Emphysematous complications in dentistry, 1960–1993: An illustrative case and review of the literature

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Seventy-four reports of emphysematous complications in ambulatory dental patients, published in the English literature between the years 1960 and 1993, are reviewed, and an additional case of subcutaneous, retropharyngeal, and mediastinal emphysema following an impression-taking procedure for a crown preparation is presented. This rare complication occurred mainly in patients in the third and fifth decades of life, after dental procedures on the third molar, in particular during mandibular extractions and treatment on the right side. The use of an air syringe, high-speed handpieces, or their combination was reported in 71% of cases. Centripetal air dissection, with retropharyngeal and mediastinal emphysema, occurred in 35% of the patients, especially following extractions. (Quintessence Int *1995;26:535–543.*)

Introduction

Maxillofacial and dental surgery may cause dissection of air into soft tissues as a result of extensive traumatic or surgical defects at the air–soft tissue interface, as well as from positive pressure respiration during resuscitation and anesthesia.[1,2] Although this complication is familiar and easily diagnosed by the experienced surgeon, it is seldom encountered in the ambulatory dental patient. In Shovelton's summary[3] of the cases reported up to 1957, soft tissue emphysema usually followed tooth extraction as a result of actions by the patient that raised intraoral pressure. Iatrogenic subcutaneous emphysema, caused by drying with compressed air or by the elaboration of gas from hydrogen peroxide during root canal treatment, has been reported as well.[3]

Since these series were reported, the introduction of advanced handpieces, which operate by the focused release of compressed gas, fluids, abrasive particles, or their combinations, has increased the risk of emphysematous complications during ambulatory nonsurgical dental procedures.[4] Gas dissection beyond the subcutaneous tissues into the retropharynx, mediastinum, pleura, pericardium, and peritoneum, with the potential risks for cardiorespiratory compromise[5–7] and infection,[8] has also been encountered.

This article presents a case of cervical, retropharyngeal, and mediastinal emphysema that followed an impression-taking procedure for crown preparation in a 25-year-old patient and reviews the occurrence of emphysematous complications in ambulatory dental patients reported in the English literature since 1960.

Case report

The mandibular left first molar of a healthy 25-year-old man was prepared for a porcelain-fused-to-metal crown. Following administration of a single oral prophylactic dose of amoxicillin and administration of local anesthesia, a retraction cord impregnated with chemical hemostatic solution was packed to the subgingival sulcus around the cervical area of the tooth with a blunt dental spatula. The tooth was desiccated with an air stream of 32 psi from a triple syringe, and an impression was taken.

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Fig 1a Anteroposterior cervical radiograph, revealing subcutaneous cervical emphasema *(arrowheads)*.

Fig 1b Lateral cervical radiograph, revealing subcutaneous retropharyngeal emphysema *(arrowheads)* and paratracheal air dissection in the neck *(arrow)*.

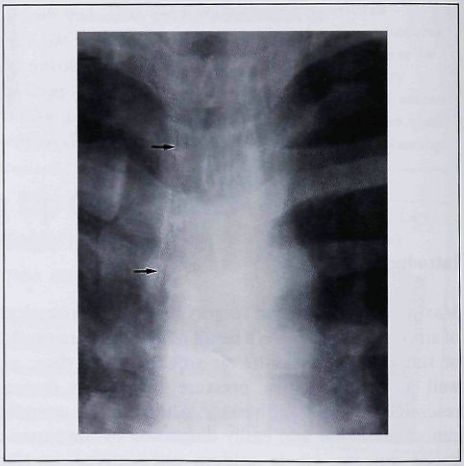

Fig 1c Detail of a posteroanterior chest radiograph, revealing paratracheal air dissection extending to the mediastinum *(arrow)*.

During the procedure, the patient complained of facial and pharyngeal swelling. Physical examination revealed no remarkable findings, and the impression procedure was completed uneventfully. During the next 6 hours the patient developed a "crackling" feeling in the left infraorbital region and below the left mandibular angle. Pharyngeal swelling changed to discomfort and moderate pain, radiating to the jugular notch and substernal region.

Referred by his dentist, the patient was examined an hour later in an emergency room. Initially misdiagnosed as having an allergic reaction, he was treated with subcutaneous adrenalin, glucocorticoids, and antihistamines. Reevaluation 8 hours later revealed mild soft tissue swelling and crepitus in the infraorbital region and below the mandibular angle. Radiographs disclosed subcutaneous cervical emphysema, extending to the retropharynx and mediastinum along the trachea, down to the level of the carina (Figs 1a to 1c).

