, IR = 38%, PCC = 4–10%, TAB = 0%, ANK= 24%
	Risk of multiple/concurrent complications high	Wang [55]	Almost all intruded incisors developed PN ~100% (developed roots)
	Prognosis also depends on age and degree of intrusion. Prognosis improves with root immaturity	Humphrey, Kenny and Barrett [69]	Significantly decreased pulp survival if intruded over 6mm. PN ~45%
	Pulp necrosis is inevitable in permanent teeth. Objective is to reduce inflammatory resorption	Trope [70]	PN ~ 100% (Permanent mature teeth)
	Revascularization may be possible in immature teeth with open apex	Andreasen *et al*. [71] Trope [70]	
	The success rates (clinical outcomes other than pulpal necrosis) of replanted teeth acheiving varying degrees of root development of immature teeth is less than 50%	Andreasen *et al*. [71] Trope [70]	Success rates of replanted immature teeth ranged from as low as 4% to as high as 50%
Avulsion	Inflammatory resorption following avulsion is very common regardless of appropriate treatment	Kinirons [72]	Replanted with no contamination IR~57% Replanted after washing contamination IR~87.5% Replanted with contamination IR~100% *Median dry time was 15 minutes, patient age 7–18 years
	Post replantation root resorption (inflammatory/replacement) is very high	Kinirons [72] Andreasen *et al*. [71]Trope [70] Donaldson and Kirnirons [73] Gonda *et al*. [74]	RR ranges from 59–80%

Key: PN = pulp necrosis; PCC = pulp canal calcification; TAB = transient apical breakdown; RR = root resoprtion; IR = inflammatory resorption; ANK = ankylosis.

Table 3. Prognosis and outcomes of traumatic dental injuries adapted from R.Lam 2016 [17]

Fractures in dental hard tissues that are confined to enamel and dentine present pathways for the entrance of bacteria that would potentially result in pulpitis. Despite the fact that pulp necrosis is rare among uncomplicated crown fractures, Wang *et al*.

reported that injuries to dentin without coverage increased the chance of necrosis of the pulp almost three times compared to teeth with exposed dentine receiving coverage[55]. In their retrospective study, Kowash *et al* (1999) found that 9% of permanent incisors with uncomplicated crown fractures and those which were left uncovered developed pulp necrosis and were eventually extracted[75]. Conservative therapies to the pulp are advantageous in dealing with complicated fractures with and exposed pulp. *Cvek's techniques,*[57] "partial pulpotomy" presents the highest rates of success and has proven to be the most successful in preserving the sensitivity of the pulp and its function[59].

Although there is an increased risk of necrosis, maintaining the vitality of the cells in root fractures is favorable.. The ability to uphold a viable and usable vascular supply to the pulp after an injury has great implications on the processes of recovery and. It has been established that pulp necrosis is significantly related to the diameter of the apical foramen. Andreasen and Kahler 2015 showed that a diameter of 1.2 mm had a higher recovery potential compared to a 0.7 mm apical foramen[76]. As such, immature teeth with incompletely developed roots have a higher blood supply to the pulp and correspondingly better prognosis.

Humphrey *et al*.(2003 has reported pulp necrosis in 45% of intruded teeth, which is significantly lower than most other studies (85-100%)[69], The authors of this study reported most of the teeth (58%) had incompletely developed roots [69]. In a sample of older patients with fully developed roots, Andreasen *et al.* reported an 85% rate of pulp necrosis[65]. The prognosis worsens when the TDI entails concurrent injuries on the same tooth and when there is more than one factor in the triad present. For example, it

has been found that there is a higher risk of pulp necrosis in teeth undergoing dislocation and fracture when there is either some damage to the neurovascular supply or an entry of bacteria[77,78]. Root resorption and external inflammation may be the results of external damage to the hard tissues and the existence of bacteria in the root canal system.

As highlighted by Andreasen there is a need for proper management and for a periodic review of TDIs and appropriate treatment [66]. Despite the demonstration of radiographic changes and no response to initial tests of pulp sensibility, in a population of 637 permanent luxated teeth, about 4% of all teeth showed a complete and spontaneous repair within 1 year after trauma; this is described as "transient apical breakdown'[66]. Unless there were other visible symptoms of the condition, Andreasen has argued that invasive treatment is not necessary for all injuries[66]. McCabe and Dummer (year) have approximated that approximately 2-4% of traumatized permanent teeth develop this condition characterized, radiographically, by the loss of pulp space, and clinically, by identifying a light yellow discoloration [79].

After studying luxated teeth for an average of 16 years, Robertson *et al*. 1997, concluded, in his study, that 8.5% of teeth with root canal calcification subsequently became infected [80]. Although there is very little data regarding primary teeth, it has been agreed upon that 10-15% undergo pulp canal calcification[80].

The most severe form of dental trauma is avulsion. Avulsion necessitates and highlights the importance of correct and early treatment. All permanent teeth which undergo avulsion are challenged with pulp necrosis[70]. Revascularization may be possible in immature teeth with incompletely developed roots, but success rates have

been reported to be less than 50% [70,71]. Andreasen *et al.* 1995 estimated that one third of avulsions occur before the age of 9, when the incisors are incompletely developed [71]. Various reports have alluded to the fact that early replantation is essential in order to attain more success [70–72]. Inflammatory resorption and internal damage may be the consequence of the presence of bacteria in the root canal system.

Many dental professionals concur that necrosis of all cells of the periodontal ligament is the result of an extra-oral dry time of 60 minutes, which also results in the replacement with eventual resorption [81,82]. Regardless of the variation in the studies which discuss the duration of extra-oral dry time, many authors regard a 15-minute or less extra-oral dry time as a possibility in reducing resorption [83].

2.4 Consequences of dental trauma

The recommended treatments for TDIs in primary dentition are aimed to decrease the possible negative impacts the TDI has on the primary tooth. Recommended treatments also seek to lessen, as much as possible, any and all developmental disorders in the permanent successor.

With the use of a barrier tissue that is less than 3 mm thick and which is constituted only of only fibrous connective tissue, the permanent tooth germ is disconnected from the region of the primary tooth [84,85].

The replacement of primary teeth which had previously undergone traumatic injuries were found to inhibit Development Sequelae to Permanent teeth (DSP) in 12-53% of cases [86–94]. Various factors such as “age, the time of the accident, the degree of root resorption of primary tooth injured, the type and extent of traumatic injury and the

stage of development of the permanent tooth germ" have an impact on these processes [84–86,88,89];

The DSP usually recorded include: discoloration of enamel, enamel hypoplasia, crown or root dilacerations, odontoma malformation similar to tooth germs, partial or total disruption of root formation [85,86,88,90,92,95,96].

Due to ethical considerations and the unavailability of long-term follow-up, only a few epidemiological studies have focused on the injuries of primary teeth [97]. It is indeed difficult to achieve the objectives of randomised studies of TDIs, and most of the data available are from experimental animal studies which are supported by clinical opinions of specialized and experienced professionals [98].

An initial lack of treatment of an injury could lead to aesthetic and functional implications alongside anxiety and discomfort on the part of the child[99]. The initial lack of treatment may also require possible advanced restoration procedures, which would lead to financial implications affecting the quality of life of the injured [99].

2.4.1 Impact of TDIs on the quality of life QoL

Untreated TDIs in adolescents are associated with reduced Oral Health-Related Quality of life (OHRQoL). Based on the type of Oral Impact on Daily Performance (OIDP), those affected are at greater risk of facing consequences [100,101].

Porret *et al.* 2011 found that it was more likely for girls, as opposed to boys, to report a higher level of impact on their OHRQoL following a traumatic injury of the permanent incisors [102].

2.4.2 Impact of treatment of TDIs on the quality of life QoL

In their study, Antúnez *et al.* 2012 analysed the parents'-caregiver perception questionnaire scores. The results indicated changes in the quality of life after TDIs; the results also indicated that positive changes were witnessed after the treatment of TDIs[103].. This alludes to the constructive results of treatment and represents an overall positive reduction and improvement in quality of life following treatment [103].

2.5 Pathophysiology of dental trauma

2.5.1 Separation injury

A traumatic dental injury has a number of consequences. One of these consequences has a ripple effect in that an acute energy transmission to a tooth and its supporting structures occurs. A fracture of the tooth and/or the displacement of the tooth occurs as a result of this [104,105].

In cases of separation injury (e.g. extrusive dislocation), most of the damage to tissues support is cleaving intracellular structures (collagen and intracellular sub-stance), with limited damage to cells the area affected by the trauma. This implies that the healing of wounds may arise from existing cellular systems with minimal delay [106].

2.5.2 Crushing injury

There are major implications on both cellular and intercellular systems which are sustained by a crushing injury (e.g. lateral dislocation and intrusive luxation). Tissue damaged as result of a crushing injury must be removed by macrophages and/or

osteoclasts before commencing in the restoration of the damaged tissue. The healing process takes longer in this type of injury and this is shown in the suggested period of splinting [106].

2.5.3 Early wound healing events

Immediate events following trauma include bleeding from broken vessels, followed by coagulation[104,105]. Platelets found in clot play an important role, not only in the transformation of fibrinogen to fibrin, but also due to its content of growth factors (for example, platelet-derived growth factor [PDGF] and transforming growth factor [TGF]-P), all of which initiate and are essential in the healing process. Subsequently, there is influx of neutrophils and macrophages leukocyte within the area affected by trauma. The first cell type, neutrophils, deals with the infection, while the second, macrophages, leukocyte, are involved in cleaning zone bodies and reparing damaged foreign tissues[104,105].. These cells are also responsible for helping neutrophilic leukocytes in defence against microbial colonization, and finally, in taking over the role of platelets in the direction of the events of wound healing[104,105].

2.5.4 Delayed wound healing events

Wound healing events include the revascularization of ischemic tissue and new tissue formation, in the case where there is a loss of tissue. Regardless, in both cases, wound healing takes place through a coordinated cell movement in the traumatised area, where

macrophages play the first role involved in the cure,, followed by the role played by endothelial cells and fibroblasts.[106]

2.5.5 Chronology of healing in uncomplicated luxation

Periodontal Ligament (PDL): After 1 week, the new formation of collagen begins to join the PDL staple fibres leading to initial consolidation of a luxated or replanted tooth. After 2 weeks, the repair of the main fibres is so advanced that about two thirds of the mechanical strength of the PDL has been restored [105].

Pulp: In a luxated tooth that experiences a disruption in the vascular supply, an ingrowth of new vessels in the pulp begins four days after injury and continues at a speed of about 0.5 mm per day in open apices teeth. Revascularisation is markedly influenced by the size of the pulp periodontal interface (ie, diameter of the apical foramen) [105]. In teeth with open apices, this is complete and predictable (> 1.0 mm), whereas in teeth with a narrow apical foramen, it is rare (<0.5 mm) [105].

The most significant factor that can stop the revascularisation process seems to be bacteria colonization in the ischemic tissue pulp. The origin of these bacteria may be from an invasion of dentinal tubules through a crown fracture or an invasion along the blood clot in a severed PDL; no matter the cause, the bacteria can find its way to the area through the bloodstream (anachoresis). Therefore, it has been found that the revascularization procedure with endothelial buds is often incontinence, allowing corpuscular elements such as erythrocytes and bacteria, to exit the blood stream [105].

2.5.6 Chronology of healing in complicated luxation

The chronology of healing in the complicated luxations, with crushing or other damage to the PDL, may result in root resorption. These processes take place because of two reasons: a no longer existing protective layer of cementoblasts and the existence of epithelial rests of Malassez along the root surface, which are the result of a traumatic event. Osteoclasts and macrophages are free to remove damaged PDL once these cells disappear. Other events are subsequently determined by three factors:

• The possible exposure of dentinal tubules.

• If pulp content is sterile or ischaemic, necrotic and infected.

• If there is a presence of adjacent vital cementoblasts.

The negative combination of these three factors can lead to healing complications. (105,107,108)

2.5.7 Repair-related resorption (surface resorption)

A saucer-shaped cavity on the surface of the root is a product of the process whereby the damaged layer of PDL is nearest to cementum. If this cavity is not in contact with the dentinal tubules and the adjacent cementoblast is intact, this resorption cavity is repaired by new cement and by inserting new Sharpey fibres. The PDL width is normal and follows the contours of the defect (107,108).