Over the next several hours the patient's complaints decreased, and the regional swelling regressed. Antibiotics were withheld, the patient was discharged, and he recovered uneventfully.

Review of the literature

Reports of emphysematous complications published in the English literature during the years 1960 to 1993 were reviewed. Cases related to trauma or maxillofacial and dental surgery under general anesthesia (with positive pressure respiration) were excluded[2] to limit the review to cases in which air dissection originated in the oral cavity of dental patients. Age, gender, dental procedures, and locations of the emphysematous spread were recorded, as well as information about antimicrobial treatment and infectious and noninfectious complications. Seventy-four case reports were found to contain all or most of the variables.

Simple correlations and multiple regression analysis were performed to determine the contribution of demographic features and dental procedures to the development and distribution of emphysematous complications.

The 75 case reports, including the present one, are detailed in Table 1 and summarized in Table 2. The incidence of emphysematous complications in the reported cases was evenly distributed between the sexes, affecting mostly patients in the third and fifth decades (Fig 2). Emphysema complicated procedures involving the mandible in 75% of the patients and occurred after treatment on the right side of the oral cavity almost twice as often as after treatment on the left side.

In most instances, emphysematous complications followed tooth extraction (n = 33) or restorative dentistry (amalgam restorations, cavity preparation, post and core, or crown preparations, n = 25). The minority of cases happened after root canal therapy (n = 9) or periodontal treatment (including treatment to the dental sulci, subgingival scaling, and irrigation, n = 8). Gas dissection into the soft tissues followed treatment of the third molar in more than one third of the patients (n = 27). All but one were mandibular teeth, 24 of which were being extracted.

Although the incidence of emphysematous complications in relation to restorative treatment was evenly distributed among all age groups, complications following tooth extractions occurred mainly in younger patients (Fig 2).

Most cases of emphysematous complications (72%) followed the use of high-speed drilling equipment (n = 27), air syringes (n = 12), or both (n = 15). In six cases, jet air turbine, water, or powder irrigation handpieces were used. In seven cases, the use of a tissue separator alone or retractors (with air syringe or high-speed equipment) was reported. Irrigation with hydrogen peroxide was performed in five of nine endodontic treatments complicated by soft tissue emphysema. In two cases, maneuvers undertaken by the patient initiated or contributed to air dissection. One patient developed cervical subcutaneous emphysema while inflating a balloon after an amalgam restorative procedure to a maxillary canine.[20] The other patient sneezed forcefully following extraction of a mandibular third molar.[59]

Gas dissection in the cervical subcutaneous region occurred in 95% of patients. Of four patients without cervical subcutaneous emphysema, two had a mediastinal gas collection and two developed emphysema of the periorbital subcutaneous tissue. The latter distribution was found in 45% of patients, its occurrence unrelated to the location or nature of the dental treatment. Subcutaneous gas collection usually caused mild pain or tenderness, regional swelling, and a crackling sensation during manual manipulation or movement of the affected region.

Gas dissection into deeper structures, with retropharyngeal and mediastinal emphysema, occurred in 27 (35%) of the affected patients, most of whom were male (n = 19). In two patients, gas dissected further into the peritoneal cavity, retroperitoneal space, pleura and pericardium (once each), resulting in pneumoperitoneum, pneumoretroperitoneum, pneumothorax, and pneumopericardium.[5,7] The incidence of emphysema of the deep structures correlated with male gender ($r = .31$; $P = .01$), manipulations of the mandible ($r = .29$; $P < .02$), and procedures affecting molars ($r = .25$, $P < .04$). Tooth extractions were markedly associated with this complication ($r = .35$, $P < .003$) and were found to be the only independent contributing factor by multiple regression analysis ($\beta = .31$, $P < .03$).

Emphysematous complications were often misdiagnosed. Seven patients were treated initially for an erroneous diagnosis of an allergic hypersensitivity reaction, and three were mistakenly assessed as having an infection, hematoma, or myocardial ischemia.

In most patients, emphysematous complications resolved spontaneously and did not require treatment. However, one patient[6] underwent tracheostomy and required intensive care following subcutaneous, retropharyngeal, and mediastinal emphysema, and two others required thoracic drainage[7] and peritoneal decompression[5] for pneumothorax and massive pneumoperitoneum, respectively. There were also reports

Table 1 Characteristics of 75 case reports of emphysematous complications, arranged chronologically