2.5.8 Infection-related resorption (inflammatory resorption)

In the event that the initial resorption penetrates the cement and exposed dentinal tubules, bacterial toxins present in the dentinal tubules and/or the infected root canal can spread through the tubules exposed to the PDL. This results in a further process of

osteoclasts and an associated PDL inflammation. This subsequently leads to resorption of the lamina dura and the adjacent bone, together with the tooth structure. This process is usually progressive until the root canal is exposed. If the bacteria in the root canal and/or dentinal tubules are removed by appropriate endodontic treatment, the resorption process will be stopped. The resorption cavity then is filled with bone or cement, dependent on the type of living tissue adjacent to the site of resorption (PDL or bone marrow-derived tissue) [107,108]

2.5.9 Ankylosis-related resorption (replacement resorption)

In cases of extensive damage to the deepest layer of the PDL, healing events will be held from the socket wall (creating bone through cells derived from bone marrow) and the PDL healing (producing cementum and Sharpey fibres) will be carried out simultaneously [107,108].

With cases of moderate injury (1-4 mm^2) an initial ankylosis forms. If functional mobility by using a semi-rigid or no splint (transient ankylosis) is allowed, the ankylosis can later can be replaced with new cement and PDL. This opens the door for initial resorption at the ankylosis site [107].

In larger injuries, (>4 mm^2) transient or progressive ankylosis takes place. This leads to the tooth becoming an essential part of the system of bone remodeling. The whole process is influenced by the osteoclastic resorption of the bone remodelling processes, the parathyroid hormone-induced resorption, and lastly, resorption because of bacteria in the gingival area and/or the root canal. All these processes are very active in children and lead to gradual development infraocclusion and disruption of the alveolar process. In children, this combination of the different processes of resorpton leads to loss of

teeth within 1-5 years. In older children, replacement resorption is considerably slower and often permits the tooth to operate for periods of time (e.g. 5-20 years) longer [106].

2.5.10 Transient marginal and apical breakdown of bone

In situations where compression of the PDL has occurred (e.g. the lateral luxation and intrusion), macrophages/osteoclasts removes traumatized tissue before periodontal healing, which often results in a transient marginal breakdown manifesting by gingival granulation tissue formation at the compression site, and radiographic transient breakdown of the lamina dura at the involved site. The periodontum will reform following about 2-3 months. Similarly, in the apical region, a transient apical breakdown can occur in closed apices teeth in cases where pulp healing occurs after luxations (e.g. extrusion, lateral luxation). In these cases a transient radiographic radiolucency is seen as a response to the ingrowth of new tissue in the pulp canal [107,108].

2.5.11 Permanent marginal breakdown of bone

The reasons behind permanent marginal breakdown are similar to those described for transient marginal breakdown. However, probably due to infection or the extent of initial damage, healing does not take place. In some cases the bone sequestration could occur. Permanent marginal breakdown can be seen after lateral luxation, avulsion, intrusion, alveolar bone fracture and jaw fractures [106].

2.5.12 Effect of tooth repositioning

Depending on the force needed to reposition a displaced tooth, major or minor additional trauma will be transmitted to the periodontlum and the pulp. The negative

effect of this should measured and evaluated alongside the positive effects effects of would healing with approximation of wound surfaces [106].

2.5.12.a Effects of repositioning upon periodontal wound healing

Incomplete - unlike complete, incomplete repositioning leads to a slight delay (about 2 weeks) in wound healing [105,107,108]. Yet, the final result for the PDL is the same. If a portion of the root surface is exposed to saliva (e.g. Extrusive luxation), an attachment loss in that specific region will occur unless complete repositioning is achieved [106].

In lateral luxation, the repositioning value is not identified (especially in those cases where it would need strong repositioning, and spontaneous setting. Occlusal and/or aesthetic demands, however, usually need immediate repositioning, even in these cases [106].

After the intrusion of permanent teeth, spontaneous re-eruption can only be expected in the teeth with incomplete root formation. In teeth with complete root formation, the repositioning of orthodontics is probably preferable to immediate (surgical) repositioning of the teeth in order to improve the healing of the marginal bone However, there is little definitive information available on this subject [106].

2.5.12.b Effects of repositioning upon pulpal healing

Repositioning leads to faster and predictable optimal pulp revascularisation. If root formation is not complete, there is a good chance of survival of the epithelial root sheath and thus an excellent chance for continuous growth of the roots.

In the root fractures, it seems ideal to reposition the healing between fragment with hard tissue (dentin and cementum), and by doing so thus reducing the chance of necrosis of the pulp [109].

2.5.13 Effect of splinting

2.5.13.a Effect of splinting on PDL healing.

With an uncomplicated breakdown of the PDL (e.g. extrusive luxation), rigid splints do not encourage healing. Flexible splint is currently believed to help promote periodontal healing, probably due to the more ideal circulatory conditions in the PDL, but this outcome has not been absolutely proven. In situations with huge cell death of the PDL (e.g. avulsions), apparently rigid splints seem to lead to prolonged preservation of ankylosis sites initially formed along the root surface. In these cases, the short rigid splinting term (e.g. 1-2 weeks to allow initial endodontic treatment) seems to be the treatment of choice [106].

2.5.13.a Effect of splining on pulpal healing.

Due to the fact that rigid splint seems to slow down pulp revascularization [105] , no-splint or flexible splinting is the preferred treatment of choice [106].

2.5.14 Effect of antibiotics upon PDL and pulpal healing

2.5.14.a Effect on PDL

In experimental conditions, antibiotics administered topically for 5 minutes before the replantation of teeth in monkeys has been found to reduce the amount of external root

resorption [110–113]. This is most likely the case due to the death of bacteria on the surface of the root- bacteria which otherwise must be eliminated by an inflammatory response, thus, leading to osteoclastic attack on root the surface.

2.5.14.b. Effect on pulp

The outcome of antibiotics on pulp healing is yet to be determined. The administration of systemic antibiotics after luxations, fractures and alveolar root fractures has not been found to improve the healing of the pulp in the clinical studies [114]; nor could it be of any influence experimentally after the replantation of the extracted teeth of monkey [111]. However, experimental studies in monkeys have shown that topical application of 5 minutes of antibiotics (doxycycline, 1 mg of 20ml physiological saline) opened the door for revascularization, after the replantation of teeth extracted displaying immature root development [110–115].

2.6 Treatment priorities

It has been commonly thought that all injuries should be treated on an emergency basis. This was the case in order that the patient is in comfort and in order to also decrease the complications of wound healing. For better utilization of resources, there are various priorities allocated to several kinds of injuries.

a) Acute priority for those injuries that would benefit from treatment within a few hours;

b) Sub-acute priority for those injuries where treatment delays of up to 24 hours are not likely to affect the results of healing;

c) Delayed priority for injuries which treatment delays over 24 hours would be acceptable.

The above sorting into the three groups is based on a recent study of the effects of delayed treatment in the several entities of trauma [116].

2.6.1 Acute treatment priority

2.6.1.a Tooth avulsion

A strong relationship was found between the healing outcome and the storage condition and the storage time. If the tooth is not already replanted, tooth avulsion should be considered a form of acute trauma.

2.6.1.b Alveolar fracture

In a clinical study by Anderesen 1970, a significant association was found between the presence of necrosis of the pulp if treatment was delayed for more than 3 hours [117]. It has been recommended to immediately reposition and splint to relieve pain and discomfort due to the occlusal interference.

2.6.1.c Extrusion, lateral luxation and root fracture

Currently there are only few studies that have analyzed the effect of delaying treatment on pulp healing after instances of root fractures and luxations. A study of luxated teeth had demonstrated a significant difference in healing after delay of treatment of 5 hours.

Other studies showed a difference between treatment delays for more than 33 hours [116].

A later study conducted in 2004 which assessed 400 fractures of the root did not confirm an effect of early treatment [109]. Until any new study shows otherwise, these traumas should be considered as acute treatment in order to hence relieve pain that is caused by occlusal interference.

2.6.2 Sub-acute treatment priorities

2.6.2.a Intrusion

An experimental study by Andreasen *et al*. 2002, showed nearly the same results of immediate healing through repositioning (surgical) and healing after delayed orthodontic repositioning [116]. Therefore, it appears realistic to use a sub-acute trauma treatment for this approach.

2.6.2.b Concussion, subluxation

An experimental study by Andreasen *et al*. 2002, could not prove an association between immediate treatment and complications of pulp [116]. Therefore classifying this trauma as sub-acute treatment is acceptable.

2.6.2.c Crown fracture with pulp exposure

Clinical studies revealed that crown fractures with pulp exposure have a similar long-term prognosis if treated in acute, sub-acute or late base [116]. Therefore, and due to the discomfort of an exposed pulp, sub-acute treatment is the course of action.

2.6.2.d Primary teeth

Primary teeth can possibly be treated with a sub-acute or delayed strategy. When, however, there is an occlusal interference due to displacement of the teeth, an acute approach treatment must be followed in order to relieve symptoms.

2.6.3 Delayed treatment priority

2.6.3.a Crown fracture without pulp exposure

A clinical study has shown that crown fractures without pulp exposure had similar long-term prognosis if treated in acute, subacute or late treatment approach [(116)].

2.7 International association of dental traumatology IADT guidelines

These guidelines are intended to provide information to health care providers regarding dental injuries. They represent the most recent and up-to-date evidence-based research, literature and professional opinions. As with all guidelines, health care providers should apply clinical judgment depending on the situation present in the traumatic dental injury given. The IADT does not guarantee favourable results following the guidelines, but using the recommended measures can maximize the probabilities of success of such treatment.

The IADT has published its first set of guidelines in 2001, with an update in 2012. The working group comprised of experienced researchers and clinicians of many dental specialties and general medicine. The existing review presents the best evidence that draws upon existing Recommendations when data is not conclusive draws upon he

agreement opinion of the working group, followed by review by members of the IADT Board of Directors.

This latest update of the guidelines includes a review of the existing dental literature using EMBASE, MEDLINE, PubMed and Scopes searches between 1996 -2011, as well as a search for Dental Traumatology 2000 to 2011.

The aim of the guidelines is to deliver information for emergency immediate care of the TDIs. Some of the following treatments may necessitate secondary and tertiary interventions involving experienced specialists in dental trauma.

2.7.1 IADT guidelines: injuries in the primary dentition

There is a close relationship between injured permanent tooth germ and the apex of the root of the primary tooh. There are number of possible complications that may ensure after sever injuries to the primary dentition; some of these complications include: ,alformations of teeth, impacted teeth, and disturbances in permanent teeth However, the most common sequelae after intrusion and avulsion of primary teeth in children at ages 1-3 years is a subsequent yellow-brown or white discoloration of the crown coupled with hypoplasia of the permanent incisors[(118)]. Due to the risk of these consequences, treatment choices should be designed to minimize these risks as well as avoid any further and future damages to the permanent teeth

It is not recommended, therefore, to replant avulsed primary incisors. The choice of treatment is multi-factorial and is affected by a number of things; as as such, all cases do not necessarily follow the same treatment plan: the child's level of maturity and his/her ability to cope with the emergency situation, the time available to shed the

injured tooth of a child, and occlusion are some of the factors that play a role. Repeated episodes of injuries are common in children. Therefore, this must be taken into account if a root canal treatment is planned in a primary teeth. There is no consensus in the literature on the best treatment for traumatised primary teeth.

The absence of dental care may lead to more pain and discomfort on the part of the child. Due to this, Children that sustain dental injuries are not always brought in for treatment immediately. There are varying views towards the proper way to treat traumatised teeth; some dental health professionals support dental extraction while others highlight the importance of a more conservative method that entails possibly saving the primary teeth. The traumatic pulp exposure of primary incisors are rare but can be treated with partial pulpotomy or pulpectomy with zinc oxide eugenol. In some certain countries, calcium hydroxide/iodoform paste is suggested[(118)].

Extraction is the better option if you cannot gain the cooperation of the child.. It has been shown that most luxations heal spontaneously. Both the skills and experience with paediatric patients in the clinical setting is essential for the effective management of the child and by the dentist in emergency situation. After an accurate diagnosis and explanation of various treatment options, clinician and the caregivers must decide the treatment plan for the child own benefit .

A summary of IADT guidelines of injuries in the primary dentition is presented in Appendix II [(118)]

2.7.2 IADT guidelines: fractures and luxations of permanent dentition

2.7.2.a Splinting type and duration

The available evidence supports short-term, non-rigid splints, to splint luxated, avulsed, and fractured teeth roots. It is considered the best option to keep the tooth placed in the right position, regardless of the fact that neither the particular type of splint nor duration of splinting for root fracture and luxated teeth are significantly related to the result of healing [109,119].

2.7.2.b The use of antibiotics

Alongside the fact that there is no evidence to prove that antibiotic coverage improves results for root-fractured teeth, there is also insufficient evidence regarding the use of antibiotics in the management of luxations. Because TDIs sometimes occur with the existence of soft tissue injuries that may need later surgery, the use of antibiotics remains at the discretion of the physician. Moreover, the patient's medical condition can justify antibiotic coverage [109,120].

2.7.2.c Sensibility tests

Measuring the extent to which the pulp is sensitive (through cold and/or electric pulp tester) is seen as an attempt to try to determine the status of the pulp. At the time of the injury, sensibility tests often give no response; this represents a lack of transient response of the pulp. Thus, at least two signs and symptoms are necessary to make the

diagnosis of pulp necrosis. Furthermore, regular monitoring of the area is a must in diagnosing the status of the pulp [4].

2.7.2.d Immature versus mature permanent teeth

The main factor that plays a role in ensuring the preservation of pulp vitality in permanent teeth is the continuous development of roots. Most of the traumatic injuries that take place in children and adolescents, and those which involve the loss of a tooth, have obvious life-long consequences. Following root fractures, luxation and pulp exposure, immature permanent in fact have considerable capacities for healing. Pulp therapies have been found, in cases of exposures following TDI, to uphold pulp tissue and to assist in the development of the root [121–124]. Within the canals of the necrotic immature pulp of permanent teeth, new therapies have revealed the capability to revascularise/regenerate tissue [125–130]. The teeth often get combination of several injuries. Studies have shown that the teeth with crown fracture, with/or without pulpal exposure and accompanied by luxation injury, are associated with pulp necrosis [78]. Preventive pulpectomy is responsive and sought after in cases where pulp necrosis is probable after severe traumatisation of a mature permanent tooth.

2.7.2.e Pulp canal obliteration

Pulp canal obliteration (PCO) takes place most often in teeth with open apices that were previously affected by a severe luxation injury. Generally, PCO indicates ongoing pulpal vitality. There are high rates of PCO in cases of extrusion, intrusion, and lateral

luxation; it is also a common after-effect of a tooth fracture[131,132]. Despite occurring less frequently, subluxation and crown fractured tooth may also express PCO [77].

A summary of IADT guidelines of injuries in the permanent dentition is presented in Appendix III.

2.7.3 IADT guidelines: avulsion of permanent teeth

Actions and responses that take place following the accident great affect the prognosis for avulsed permanent teeth. Therefore, it is public awareness regarding correct first aid treatment and initial responses to dental avulsion is highly recommended and without a doubt necessary. Various factors influece by energy of the PDL and its root maturity affect the methods of treatment and the prognosis of dental avulsion.

2.7.3.a First aid for avulsed teeth at the place of accident

Dentists should always be receptive to questions concerning first aid management of avulsed teeth. Healthcare professionals, caretakers and teachers must all be educated on how to act following such injuries; this should be done by and through public awareness campaigns such as, media campaigns. Moreover, first responders in emergencies, such as those answering hospital telephone lines, should be adequately equipped with dental knowledge such that they should be able to give instructions on the phone to people at the scene of the emergency. Immediate replantation is the best treatment for this injury; primary teeth must not be replanted, as shown in figure 1 [(133)].

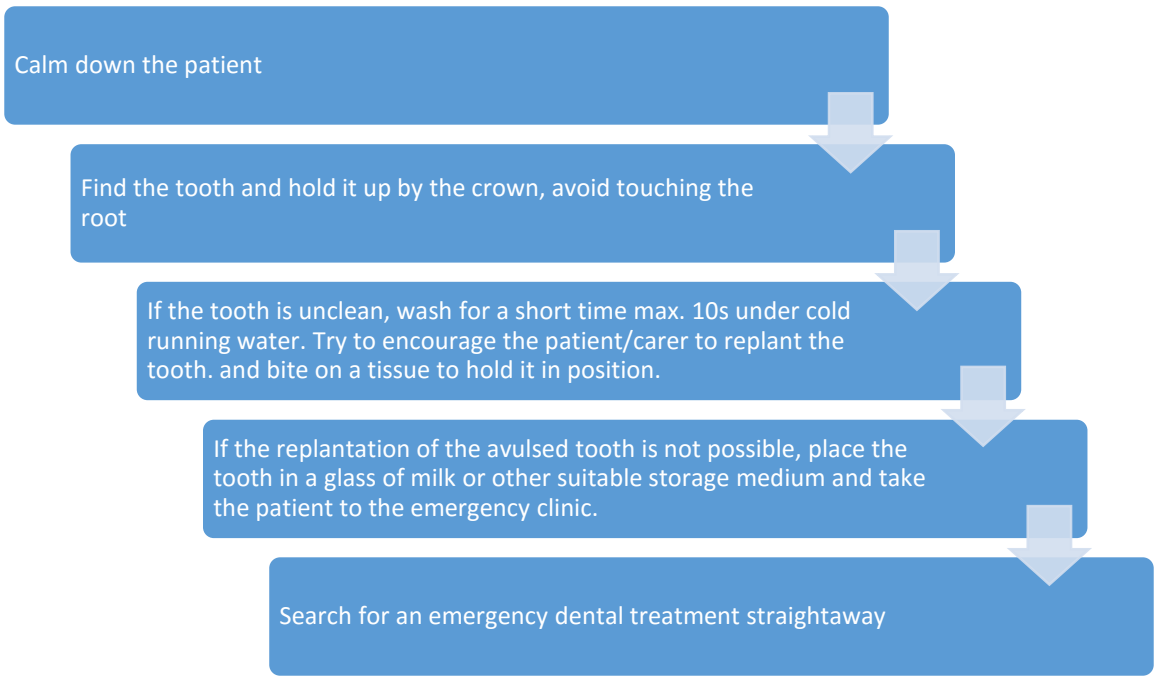

Figure 1. Flow chart of the first aid management of an avulsed permanent tooth

2.7.3.b Treatment guidelines for avulsed permanent teeth

The decision of treatment depends two things: the maturity of the root, and the status of periodontal ligament cells. The storage medium and the time out of the mouth determines the status of the cells, If the dry time of the avulsed tooth is 60 min or more, all PDL cells are thought to be nonviable. Thus, the dry time of the tooth, before implantation or if placed in a storage medium, is very significant to assess from the patient's history.

From a clinical point of view, it is essential to assess the approximate clinical state of the cells by classifying the avulsed tooth in one of the following three groups:

- "The PDL cells are most likely viable, the tooth has been replanted immediately or after a very short time at the place of accident"[133]
- "The PDL cells may be viable, but compromised. The tooth has been kept in a storage medium" [133]
- "The PDL cells are not viable, when trauma history tells us that the total extra-oral dry time has been >60 min, regardless of whether the tooth was stored in a medium or not, or if the storage medium was not physiological" [133]

Storage media for the cells consist of physiological tissue culture medium and cellular transport media. Examples of balanced osmolality media are: Hanks Balanced, Saline Solution (HBSS), normal saline, milk. Saliva may also be used [133].

Delayed replantation should be avoid as it has a poor long-term prognosis. The PDL will be necrotic and it is not expected to heal. Although the objectives of delayed replantation are the same as immediate replantation: to restore aesthetics, function, for psychological reasons and to maintain the contour of the alveolar bone, the likely outcome of a delayed replantation is ankylosis, root resorption and tooth loss [133].

In case of, In order to temporarily inhibit the ankylosis of the tooth in cases of open apices when dry time >60min, it has been suggested that the root surface should be treated with fluoride prior to replantation (2% sodium fluoride solution for 20 min) [133].

After a delayed replantation, Ankylosis cannot be avoided and should be accompanied by infra-position, in both children and adolescents alike. Close monitoring and good communication is necessary for the patient and care-giver, in order to be aware of likely outcomes. Decoronation may be necessary with infra-position (>1mm) [133].

Treatment guidelines for avulsed permanent teeth with open and closed apex are presented in Appendix IV.

2.7.3.c Follow-up

As previously mentioned, ankylosis is often associated with infra-position. It is necessary that the patient and the care-giver discuss possible outcomes of this with the clinician. Close and careful monitoring of the patient is required, too. Decoronation may be necessary later when infra-position is > 1 mm [(133)].

2.7.3.d Anaesthetics

Patients and caregivers are recommended to perform an implantation of the tooth right after the accident and, obviously as there is no access to this immediately following an accident, without anaesthesia. In the clinic, when local anaesthetics is available, and as there are often concomitant injuries, there is no need to avoid using the local anaesthesia. The concern raised is that there is risk of compromising the healing by way of the vasoconstrictor in the local anaesthesia. The evidence is weak to avoid the presence of a vasoconstrictor in the oral and maxillofacial region. However, before any suggestions are given against its use, it must be documented Block anaesthesia (e.g. infraorbital nerve block) can be considered as an alternative to infiltration anaesthesia in the areas most seriously injured [(201)].

2.7.3.e Antibiotics

The extent to which the systemic administration of antibiotics is effective remains to be unknown. Experimental studies have, however, generally shown that when antibiotics are administered topically, there are positive effects on periodontal healing and pulp. This is the reason why antibiotics are recommended in most situations following teeth replantation. Holding that the risk of discoloration of permanent teeth must be considered, tetracycline is the first choice during the first week following replantation. Tetracycline is seen to occasionally cause coloration; therefore, patients below 12 years of age are not recommended to take it. A phenoxymethyl penicillin (Pen V) or amoxicillin, at the first week, can be prescribed as alternative to tetracycline.

Experimental studies have show that in increasing the chances for topical pulp revascularization and periodontal healing, antibiotics (minocycline or doxycycline, 1 mg per 20 ml of saline for 5 minutes at low temperature) are favourable [(201).]

2.7.3.f Tetanus

Patients should be referred to a physician who can assess the necessity for a tetanus booster based on whether or not the avulsed tooth has contacted the dirt or if the tetanus coverage was uncertain.[(133)]

2.7.3.g Patient instructions

Patients should comply with follow-up appointments and should effectively use home-care enhancement methods and techniques of healing following any injury. Both patients and their care-givers should be adequately aware of thow to effectively care

for the replanted tooth in order to foster ideal healing and to avoid any additional injury [133]. The following instructions should be given to patient and carer:

- Follow a soft diet for up to 2 weeks
- Avoid participating in contact sports
- Brush teeth with a soft toothbrush after every meal
- Use a mouthwash of chlorhexidine (0.1%) twice a day for 1 week

2.7.3.h Endodontic considerations

Seven to ten days prior to replantation is the best time to start root canal therapy, if previously indicated, with calcium hydroxide as an intra-canal medication for up to 1 month followed by a root canal filling. If the patient is instead using an antibiotic corticosteroid paste is used as an anti-inflammatory the use of it can commence shortly after replantation and for at least 2 weeks. Using the paste should follow caution and care as not to apply paste to the root canal and to avoid touching the walls of the pulp chamber as there is a risk of tooth discoloration.

In case of >60 min dry time before replantation, root canal treatment can be initiated extra-orally before replantation [133].

The revascularization of the pulp is most likely in cases where teeth with open apices have been replanted straightaway or stored in a suitable storage media before replantation. The risk of infection-related root resorption should be assessed in contrast to the chances of pulp revascularization. Such resorption is fast in the teeth of young

children. Root canal therapy in the immature teeth should be avoided unless there is clinical or radiologic indication of pulp necrosis [133].

2.7.3.i Follow-up procedures

Replanted teeth must be followed up by clinical check-ups and radiographs at 4 weeks, 3 months, 6 months, one year and annually thereafter. The clinical and radiographic investigations will provide information to decide the outcome of replantation and its success [133].

The infra-position of the tooth is very likely to lead to disturbances in alveolar growth as well as facial growth over the short, medium and long-term- this would be the case with the commencement of ankylosis.

In cases were teeth are lost, whether in the emergency phase or later during the trauma, other dental specialities should be consulted for assistance. It is preferable that these discussions are done before the tooth shows any signs of infra-position. Decisions of treatment should be based on discussion with children as well as their care-givers and can include decoronation, autologous transplant, resin retained bridge, dentures, orthodontic space closure with composite modification and osteotomy. Furthermore, implant treatments after the completion of growth may also be considered [133]. Treatment possibilities should be kept open until maturity

2.7.3.j Splinting

It is often considered best practice to position the tooth back in the socket, all the while offering patient comfort and support. It is important to note, however, that there is so far no specific kind of splint linked to healing results Available evidence supports short-term, flexible splinting of the teeth replanted. When there is opportunity for minor movement of the replanted tooth, studies have found that periodontal and pulpal healing is stimulated. In order to allow access for endodontic procedures and also to avoid occlusal interference, the splint must be placed and subsequently positioned on the buccal surfaces of the [(133)]. The IADT recommendations for splinting time and type for various types of injuries is presented in Table 4.

Type of injury	**Splinting time**	**Splinting type**
Subluxation	2 weeks	Flexible splint
Extrusive luxation	2 weeks	Flexible splint
Lateral luxation	4 weeks	Flexible splint
Intrusive luxation	4 weeks	Flexible splint
Root fracture	4 weeks	Flexible splint
Root fracture (cervical 1/3)	4 months	Flexible splint
Avulsion	2 weeks	Flexible splint
Avulsion. Dry time >60 minutes	4 weeks	Flexible splint
Alveolar fracture	4 weeks	No recommendation

Table 4. IADT recommendations for splinting time and type for various types of injurie

2.8 THE AIMS OF THE STUDY

The aims of this UAE study was to:

- To assess the level of General Dental Practitioners' (GDPs) knowledge and application of IADT guidelines to the management of TDIs.

- To compare the GDPs' knowledge with the Paediatric Dentists' (PDs) knowledge.

3.0 MATERIALS AND METHODS

3.1 Study Design and Population

This study is a cross-sectional quantitative study with a descriptive design. Data were collected by means of a questionnaire (Appendix I), which was completed by the general dental practitioners and paediatric dentists working in the United Arab Emirates. Between the period of November 2015 to February 2016, these questionnaires were distributed to dentists' electronic mail as well as in two local conferences.

3.2 Sample Size and data collection procedure

The sample size calculation was based on the proportion of knowledge of the study conducted by Akhlaghi et al. 2014 [134], and using the formula of Cochran's sample size calculation for the cross-sectional design:

$$N = \frac{Z^2_{\frac{\alpha}{2}}\, pq}{B^2}$$

Where

$$B = z_{\alpha/2}\sqrt{\frac{pq}{n}}$$

Where

P = the proportion of knowledge from the referenced study [134].

q = (1-p)

Zα/2 is the quartile of 95%, and

B is the width of the confidence interval of 95% (error)

Using the above formula with error 0.05, the calculation yields 344 participants as an ideal sample size.

4.3 The Questionnaire

The questionnaire, was adopted from a previous study and was validated and tested for reliability [134]. Permission was obtained from the authors to use this questionnaire in this study. The questionnaire was anonymous, neither names nor numbers identifying members were mentioned on the questionnaire sheets. The questions covered aspects of knowledge of TDIs in the primary and permanent dentition (Appendix I).

A total number of 500 questionnaires were distributed; the dentists were contacted to request their participation in this study over a period of four months starting in November 2015. One investigator who participated in the data collection process approached each of the prospective participant's individually, in person or thorough personal e-mail.

A total of 332 questionnaires were received, the response rate of 66% can be considered good for this type of study. However, 36 questionnaires completed by other dental specialists were excluded and hence a total of 296 questionnaires were analysed.

3.3 Eligibility criteria

a. Inclusion criteria:
    - General dental practitioners working in the UAE
    - Paediatric dentists working in the UAE
b. Exclusion criteria:

- Dental professionals working outside the UAE
- Other dental specialities working inside the UAE
- Dental students

3.4 Statistical considerations and data analysis

All data from the completed questionnaires were transferred to a data sheet using Windows Excel 2010 and analysed using computerized Statistical Package for Social Sciences (SPSS, version 20, Chicago, SPSS Inc). Descriptive statistics were performed to identify GDPs' and PDs' knowledge using T-Test and Odd-ratio test. The Kolmogorov–Smirnov test was used to compare the score of GDPs' knowledge and PDs' knowledge. The level of statistical significance was set at $p< 0.05$.

3.5 Ethical Considerations

This study was conducted in full conformance with principles of the "Declaration of Helsinki", Good Clinical Practice (GCP), and within the laws and regulations of the UAE/DHCC. The ethical approval was obtained from the Research and Ethics Committee at Hamdan Bin Mohammad College of Dental Medicine (HBMCDM), Mohammad bin Rashid University of Medicine and Health Sciences MBRU.

A flowchart summarzing the study methodology is presented in Figure. 2

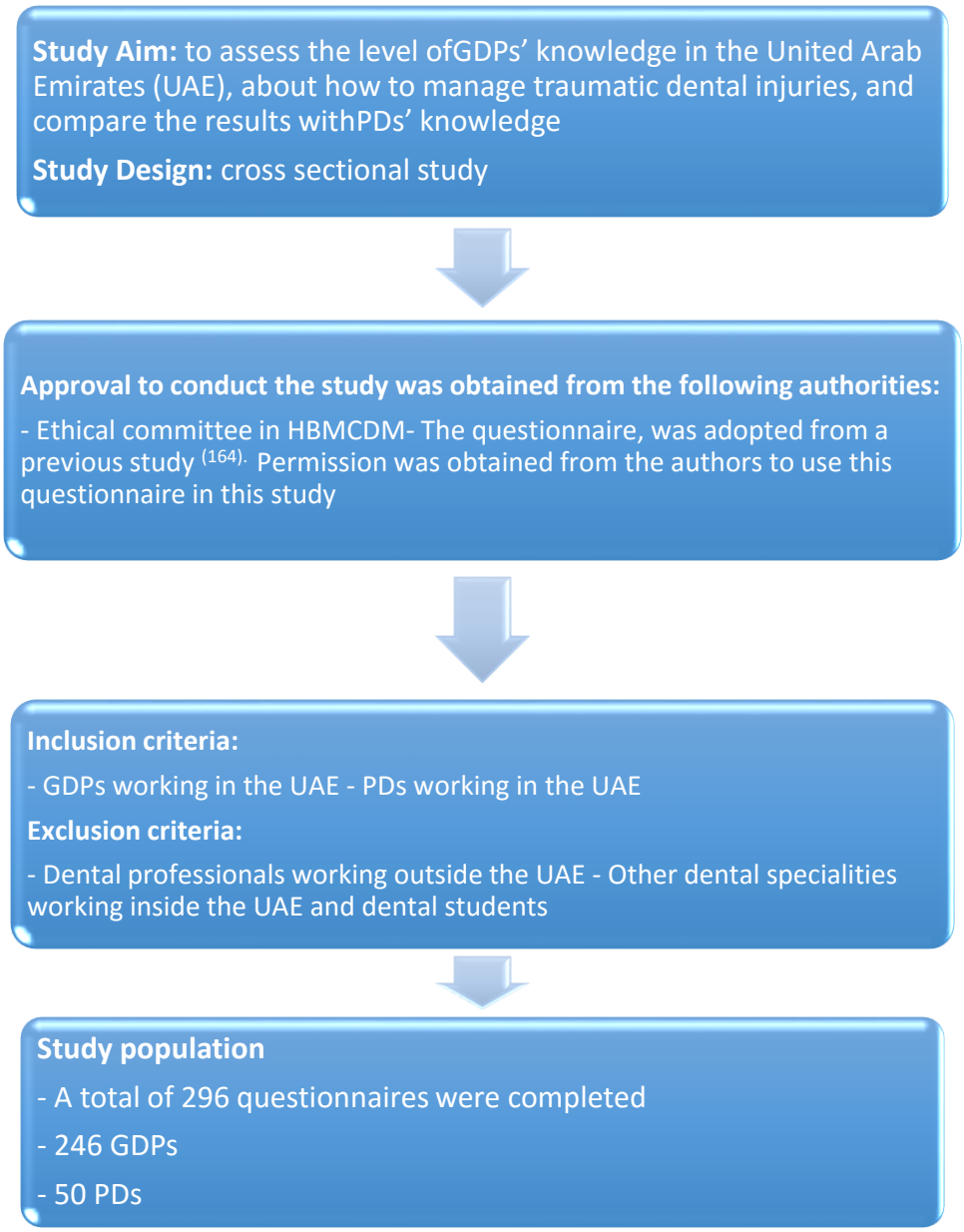

Figure 2. Study methodology summary flowchart.

4.0 RESULTS

A total of 296 dentists completed the questionnaires with data suitable for statistical analysis. The number of GDPs was 246 (83.1%) while the PDs were 50 (16.9%). The results revealed no statistically significant difference between gender, age groups, frequency of patients with dental trauma in the practice, attendance to continuing educational courses of dental trauma or traumatology knowledge. The demographic characteristics and the mean of knowledge of participants in the study population are shown in Table 5. The results showed that the specialty demographic variable was the only variable which had a statistically significant effect on the mean knowledge $p = 0.005$.

Demographic variables	***N (%)***	***Mean knowledge (SD)***	***P- Value***
Gender			
Female	200(68%)	5.04(1.79)	
Male	94(32%)	4.87(1.80)	0.488
Age			
20-29	103(34.8%)	5.11(0.15)	
30-39	118(39.9%)	4.81(0.17)	
40-49	47(15.9%)	5.23(0.29)	0.485
50-59	23(7.8%)	4.96(0.43)	
Specialization			
GDPs	246(83.1%)	4.87(1.82)	0.005
PDs	50(16.9%)	5.56(1.47)	
Frequency of patients with dental trauma in the practice			
Frequent	48(16.7%)	4.92(2.0)	
Occasional	122(42.4%)	5.00(1.71)	0.872
Very rare	118(41%)	5.07(1.76)	
Attendance to continuing educational courses of dental trauma			
No	*122(41.9%)*	*4.96(1.69)*	*0.826*
Yes	*169(58.1%)*	*5.01(1.86)*	

Table 5 the demographic characteristics of the study population

The mean knowledge of the responses to the scenario questions regarding the management of TDIs is shown in Table 6. All the participants correctly responded to the best storage medium of an avulsed tooth scoring (n=296; 100%), followed by questions regarding the immediate treatment of intrusion and extrusion luxation injuries (n=281; 94.9%) for both of them. As for the question regarding the type of medicament which should be used in complicated crown fracture occurring 2 days prior, the score of the correct answer was the lowest in the survey (n=45; 15.2%).

The mean score for the knowledge of correct management of traumatic dental injuries were according to demographic variables as shown in Table 7. This measured was based on question 20 that states, *"What is the management of an avulsed primary incisor in a 4 years old child?"* This question was chosen as a representative for the basic knowledge needed in dealing with TDIs. The overall average of knowledge among participants answering all the questions correctly was 5.54, while the participants missed answering this question scored an average of knowledge of 3.2. Hence, we had used the cut off-point 6 as an indicator, to distinguish between adequate and poor respondents' knowledge.

Overall, the total number of respondents with adequate knowledge was (133; 67.9%). Females who had scored adequate knowledge (96; 48%) were better than males who scored (37; 39.4%) *p* value= 0.103. Dentists aged between 30-39 scored the highest average in adequate knowledge (49; 41.5%) while those aged between 50-59 scored the lowest average of adequate knowledge (10; 43.5%) (*p* value= 0.058). Dentists who had rarely encountered dental trauma cases in their practice demonstrated adequate knowledge (51; 43.2%) versus who saw trauma cases more frequently (22; 45.8%).

While on the other hand, those who attended continuing educational courses in dental trauma had adequate knowledge (80; 47.3%) more than dentists who did not attend the courses (52; 42.6%). Regardless, the difference was not statistically significant (p value= 0.249). The difference of knowledge between GDPs and PDs was statistically significant. PDs scored adequate knowledge were (32; 64%) while GDPs who scored adequate knowledge were (101; 41.1%) (*P* value= 0.002). There was no statistically significant correlation between the genders of the participants, different age groups, frequency of TDIs in the practice, attendance to continuing educational courses of dental trauma and their level of adequate knowledge.

Demographic Variables	Adequate Knowledge	Poor Knowledge	P- Value
Gender			
Female	96(48%)	104(52%)	0.103
Male	37(39.4%)	57(60.6%)	
Age			
20-29	44(42.7%)	59(57.3%)	
30-39	49(41.5%)	69(58.5%)	0.058
40-49	30(63.8%)	17(36.2%)	
50-59	10(43.5%)	13(56.5%)	
Specialization			
GDPs	101(41.1%)	145(58.9%)	0.002
PDs	32(64%)	18(36%)	
Frequency of patients with dental trauma in the practice			
Frequent	22(45.8%)	26(54.2%)	
Occasional	57(46.7%)	65(53.3%)	0.857
Very rare	51(43.2%)	67(56.8.1%)	
Attendance to continuing educational courses of dental trauma			
No	52(42.6%)	70(57.4%)	0.249
Yes	80(47.3%)	89(52.7%)	

Table 7. The percentage of the quality of knowledge of TDIs management according to demographic variables

	P-Value	Odd Ratio	95% C.I.	
			Lower	Upper
Gender	0.214	0.694	0.39	1.234
Age	**0.022**			
Age 20-29	0.782	0.871	0.327	2.32
Age 30-39	0.705	0.828	0.312	2.199
Age 40-49	0.075	2.634	0.907	7.645
Age 50-59				
Specialization	**0.004**	0.339	0.163	0.707
Frequency of patients with dental trauma in the practice	0.381	1.176	0.818	1.689
Attendance to continuing educational courses of dental trauma	0.962	1.013	0.602	1.704
Constant	0.323	2.32		

The filling was significant chi square was 20.037, p-value 0.005. R^2 = 9.3%

Table 8. Logistic regression analyses of the knowledge according to the demographic variables

Table 8 shows that 9.3% of the knowledge explained by age and specialization adjusted over gender, frequency of dental trauma cases and the attendance of the participants to continuing educational courses about dental trauma. In addition, the logistic regression analysis test revealed, knowledge among PDs was 2.95 times more than that among the GDPs (*p* value= 0.004).

Scenario questions	*N (%)*	*Mean (SD)*
Q1.What's the immediate treatment? *Partial pulpotomy*	98(33.1%)	0.69(0.47)
Q2.Which medicament should be used for the above patient? *Calcium hydroxide or MTA*	45(15.2%)	0.85(0.36)
Q3.What's the immediate treatment? *Glass Ionomer or composite restoration*	151(51%)	0.49(0.50)
Q4.What's the immediate treatment? *Immediate repositioning and splint and follow*	262(88.5%)	0.11(0.32)
Q5.What's the best splint duration for the above patient? *3-4 weeks*	145(49%)	0.51(0.50)
Q6.What's the immediate treatment? *Allow for spontaneous eruption of tooth and if no movement occurs in 3 weeks, rapid orthodontic extrusion*	281(94.9%)	0.05(0.22)
Q7.What's the immediate treatment? *Immediate repositioning and splint*	281(94.9%)	0.05(0.22)
Q8.What's the immediate treatment? *Removing necrotic tissue with gauze, RCT, removing the coagulum from socket with saline, immersing in a 25 % sodium fluoride, replant and splint, antibiotic therapy*	246(83.1%)	0.17(0.38)
Q9.What instructions do you give? *Replantation of tooth immediately, and if the replantation procedure cannot be performed at this time, the tooth can be stored in milk and go to the dental office immediately*	296(100%)	0.00(0.00)

Table 6. The most accurate answers along with the mean knowledge of the responses to the scenario questions regarding TDIs management

Q10.The above patient came to your office. What is the next procedure to be done? *Replantation if not performed before and splint*	93(31.4%)	0.69(0.47)
Q11.For the above patient, what's the best splint duration? *7-10 days*	207(69.9%)	0.30(0.46)
Q12.When should an endodontic treatment (RCT) be performed for the above patient? *7-10 days after replantation and before removal of the splint*	190(64.2%)	0.36(0.48)
Q13.What is the management of an avulsed primary incisor in a 4 years old child? *Do not replant*	*78(26.4%)*	*0.74(0.44*

5.0 DISCUSSION

The appropriate management of TDIs, some of which are considered immediate dental emergencies, can reduce stress and anxiety for both patients and dentists [(5)]. Importantly, accurate and immediate post-traumatic management protocols were shown to improve both the short and long-term prognosis of the traumatized tooth [(6)]. The aim of this cross-sectional study was to assess the level of knowledge of GDPs and PDs working in the UAE with regards to the management of TDIs.

The population chosen for this study were GDPs and PDs, since the majority of the registrations of TDIs are usually performed in primary care centres where GDPs are the primary health care professional initially facing the emergency situations [(1–3)]. PDs are strongly linked to the management of TDIs since most of dental trauma cases occur in children. PDs have special skills in properly communicating with the injured child and providing the required care. The key to success when treating children is good mastery of pain control and other pharmacological means of alleviating anxiety. Healing complications such as tooth development disturbances, ankylosis, and tooth loss are challenges that are managed well by PDs.[(135)]

To start with a change, a clear picture of the current situation should be investigated. This study was conducted to estimate dentists' level of knowledge in dental traumatology. No other similar investigation was done in the UAE, and in the greater Middle East in general. Thus, this study is considered an important initial step toward change.

The response rate of this study can be considered good for such an investigation. To examine the knowledge of the professionals is not easily accepted amongst the professionals themselves. The principal reason for the lack of response to the questionnaire may be due because the dental practitioners did not want to have their knowledge tested. Moreover, other reasons for a lack of response might be related to other problems relating to the refusal or delay in replying and difficulty in understanding the questions [136].

Several studies have evaluated dental trauma knowledge among general dentists and reported that the surveyed dental practitioners had insufficient knowledge to manage dental trauma [9–12]. These findings were consistent with the results of our study. However, these studies used different questions to determine the knowledge score. In this study, the level of knowledge of the surveyed participants was found to be insufficient, with an overall mean knowledge score of 4.87±1.82 3for GDPS and 5.56±1.47 for the PDs. This difference in the mean knowledge score was statistically significant (*p* value= of 0.005).

5.1 TDIs management knowledge according to demographic variables

The results have shown that the specialty had a significant effect on the mean knowledge ($p = 0.005$), while there was no statistically significant difference found between traumatology knowledge, gender, age group, the attending of educational courses in dental trauma and the frequency of trauma cases. The results are inconsistent with the study done by Akhlaghi *et al.* (2014) and which was conducted in Tehran, Iran. Akhlaghi *et al.* (2014) found that the frequency of patients in dental practice and the attendance of the participants in educational courses regarding dental traumatology did in fact have statistically significant effect on the participants' knowledge. However, the current study's' data indicated that specialisation in paediatric dentistry is an influencing factor in the knowledge about the emergency management of dental trauma cases. This was consistent with a study done by Kostopoulou and Duggal [10] in UK, who observed that specialization played an influencing role in the knowledge about the emergency management of dental trauma. On the contrary, Hamilton *et al.* [9] found an inverse relationship between the level of knowledge and the age of the dentist; a general conclusion that could be drawn from that study was that the older the practitioner, the lower is the level of knowledge.

5.2 TDI management knowledge according to case scenarios

In the current study only about half of the participants (51%) suggested a restorative treatment in uncomplicated crown fracture in mature teeth. Kostopoulou and Duggal [10] observed that 69% of dentists always provided emergency treatments for uncomplicated crown fractures in the permanent dentition. However, only half of the participants would perform an immediate permanent restoration. This, for Kostopoulou and Duggal indicated insufficient knowledge. Long term clinical studies have shown very little pulpal response to uncomplicated crown fractures [54,137,138], if irritation was eliminated by the restorative procedures, the localized inflammation in the pulp will be resolved [139,140].

In regards to the management of complicated crown fracture in immature teeth in the present study, the participant's demonstrated insufficient knowledge as only (33.1%) answered this issue accurately. Cvek in 1978 found that the outcome of complicated fractures when the pulp is exposed is favorable with conservative pulp therapies, and partial pulpotomy has a high rates of success and is the most successful in preserving the vitality of the pulp [59]. This was consistent with the recommendation of the IADT guidelines[4]

Based on literature on the management of root fracture in mature teeth, the prognosis can be improved with rapid treatment and close adaptation of the root segments [141]. The participants scored 88.5% correct answer, which was a good score. This was consistent with another study done by Gabriel Krastl *et al*. (2009) [16] in Germany, which revealed that almost half of the dentists correctly answered that, in most cases,

only the splinting of the tooth with a fractured root is required. On the other hand, there is evidence that supports short-term splints for the splinting of root-fractured teeth; no specific duration of splinting for root-fractured teeth has been found to be significantly related to healing outcomes[4]. In this study 49% of the participants answered correctly about the duration of splinting of root-fractured teeth. This is accordant with the IADT guidelines despite how sure or unsure it is that the healing outcome is influenced.

A large proportion of the participants showed adequate knowledge regarding the treatment of intrusion and extrusion luxation injuries 94.9%. Andreasen *et al.* (2006) reported that repositioning an intruded immature tooth with either orthodontic or surgical forces can affect the healing outcome of the tooth [142]. In the case of an immature tooth, spontaneous re-eruption should be allowed, and if no movement occurs during a 3 weeks period an intervention should be conducted. In case of extrusion of mature teeth, the IADT guidelines suggested an immediate repositioning of the extruded tooth and splinting it [4].

The most important factor in managing avulsed teeth is time: the extra-alveolar period is considered to be the most critical factor for optimal healing[71,143]. A majority of participants (83.1%) correctly recognized the management of an avulsed tooth with extra-alveolar dry time as >60 min. This response is in accordance with the current guidelines and recommendations suggested by the IADT [4]. On the other hand, the participants showed poor knowledge on the immediate treatment of a recently avulsed mature permanent tooth (31.4%). A confusion in the question might have led to this peculiar irregularity in knowledge between the management of avulsed teeth and the

extra-oral dry time. In another study done by Cohenca *et al.* (2006)[7] it was shown that some confusion exists among study participants regarding the immediate treatment of the avulsed tooth and only <25% correctly recommended replanting the tooth back into its socket as soon as possible.

For the long-term success of a replanted avulsed tooth, the means and method of storage is essentially important [144–146]. Although numerous research has shown that fresh cold milk is superior to saliva in maintaining vitality, most dentists preferred saliva or saline solution to store the tooth in[147], both in vitro and in vivo [148]. In this study, 100% of dentists correctly agreed to store the avulsed tooth in milk instead of water if replantation could not be done at the accident site. Our study was consistent with Hamilton *et al.* [9] who reported in their study that more than 90% of participants suggested milk as the best storage medium for avulsed teeth.

A splinting technique should allow physiologic movement of an avulsed tooth after replantation and during the healing period; this should follow the course of a maximum period of two weeks, and should ideally lead to a decrease in the risk for ankylosis [70,149]. In this study about 70.1% of the participants agreed to splint the avulsed teeth for 7-10 days, this percentage was shown to be higher compared to previous studies that reported only 10-30% of clinicians would splint the tooth for that duration [9,10]. Our results were equivalent with the results of Akhlaghi *et al.* 2014, and both were consistent with the current guidelines and recommendations of the IADT [4]

The IADT guidelines[4] recommends a root canal treatment for an avulsed tooth with completed root development, with the ideal time to start treatment beginning 7-10 days after replantation. This was agreed by 64.2% of the participants in this study. Other

study done by Krastl *et al*. [16] has reported that a majority of their participants agreed that root canal treatment must be performed within 7-14 days for an avulsed permanent tooth. This study shows that the dentists in the UAE have poor knowledge in avoiding the replantation of primary teeth: only 26.4% reported that they would not replant an avulsed deciduous tooth, which is inconsistent with the current guidelines and recommendations of the IADT [4]. Other studies have reported that 83% of dentists were unwilling to replant primary teeth [7,150]

Above all, the results revealed an uneven pattern of knowledge among dentists regarding the emergency management of dental injuries; dental professionals had good knowledge in some parts of dental traumatology while they have poor knowledge in some other areas. Lack of the knowledge of standard guidelines may be one of the reasons. In agreement to the above findings, Yeng *et al*. (2008_ [151], reported a lack of information concerning the level of knowledge to treatment for dental trauma by dental professionals worldwide.

5.3 Study limitations

Although the results of this study may be similar to other studies, there an important limitation to this study was the failure to assess the source of the knowledge of the dental professionals. This would have been useful in standardising the dental professionals' knowledge and ascertaining which guidelines they follow. It would also highlight the need to develop strategies to improve the knowledge base in dental traumatology. Since most of the participants were attending dental conferences, another limitation could be selection bias. Also, ideally we would have liked the sample of PDs

to be the same size of GDPs. However, it is known that there are fewer specialist PDs per paediatric dental population (average 7 per 100000 in the USA (Nainar 2004) compared to GDPs (60 per 100000 persons in the USA[152]). Therefore, our study sample effectively reflected the relative proportions of the said groups in society [152].

6.0 CONCLUSION AND RECOMMENDATIONS

7.1 Conclusions

- The survey demonstrated a generally poor level of knowledge among GDPs, and PDs in the UAE in different scenarios regarding TDIs management.
- In comparison to GDPs, PDs did not demonstrate more knowledge in different TDIs scenarios, despite this topic being a core PD specialist area.

7.2 Recommendations

- Strategies: These results highlighted the need to develop UAE-wide strategies to improve the knowledge base of dental traumatology. UAE-wide strategies are also important in ensuring an adequate treatment for patients with dental injuries. The most effective way of doing this is by establishing links with the Ministry of Health and Community Prevention, local health authorities and private dental surgereons.
- It is necessary to establish the concept of compulsory "Core Continuous Dental Education" to include dental trauma for all registered GDPs across the UAE, alongside other compulsory training courses like Basic Life Support (BLS).
- Courses: As a recommendation, mandatory comprehensive courses are suggested to update the knowledge of both GDPs and PDs about dental trauma management. Courses should include Continuous Medical/Dental Education courses (CM/DE), specialised in dental traumatology conducted biannually.

- Licensing link: We suggest that the responsible authorities in the UAE for annual dental practice licensure renewal require the aforementioned courses.
- In addition, and in agreement with Alkhlaghi *et al*. (2014) [134], we suggest specialised dental trauma emergency clinics in the specialised dental centres to be established in UAE cities with trained staff in dental traumatology.
- We recommend these specialist centres to be linked to GDPs' clinics in the city, which should act as referral centres, with clear referral pathways to follow the treatment process.
- We recommend increasing the awareness of both GDPs and PDs to the availability of online support by using the IADT free website (www.dentaltraumaguide.com).

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8.0 APPENDIX

Appendix I: The questionnaire

Appendix II: IADT guidelines for the management of traumatic injuries in primary dentition

Appendix III: IADT guidelines for the management of fractures and luxation injuries in Permanent dentition

Appendix IV: IADT guidelines for avulsed permanent teeth with closed and open apex

8.1 APPENDIX I

The questionnaire

Dear participant,

This is a questionnaire conducted for our master degree in Paediatric Dentistry Specialty, and will be so helpful to assess the trauma management knowledge among dental professionals.

There are 20 question. Please take your time and answer by yourself what you think is right. We are not going to judge your answers, as this survey is anonymous and confidential.

Please answer Parts I and II of the questionnaire:

Part 1: questions about personal and professional information

1. **Specialization**

( ) General Dental Practitioner

( ) Paediatric dentist

( ) Endodontist

( ) Resident

( ) dental Intern

( ) other specialities (please specify)

2. **Country of Practice**

( ) UAE

( ) Other (please specify)

3. **Gender**

( ) male
( ) female

4. **Age**

( ) 20-29

( ) 30-39

( ) 40-49

( ) 50-59

5. **Frequency of patients with dental trauma in your practice:**

( ) Frequent

( ) occasional

( ) very rare

6. **Attendance of continuing educational courses of dental trauma**:

( ) yes

( ) no

7**. Site of present professional practice:**

( ) personal office

( ) government clinics,

( ) health centres

( ) dental school

( ) other (please specify)

Part 2: Case study. Please read carefully the following seven cases, and tick your best single answer.

Case 1

A 7 years old boy fell down at the school 2 days ago. Clinical and radiographic examination revealed a complicated crown fracture in the permanent upper left central incisor, with an open apex.

Q8. What's the immediate treatment?

( ) Pulp capping

( ) Partial pulpotomy

( ) one visit RCT

Q9. Which medicament should be used for the above patient?

( ) Calcium hydroxide or MTA

( ) Formacresol

( ) Ferric sulfate

( ) Zonalin

( ) Gutta Percha

Case 2

A patient fell down, diagnosed with uncomplicated crown fracture of the two permanent upper incisors, the patient came to your office almost immediately after trauma. There is no luxation injury or root and alveolar bone fracture, radiographic examination revealed a closed apex.

Q10. What's the immediate treatment?

( ) partial pulpotomy

( ) Glass Ionomer or composite restoration

( ) 2weeks follow up and then deciding for final restoration or RCT

Case 3

A 17 years old patient, who was hit with a basketball, had a trauma in two upper permanent incisors. Mobility was more than normal range and teeth were sensitive to percussion test and were dislocated to a palatal direction. A questionable apical third root radiolucent line in these teeth with closed apex was found in the radiograph.

Q11. What's the immediate treatment?

( ) Immediate repositioning and splint and follow

( ) Immediate repositioning, RCT, splint

( ) Immediate repositioning, 2 weeks follow up and then splint if needed

Q12. What's the best splint duration for the above patient?

( ) 1-2 weeks

( ) 3-4 weeks

( ) more than 4 month

( ) I don't know

Case 4

A 7 years old boy came to your clinic due to a traumatic injury of the permanent maxillary left central incisor which was intruded 4 millimetres into the alveolar socket axially. There was no mobility and the percussion sound was dull.

Q13. What's the immediate treatment?

( ) immediate repositioning orthodontically

( ) Allow for spontaneous eruption of tooth and if no movement occurs in 3 weeks, rapid orthodontic extrusion

( ) allow for spontaneous eruption of tooth and if no movement occurs in 3 weeks, surgical extrusion by forceps

Case 5

A 15 years old patient came to your clinic due to a traumatic injury. The maxillary permanent right central incisor was mobile and seemed to be elongated clinically. Radiographic examination revealed widening in the periodontal ligament space.

Q14. What's the immediate treatment?

( ) Immediate repositioning and splint

( ) grinding teeth off from occlusion and splint

( ) allow for spontaneous repositioning

Case 6

A 12 years old patient had an accident. The maxillary central incisors and the left lateral incisor were avulsed and the teeth were found after 7hours at the site of the accident.

Q15. What's the immediate treatment?

( ) Removing necrotic tissue with gauze, RCT, removing the coagulum from socket with saline, immersing in a 25 % sodium fluoride, replant and splint, antibiotic therapy

( ) removing necrotic tissue with gauze, replant and splint, antibiotic therapy

( ) prosthetic replacement

Case 7

An exercise school teacher called your dental office informing you that a 16 years old student had a 'knocked-out' tooth at this exact moment.

Q16. What instructions do you give?

( ) Replantation of tooth immediately, and if the replantation procedure cannot be performed at this time, the tooth can be stored in milk and go to the dental office immediately

( ) Store the tooth in the water and go to the dental office immediately.

Q17. The above patient came to your office. What is the next procedure to be done?

( ) Replantation if not performed before and splint

( ) Thermal test, endodontic treatment, radiographic examination, splint, antibiotic therapy

Q18. For the above patient, what's the best splint duration?

( ) 7-10 days

( ) 2 months

( ) 4 months

Q19. When should an endodontic treatment (RCT) be performed for the above patient?

( ) At the emergency first visit

( ) 7-10 days after replantation and before removal of the splint

( ) After removal of the splint until necrosis was found

Q20. What is the management of an avulsed primary incisor in a 4 years old child?

( ) Do not replant

( ) Replant and splint for 7-10 days

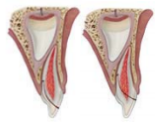
8.2 Appendix II

IADT guidelines for the management of traumatic injuries in primary dentition

				Follow-up Procedures for fractures of teeth and alveolar bone	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:	
ENAMEL FRACTURE	**Clinical findings**	**Radiographic findings**	**Treatment**		**Favorable Outcome**	**Unfavorable Outcome**
	• Fracture involves enamel.	• No radiographic abnormalities	• Smooth sharp edges.			
ENAMEL DENTIN FRACTURE	**Clinical findings**	**Radiographic findings**	**Treatment**		**Favorable Outcome**	**Unfavorable Outcome**
	• Fracture involves enamel and dentin; the pulp is not exposed.	• No radiographic abnormalities The relation between the fracture and the pulp chamber will be disclosed	If possible, seal completely the involved dentin with glass ionomer to prevent microleakage. In case of large lost tooth structure, the tooth can be restored with composite.	3-4 weeks C		

CROWN FRACTURE WITH EXPOSED PULP	**Clinical findings**	**Radiographic findings**	**Treatment**	**Followup**	**Favorable Outcome**	**Unfavorable Outcome**
	• Fracture involves enamel and dentin and the pulp is exposed.	• The stage of root development can be determined from one exposure.	• If possible preserve pulp vitality by partial pulpotomy. Calcium hydroxide is a suitable material for such procedures. A well-condensed layer of pure calcium hydroxide paste can be applied over the pulp, covered with a lining such as reinforced glass ionomer. Restore the tooth with composite. • The treatment is depending on the child´s maturity and ability to cope. Extraction is usually the alternative option.	1 week C 6-8 weeks C+R 1 year C+R	• Continuing root development in immature teeth and a hard tissue barrier.	• Signs of apical periodontitis; no continuing root development in immature teeth. Extraction or root canal treatment

C=Clinical examination; R=Radiographic examination

				Follow-Up Procedures for fractures of teeth and alveolar bone	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:	
CROWN-ROOT FRACTURE	**Clinical findings**	**Radiographic findings**	**Treatment**		**Favorable Outcome**	**Unfavorable Outcome**
	• Fracture involves enamel, dentin and root structure; the pulp may or may not be exposed. • Additional findings may include loose, but still attached, fragments of the tooth. • There is minimal to moderate tooth displacement	• In laterally positioned fractures, the extent in relation to the gingival margin can be seen. One exposure is necessary to disclose multiple fragments	Depending on the clinical findings, two treatment scenarios may be considered: • Fragment removal only. If the fracture involves only a small part of the root and the stable fragment is large enough to allow coronal restoration. • Extraction in all other instances	In cases of fragment removal only: 1 week C 6-8 weeks C+R 1 year C(*)	• Asymptomatic; continuing root development in immature teeth	• Symptomatic; signs of apical periodontitis; no continuing root development in immature teeth.

ROOT FRACTURE	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	•The coronal fragment may be mobile and may be displaced.	• The fracture is usually located mid-root or in the apical third.	•If the coronal fragment is not displaced no treatment is required. •If the coronal fragment is displaced, extract only that fragment. The apical fragment should be left to be resorbed	• **No displacement:** 1 week C, • 6-8 weeks C, • 1 year C+R and C(*) each subsequent year until exfoliation. • **Extraction** 1 year C+R and C(*)each subsequent year until exfoliation.	• Signs of repair between fractured segments. • Continuous resorption of the left apical fragment	None

ALVEOLAR FRACTURE	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	• The fracture involves the alveolar bone and may extend to adjacent bone. • Segment mobility and dislocation are common findings. • Occlusal interference is often noted.	• The horizontal fracture line to the apices of the primary teeth and their permanent successors will be disclosed. • A lateral radiograph may also give information about the relation between the two dentitions and if the segment is displaced in labial direction	• Reposition any displaced segment and then splint. • General anesthesia is often indicated. • Stabilize the segment for 4 weeks. • Monitor teeth in fracture line	1 week C 3-4 weeks S+C+R 6-8 weeks C+R 1 year C+R and C(*) each subsequent year until exfoliation.	• Normal occlusion • No signs of apical periodontitis. • No signs of disturbances in the permanent successors	• Signs of apical periodontitis or external inflammatory root resorption of primary teeth. • Signs of disturbances in the permanent successors require follow-up until full eruption.

S=Splint removal C=Clinical examination; R=Radiographic examination; (C*)=Clinical and radiographic monitoring until eruption of the permanent successor

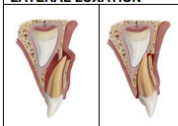
2. Treatment guidelines for luxation injuries

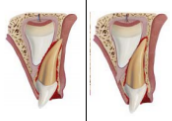
				Follow-Up	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:	
CONCUSSION	**Clinical findings**	**Radiographic findings**	**Treatment**		**Favorable Outcome**	**Unfavorable Outcome**
	• The tooth is tender to touch. It has normal mobility and no sulcular bleeding.	No radiographic abnormalities. Normal periodontal space.	• No treatment is needed. Observation.	1 week C 6-8 weeks C	• Continuing root development in immature teeth	• No continuing root development in immature teeth, periradicular radiolucencies. • Crown dark discoloration. No treatment is needed unless a fistula develops.

SUBLUXATION	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	• The tooth has increased mobility but has not been displaced. • Bleeding from gingival crevice may be noted.	Radiographic abnormalities are usually not found. Normal periodontal space. An occlusal exposure is recommended in order to screen for possible signs of displacement or the presence of a root fracture. The radiograph can furthermore be used as a reference point in case of future complications.	• No treatment is needed. Observation. Brushing with a soft brush and use of chlorhexidine 0.12% alcohol-free topically to the affected area with cotton swabs twice a day for one week.	1 week C 6-8 weeks C Crown discoloration might occur. No treatment is needed unless a fistula develops. Dark discolored teeth should be followed carefully to detect sign of infection as soon as possible	• Continuing root development in immature teeth • Transient red/gray discoloration. A yellow discoloration indicates pulp obliteration and has a good prognosis	• No continuing root development in immature teeth, periradicular radiolucencies. • A dark persisting discoloration indicating pulp necrosis.

EXTRUSIVE LUXATION	**Clinical Findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	• Partial displacement of the tooth out of its socket. • The tooth appears elongated and can be excessively mobile.	Increased periodontal ligament space apically.	• Treatment decisions are based on the degree of displacement, mobility, root formation and the ability of the child to cope with the emergency situation. • For minor extrusion (< 3mm) in an immature developing tooth, careful repositioning or leaving the tooth for spontaneous alignment can be treatment options. • Extraction is the treatment of choice for severe extrusion in a fully formed primary tooth.	1 week C 6-8 weeks C+R 6 months C+R 1 year C+R Discoloration might occur. Dark discolored teeth should be followed carefully to detect sign of infection as soon as possible.	• Continuing root development in immature teeth. • Transient red/gray discoloration. A yellow discoloration indicates pulp obliteration and has a good prognosis.	• No continuing root development in immature teeth, periradicular radiolucencies. • A dark persisting discoloration indicating pulp necrosis.

C=Clinical examination; R=Radiographic examination

				Follow-Up	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:	
LATERAL LUXATION	**Clinical findings**	**Radiographic findings**	**Treatment**		**Favorable Outcome**	**Unfavorable Outcome**
	• The tooth is displaced, usually in a palatal/lingual or labial direction. • It will be immobile.	Increased periodontal ligament space apically is best seen on the occlusal exposure. And an occlusal exposure can sometimes also show the position of the displaced tooth and its relation to the permanent successor	• If there is no occlusal interference, as is often the case in anterior open bite, the tooth is allowed to reposition spontaneously. • If minor occlusal interference, slight grinding is indicated. • When there is more severe occlusal interference, the tooth can be gently repositioned by combined labial and palatal pressure after the use of local anesthesia. • In severe displacement, when the crown is dislocated in a labial direction, extraction is the treatment of choice.	1 week C 2-3 weeks C 6-8 weeks C+R 1 year C+R	• Asymptomatic • Clinical and radiographic signs of normal or healed periodontium. • Transient discoloration might occur	• Symptoms and radiographic sign consistent with periodontitis. • Grey persistent discoloration

INTRUSIVE LUXATION	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	• The tooth is usually displaced through the labial bone plate, or can be impinging upon the succedaneous tooth bud	When the apex is displaced toward or through the labial bone plate, the apical tip can be visualized and appears shorter than its contra lateral. When the apex is displaced towards the permanent tooth germ, the apical tip cannot be visualized and the tooth appears elongated	If the apex is displaced toward or through the labial bone plate, the tooth is left for spontaneous repositioning If the apex is displaced into the developing tooth germ, extract	1 week C 3-4 weeks C + R 6-8 weeks C 6 months C+R • 1 year C+R and (C*)	• Tooth in place or erupting. • No or transient discoloration.	• Tooth locked in place • Radiographic signs of apical periodontitis • Persistent discoloration • Damage to the permanent successor.

C=Clinical examination; R=Radiographic examination; (C*)=Clinical and radiographic monitoring until eruption of the permanent successor

AVULSION	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	The tooth is completely out of the socket	A radiographic examination is essential to ensure that the missing tooth is not intruded.	It is not recommended to replant avulsed primary teeth.	1 week C 6 months C + R • 1 year C + R and (C*)		Damage to the permanent successor.

C=Clinical examination; R=Radiographic examination; (C*)=Clinical and radiographic monitoring until eruption of the permanent successor

8.3 Appendix III

IADT guidelines for the management of fractures and luxation injuries in Permanent dentition

1. Treatment guidelines for fractures of teeth and alveolar bone

				Followup Procedures for fractures of teeth and alveolar bone*	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:	
INFRACTION	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	• An incomplete fracture (crack) of the enamel without loss of tooth structure. • Not tender. If tenderness is observed evaluate the tooth for a possible luxation injury or a root fracture.	• No radiographic abnormalities. • Radiographs recommended: a periapical view. Additional radiographs are indicated if other signs or symptoms are present.	• In case of marked infractions, etching and sealing with resin to prevent discoloration of the infraction lines. Otherwise, no treatment is necessary.	• No follow-up is generally needed for infraction injuries unless they are associated with a luxation injury or other fracture types.	• Asymptomatic • Positive response to pulp testing. • Continuing root development in immature teeth.	• Symptomatic • Negative response to pulp testing. • Signs of apical periodontitis. • No continuing root development in immature teeth. • Endodontic therapy appropriate for stage of root development is indicated.

ENAMEL FRACTURE	**Clinical findings**	**Radiographic findings**	**Treatment**	**Followup**	**Favorable Outcome**	**Unfavorable Outcome**
	• A complete fracture of the enamel. • Loss of enamel. No visible sign of exposed dentin. • Not tender. If tenderness is observed evaluate the tooth for a possible luxation or root fracture injury. • Normal mobility. • Sensibility pulp test usually positive.	• Enamel loss is visible. • Radiographs recommended: periapical, occlusal and eccentric exposures. They are recommended in order to rule out the possible presence of a root fracture or a luxation injury. • Radiograph of lip or cheek to search for tooth fragments or foreign materials.	• If the tooth fragment is available, it can be bonded to the tooth. • Contouring or restoration with composite resin depending on the extent and location of the fracture.	6-8 weeks C** 1 year C**	• Asymptomatic • Positive response to pulp testing. • Continuing root development in immature teeth. • Continue to next evaluation.	• Symptomatic • Negative response to pulp testing. • Signs of apical periodontitis • No continuing root development in immature teeth. • Endodontic therapy appropriate for stage of root development is indicated.

* = for crown fractured teeth with concomitant luxation injury, use the luxation followup schedule.
C** = clinical and radiographic examination.

				Follow-Up Procedures for fractures of teeth and alveolar bone*	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:	
ENAMEL-DENTIN-FRACTURE	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	• A fracture confined to enamel and dentin with loss of tooth structure, but not exposing the pulp. • Percussion test: not tender. If tenderness is observed, evaluate the tooth for possible luxation or root fracture injury. • Normal mobility. • Sensibility pulp test usually positive.	• Enamel-dentin loss is visible. • Radiographs recommended: periapical, occlusal and eccentric exposure to rule out tooth displacement or possible presence of root fracture. • Radiograph of lip or cheek lacerations to search for tooth fragments or foreign materials.	• If a tooth fragment is available, it can be bonded to the tooth. Otherwise perform a provisional treatment by covering the exposed dentin with glass-lonomer or a more permanent restoration using a bonding agent and composite resin, or other accepted dental restorative materials • If the exposed dentin is within 0.5mm of the pulp (pink, no bleeding) place calcium hydroxide base and cover with a material such as a glass ionomer.	6-8 weeks C** 1 year C**	• Asymptomatic • Positive response to pulp testing. • Continuing root development in immature teeth • Continue to next evaluation	• Symptomatic • Negative response to pulp testing. • Signs of apical periodontitis. • No continuing root development in immature teeth. • Endodontic therapy appropriate for stage of root development is indicated.

ENAMEL-DENTIN-PULP FRACTURE	**Clinical findings**	**Radiographic findings**	**Treatment**		**Favorable Outcome**	**Unfavorable Outcome**
	• A fracture involving enamel and dentin with loss of tooth structure and exposure of the pulp. • Normal mobility • Percussion test: not tender. If tenderness is observed, evaluate for possible luxation or root fracture injury. • Exposed pulp sensitive to stimuli.	• Enamel – dentin loss visible. • Radiographs recommended: periapical, occlusal and eccentric exposures, to rule out tooth displacement or possible presence of root fracture. • Radiograph of lip or cheek lacerations to search for tooth fragments or foreign materials.	• In young patients with immature, still developing teeth, it is advantageous to preserve pulp vitality by pulp capping or partial pulpotomy. Also, this treatment is the choice in young patients with completely formed teeth. • Calcium hydroxide is a suitable material to be placed on the pulp wound in such procedures. • In patients **with mature apical development**, root canal treatment is usually the treatment of choice, although pulp capping or partial pulpotomy also may be selected. • If tooth fragment is available, it can be bonded to the tooth. • Future treatment for the fractured crown may be restoration with other accepted dental restorative materials.	6-8 weeks C** 1 year C**	• Asymptomatic. • Positive response to pulp testing. • Continuing root development in immature teeth. • Continue to next evaluation.	• Symptomatic. • Negative response to pulp testing. • Signs of apical periodontitis. • No continuing root development in immature teeth. • Endodontic therapy appropriate for stage of root development is indicated.

* = for crown fractured teeth with concomitant luxation injury, use the luxation followup schedule
C** = clinical and radiographic examination.

				Follow-Up Procedures for fractures of teeth and alveolar bone +	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:	
CROWN-ROOT FRACTURE WITHOUT PULP EXPOSURE	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	• A fracture involving enamel, dentin and cementum with loss of tooth structure, but not exposing the pulp. • Crown fracture extending below gingival margin. • Percussion test: Tender. • Coronal fragment mobile. • Sensibility pulp test usually positive for apical fragment.	• Apical extension of fracture usually not visible. • Radiographs recommended: periapical, occlusal and eccentric exposures. They are recommended in order to detect fracture lines in the root.	**Emergency treatment** • As an emergency treatment a temporary stabilization of the loose segment to adjacent teeth can be performed until a definitive treatment plan is made. **Non-Emergency Treatment Alternatives** **Fragment removal only** • Removal of the coronal crown-root fragment and subsequent restoration of the apical fragment exposed above the gingival level. **Fragment removal and gingivectomy** (sometimes ostectomy) • Removal of the coronal crown-root segment with subsequent endodontic treatment and restoration with a post-retained crown. This procedure should be preceded by a gingivectomy, and sometimes ostectomy with osteoplasty. **Orthodontic extrusion of apical fragment** • Removal of the coronal segment with subsequent endodontic treatment and orthodontic extrusion of the remaining root with sufficient length after extrusion to support a post-retained crown. **Surgical extrusion** • Removal of the mobile fractured fragment with subsequent surgical repositioning of the root in a more coronal position. **Root submergence** • Implant solution is planned. **Extraction** • Extraction with immediate or delayed implant-retained crown restoration or a conventional bridge. Extraction is inevitable in crown-root fractures with a severe apical extension, the extreme being a vertical fracture.	6-8 weeks C++ 1 year C++	• Asymptomatic • Positive response to pulp testing. • Continuing root development in immature teeth • Continue to next evaluation	• Symptomatic • Negative response to pulp testing. • Signs of apical periodontitis. • No continuing root development in immature teeth. • Endodontic therapy appropriate for stage of root development is indicated.

+=for crown fractured teeth with concomitant luxation injury, use the luxation followup schedule.
C++ =clinical and radiographic examination

				Follow-Up Procedures for fractures of teeth and alveolar bone +	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:	
CROWN-ROOT FRACTURE WITH PULP EXPOSURE	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	• A fracture involving enamel, dentin, and cementum and exposing the pulp. • Percussion test: tender. • Coronal fragment mobile.	• Apical extension of fracture usually not visible. • Radiographs recommended: periapical and occlusal exposure.	**Emergency treatment** • As an emergency treatment a temporary stabilization of the loose segment to adjacent teeth. • In patients with open apices, it is advantageous to preserve pulp vitality by a partial pulpotomy. This treatment is also the choice in young patients with completely formed teeth. Calcium hydroxide compounds are suitable pulp capping materials. In patients with mature apical development, root canal treatment can be the treatment of choice. **Non-Emergency Treatment Alternatives** **• Fragment removal and gingivectomy (sometimes ostectomy)** Removal of the coronal fragment with subsequent endodontic treatment and restoration with a post-retained crown. This procedure should be preceded by a gingivectomy and sometimes ostectomy with osteoplasty. This treatment option is only indicated in crown-root fractures with palatal subgingival extension. **• Orthodontic extrusion of apical fragment** Removal of the coronal segment with subsequent endodontic treatment and orthodontic extrusion of the remaining root with sufficient length after extrusion to support a post-retained crown. **• Surgical extrusion** Removal of the mobile fractured fragment with subsequent surgical repositioning of the root in a more coronal position. **•Root submergence** An implant solution is planned, the root fragment may be left in situ. **•Extraction** Extraction with immediate or delayed implant-retained crown restoration or a conventional bridge. Extraction is inevitable in very deep crown-root fractures, the extreme being a vertical fracture	6-8 weeks C++ 1 year C++	• Asymptomatic • Positive response to pulp testing. • Continuing root development in immature teeth • Continue to next evaluation	• Symptomatic • Negative response to pulp testing. • Signs of apical periodontitis. • No continuing root development in immature teeth. • Endodontic therapy appropriate for stage of root development is indicated.

+= for crown fractured teeth with concomitant luxation injury, use the luxation followup schedule
C++ = clinical and radiographic examination;

				Follow-Up Procedures for fractures of teeth and alveolar bone	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:**	
ROOT FRACTURE	**Clinical findings**	**Radiographic findings**	**Treatment**		**Favorable Outcome**	**Unfavorable Outcome**
	•The coronal segment may be mobile and may be displaced. • The tooth may be tender to percussion. • Bleeding from the gingival sulcus may be noted. • Sensibility testing may give negative results initially, indicating transient or permanent neural damage. • Monitoring the status of the pulp is recommended. • Transient crown discoloration (red or grey) may occur.	• The fracture involves the root of the tooth and is in a horizontal or oblique plane. • Fractures that are in the horizontal plane can usually be detected in the regular periapical 90º angle film with the central beam through the tooth. This is usually the case with fractures in the cervical third of the root. • If the plane of fracture is more oblique which is common with apical third fractures, an occlusal view or radiographs with varying horizontal angles are more likely to demonstrate the fracture including those located in the middle third.	• Reposition, if displaced, the coronal segment of the tooth as soon as possible. • Check position radiographically. • Stabilize the tooth with a flexible splint for 4 weeks. If the root fracture is near the cervical area of the tooth, stabilization is beneficial for a longer period of time (up to 4 months). • It is advisable to monitor healing for at least one year to determine pulpal status. • If pulp necrosis develops, root canal treatment of the coronal tooth segment to the fracture line is indicated to preserve the tooth.	4 Weeks S^{+}, C^{++} 6-8 Weeks C^{++} 4 Months S^{++}, C^{++} 6 Months C^{++} 1 Year C^{++} 5 Years C^{++}	• Positive response to pulp testing (false negative possible up to 3 months). • Signs of repair between fractured segments. • Continue to next evaluation.	• Symptomatic • Negative response to pulp testing (false negative possible up to 3 months). • Extrusion of the coronal segment. • Radiolucency at the fracture line. • Clinical signs of periodontitis or abscess associated with the fracture line. • Endodontic therapy appropriate for stage of root development is indicated.

ALVEOLAR FRACTURE	Clinical findings	Radiographic findings	Treatment	**Follow-Up**	Favorable Outcome	Unfavorable Outcome
	• The fracture involves the alveolar bone and may extend to adjacent bone. • Segment mobility and dislocation with several teeth moving together are common findings. • An occlusal change due to misalignment of the fractured alveolar segment is often noted. • Sensibility testing may or may not be positive.	• Fracture lines may be located at any level, from the marginal bone to the root apex. • In addition to the 3 angulations and occlusal film, additional views such as a panoramic radiograph can be helpful in determining the course and position of the fracture lines.	• Reposition any displaced segment and then splint. • Suture gingival laceration if present. • Stabilize the segment for 4 weeks.	4 Weeks S^{+}, C^{++} 6-8 Weeks C^{++} 4 Months C^{++} 6 Months C^{++} 1 Year C^{++} 5 Years C^{++}	• Positive response to pulp testing (false negative possible up to 3 months). • No signs of apical periodontitis. •Continue to next evaluation.	• Symptomatic • Negative response to pulp testing (false negative possible up to 3 months). • Signs of apical periodontitis or external inflammatory root resorption. • Endodontic therapy appropriate for stage of root development is indicated.

S^{+}=splint removal; S^{++}=splint removal in cervical third fractures.
C^{++} = clinical and radiographic examination.
++=Whenever there is evidence of external inflammatory root resorption, root canal therapy should be initiated immediately, with the use of calcium hydroxide as an intra-canal medication.

2. Treatment Guidelines for Luxation Injuries

				Follow-Up Procedures for luxated permanent teeth	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:**	
CONCUSSION	**Clinical findings**	**Radiographic findings**	**Treatment**		**Favorable Outcome**	**Unfavorable Outcome**
	• The tooth is tender to touch or tapping; it has not been displaced and does not have increased mobility. • Sensibility tests are likely to give positive results.	•No radiographic abnormalities	• No treatment is needed. • Monitor pulpal condition for at least one year.	4 Weeks C^{++} 6-8 Weeks C^{++} 1 Year C^{++}	• Asymptomatic • Positive response to pulp testing • False negative possible up to 3 months. • Continuing root development in immature teeth • Intact lamina dura	• Symptomatic • Negative response to pulp testing • False negative possible up to 3 months •No continuing root development in immature teeth, signs of apical periodontitis. • Endodontic therapy appropriate for stage of root development is indicated.
SUBLUXATION	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	• The tooth is tender to touch or tapping and has increased mobility; it has not been displaced. • Bleeding from gingival crevice may be noted. • Sensibility testing may be negative initially indicating transient pulpal damage. • Monitor pulpal response until a definitive pulpal diagnosis can be made.	•Radiographic abnormalities are usually not found.	• Normally no treatment is needed, however a flexible splint to stabilize the tooth for patient comfort can be used for up to 2 weeks.	2 Weeks S^{+}, C^{++} 4 Weeks C^{++} 6-8 Weeks C^{++} 6 Months C^{++} 1 Year C^{++}	• Asymptomatic • Positive response to pulp testing • False negative possible up to 3 months. • Continuing root development in immature teeth • Intact lamina dura	• Symptomatic • Negative response to pulp testing • False negative possible up to 3 months • External inflammatory resorption. • No continuing root development in immature teeth, signs of apical periodontitis. • Endodontic therapy appropriate for stage of root development is indicated.
EXTRUSIVE LUXATION	**Clinical Findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable Outcome**
	• The tooth appears elongated and is excessively mobile. • Sensibility tests will likely give negative results.	•Increased periodontal ligament space apically.	• Reposition the tooth by gently re-inserting It into the tooth socket. • Stabilize the tooth for 2 weeks using a flexible splint. • In mature teeth where pulp necrosis is anticipated or if several signs and symptoms indicate that the pulp of mature or immature teeth became necrotic, root canal treatment is indicated.	2 Weeks S^{+}, C^{++} 4 Weeks C^{++} 6-8 Weeks C^{++} 6 Months C^{++} 1 Year C^{++} Yearly 5 years C^{++}	• Asymptomatic • Clinical and radiographic signs of normal or healed periodontium. • Positive response to pulp testing (false negative possible up to 3 months). • Marginal bone height corresponds to that seen radiographically after repositioning. • Continuing root development in immature teeth.	• Symptoms and radiographic sign consistent with apical periodontitis. • Negative response to pulp testing (false negative possible up to 3 months). • If breakdown of marginal bone, splint for an additional 3-4 weeks. • External inflammatory root resorption. • Endodontic therapy appropriate for stage of root development is indicated.

S^{+}=splint removal;
C^{++} = clinical and radiographic examination.
++=Whenever there is evidence of external inflammatory root resorption, root canal therapy should be initiated immediately, with the use of calcium hydroxide as an intra-canal medication.

				Follow-Up Procedures for luxated permanent teeth	Favorable and Unfavorable outcomes include some, but not necessarily all, of the following:**	
LATERAL LUXATION	**Clinical findings**	**Radiographic findings**	**Treatment**		**Favorable Outcome**	**Unfavorable Outcome**
	• The tooth is displaced, usually in a palatal/lingual or labial direction. • It will be immobile and percussion usually gives a high, metallic (ankylotic) sound. • **Fracture of the alveolar process present.** • Sensibility tests will likely give negative results	• The widened periodontal ligament space is best seen on eccentric or occlusal exposures.	• Reposition the tooth digitally or with forceps to disengage it from its bony lock and gently reposition it into its original location. • Stabilize the tooth for 4 weeks using a flexible splint. • Monitor the pulpal condition. • If the pulp becomes necrotic, root canal treatment is indicated to prevent root resorption.	2 Weeks, C++ 4 Weeks S+, C++ 6-8 Weeks C++ 6 Months C++ 1 Year C++ Yearly for 5 years C++	• Asymptomatic • Clinical and radiographic signs of normal or healed periodontium. • Positive response to pulp testing (false negative possible up to 3 months). • Marginal bone height corresponds to that seen radiographically after repositioning. •Continuing root development in immature teeth	• Symptoms and radiographic signs consistent with apical periodontitis. • Negative response to pulp testing (false negative possible up to 3 months). • If breakdown of marginal bone, splint for an additional 3-4 weeks. • External inflammatory root resorption or replacement resorption • Endodontic therapy appropriate for stage of root development is indicated.

INTRUSIVE LUXATION	**Clinical findings**	**Radiographic findings**	**Treatment**	**Follow-Up**	**Favorable Outcome**	**Unfavorable**
	• The tooth is displaced axially into the alveolar bone. • It is immobile and percussion may give a high, metallic (ankylotic) sound. • Sensibility tests will likely give negative results.	•The periodontal ligament space may be absent from all or part of the root. • The cemento-enamel junction is located more apically in the intruded tooth than in adjacent non-injured teeth, at times even apical to the marginal bone level.	<u>Teeth with incomplete root formation</u> • Allow eruption without intervention • If no movement within few weeks, initiate orthodontic repositioning. • If tooth is intruded more than 7mm, reposition surgically or orthodontically. <u>Teeth with complete root formation:</u> • Allow eruption without intervention if tooth intruded less than 3mm. If no movement after 2-4 weeks, reposition surgically or orthodontically **before ankylosis can develop.** • If tooth is intruded 3-7 mm, reposition surgically or orthodontically. • If tooth is intruded beyond 7mm, reposition surgically. • The pulp will likely become necrotic in teeth with complete root formation. Root canal therapy using a temporary filling with calcium hydroxide is recommended and treatment should begin 2-3 weeks after repositioning. • Once an intruded tooth has been repositioned surgically or orthodontically, stabilize with a flexible splint for 4 weeks.	2 Weeks, C++ 4 Weeks S+, C++ 6-8 Weeks C++ 6 Months C++ 1 Year C++ Yearly for 5 years C++	• Tooth in place or erupting. • Intact lamina dura • No signs of resorption. • Continuing root development in immature teeth.	• Tooth locked in place/ankylotic tone to percussion. • Radiographic signs of apical periodontitis • External inflammatory root resorption or replacement resorption. • Endodontic therapy appropriate for stage of root development is indicated.

S+=splint removal;
C++ = clinical and radiographic examination.
++= whenever there is evidence of external inflammatory root resorption, root canal therapy should be initiated immediately, with the use of calcium hydroxide as an intra-canal medication.

8.4 Appendix IV

IADT guidelines for avulsed permanent teeth with closed apex

	Replanted tooth at the scene	Dry time < 60 min the tooth kept in a physiologic storage medium and/or stored dry	Dry time >60 min
Closed Apex	• Leave the tooth in place. • Clean the area with water, saline or chlorhexidine • Suture gingival lacerations • Verify normal position of the tooth both clinically and radiographically. • Apply a flexible splint for up to 2 weeks • Manage systemic antibiotics. • Check tetanus protection. • Give patient instructions. • Initiate root canal treatment 7-10 days after replantation and before splint removal	• Clean the root surface and apical foramen with a stream of saline and soak the tooth in saline to remove contamination and dead cells from the root surface. • Administer local anesthesia. • Irrigate the socket with saline. • Examine the alveolar socket. If there is a fracture of the socket wall, reposition it. • Replant the tooth slowly without force. • Suture gingival lacerations. • Verify normal position of the replanted tooth both clinically and radiographically. • Apply a flexible splint for up to 2 weeks • Administer systemic antibiotics. • Check tetanus protection. • Give patient instructions. • Initiate root canal treatment 7–10 days after replantation and before splint removal.	• Remove attached soft tissue with gauze. • In cases of delayed replantation, root canal treatment should be either carried out on the tooth prior to replantation or it can be carried out 7-10 days later like in other replantation situations. • Administer local anaesthesia. • Irrigate the socket with saline. • Examine the alveolar socket. If there is a fracture of the socket wall, reposition it. • Replant the tooth. • Suture gingival lacerations. • Verify normal position of the tooth clinically and radiographically. • Stabilize the tooth for 4 weeks using a flexible splint. • Administration of systemic antibiotics. • Check tetanus protection. • Give patient instructions.

IADT guidelines for avulsed permanent teeth with open apex

	Replanted tooth at the scene	***Dry time < 60 min the tooth kept in a physiologic storage medium and/or stored dry***	***Dry time >60 min***
Open Apex	• Leave the tooth in place. • Clean the area with water spray, saline, or chlorhexidine. • Suture gingival lacerations. • Verify normal position of the tooth both clinically and radiographically. • Apply a flexible splint for up to 2 weeks. • Administer systemic antibiotics. • Check tetanus protection. • Give patient instructions. • The goal for replanting immature teeth in children is to allow for possible revascularization of the pulp space.	• If contaminated, clean the root surface and apical foramen with a stream of saline. • Topical application of antibiotics to enhance chances for revascularization of the pulp. • Administer local anesthesia. • Examine the alveolar socket. • If there is a fracture of the socket wall, reposition it. • Remove the coagulum in the socket and replant the tooth slowly with slight digital pressure. • Suture gingival lacerations. • Verify normal position of the tooth clinically and radiographically. • Apply a flexible splint for up to 2 weeks. • Administer systemic antibiotics. • Check tetanus protection. • Give patient instructions.	• Remove attached soft tissue carefully with gauze. • Root canal treatment to the tooth can be carried out prior to replantation or later. • Administer local anesthesia. • Remove the coagulum from the socket with a stream of saline. • Examine the alveolar socket. If there is a fracture of the socket wall, reposition. • Replant the tooth slowly with digital pressure. •Suture gingival laceration. •Verify normal position of the tooth clinically and radiographically. • Stabilize the tooth for 4 weeks using a flexible splint. • Administer systemic antibiotics. • Check tetanus protection. • Give patient instructions.