	Gender and age (y)	Tooth No.	Dental procedure	Equipment used*	Gas distribution				Ref No.
					Subcutaneous	Orbital	Mediastinum	Other†	
1	M 37	35	Perio treat	AS	+	+			9
2	M 37	48	Extraction		+		+		10
3	M 34	38	Extraction				+		11
4	M 23	48	Extraction		+				12
5	F 52	26	Perio treat	AS		+			13
6	F 16	46	Restoration	HS	+				13
7	F 42	45	Perio treat	AS	+	+			13
8	M 39	47, 48	Extraction	HS	+	+	+		14
9	M 46	48	Extraction	HS+RS	+	+			15
10	M 20	48	Extraction	HS+RS	+				15
11	M 47	35	Restoration	AS+HS	+	+			16
12	M 19	16	Extraction	HS	+	+			17
13	F 36	46, 47	Restoration	AS+HS	+				18
14	F 54	37	Restoration	HS	+	+			19
15	M 27	13	Restoration	AS+HS	+				20
16	M 23	38/48?	Extraction	HS	+				20
17	F 19	47	Extraction	HS	+				21
18	M 38	48	Extraction	HS	+	+	+		22
19	M 12	?	Extraction		+	+	+		22
20	M 60	38	Extraction	HS	+	+			23
21	M 22	48	Extraction		+				24
22	F 20	22	Crown prep	HS	+	+			25
23	F 42	21	Root canal	AS	+	+			26
24	M 47	47	Subgingival scaling	AS+JS	+				27
25	F 16	47	Extraction	HS	+				28
26	M 54	47	Restoration	AS+HS	+		+		29
27	M 20	48	Extraction	LS+JS			+		30
28	M 23	46	Extraction	HS	+	+	+		31
29	F 24	37	FPD prep	AS+HS+Rub dam	+				32
30	M 20	11	Root canal	H_2O_2		+	+		33
31	F 27	16	Root canal	H_2O_2		+			34
32	F 28	47,48	Extraction		+		+	Pericardium & peritoneum	5
33	F 53	47	Tooth prep	HS	+				35
34	F 26	33	Root canal	AS	+		+		36
35	F 34	48	Restoration	HS	+	+			37
36	F 20	33	Restoration	HS	+	+		RPX	38
37	M 44	47	Perio surg	AS+HS	+	+			39
38	M ?	12	Restoration	AS+HS	+		+		40
39	M 23	35	Extraction	HS	+	+	+	RPX	41
40	F 17	27	Restoration	AS+HS		+			42
41	F 26	47	Restoration	AS+HS	+	+			43

Table 1 (continued)

Gender and age (y)	Tooth No.	Dental procedure	Equipment used*	Gas distribution				Ref No.
				Subcutaneous	Orbital	Mediastinum	Other†	
42 F 8	16,26	Restoration	AS+HS	+				44
43 F 48	47	Restoration	AS+HS+Rub dam	+	+			45
44 M 41	17	Extraction		+		+		8
45 F 49	45	Restoration	AS+HS	+			RPX	46
46 F 20	15	Onlay prep	HS	+				47
47 F 41	25	Root canal	H_2O_2		+	+		48
48 M 23	23	Root canal	AS	+	+			48
49 F ?	26,27,28	Extraction	AS+JS	+				49
50 M 21	48	Extraction	HS	+		+		50
51 F 30	11	Root canal	AS	+	+			51
52 M 60	23	Post & core prep	AS	+				52
53 F 30	48	Extraction	AS	+				52
54 M 23	35/45?	Root canal	H_2O_2		+			52
55 F 40	36	Crown prep	HS	+				52
56 F 58	44	Restoration	HS	+				53
57 M 20	38	Extraction	LS+JS	+	+	+		54
58 F 41	48	Extraction	RS	+		+		55
59 M 40	48	Extraction	RS	+	+			55
60 M 51	48	Extraction	RS	+		+		55
61 M 49	27	Irrigation	JS	+				56
62 M 42	48	Restoration	AS+HS	+	+	+	RPX	6
63 F 63	35	Restoration	AS+HS+ Retr cord	+	+			57
64 F 40		Mandib implants cleaning	JS	+				58
65 F 28	48	Extraction	LS	+				59
66 M 29	48	Extraction	HS	+				60
67 F 32	37	Extraction	HS	+	+			61
68 M 30	48	Root canal	H_2O_2	+		+		62
69 M 28	38	Extraction	HS	+	+	+		63
70 F 47		Perio surg	AS	+			RPX	64
71 F ?	46	Restoration	AS+HS	+		+		65
72 M 52	37	Extraction	HS	+		+		66
73 F 26	48	Extraction	HS	+	+	+		67
74 F 24	48	Extraction	HS	+	+	+	Peritoneum & pleura	7
75 M 25	36	Restoration	RS+JS	+	+	+	RPX	‡

* AS = air syringe; HS = high-speed handpiece; RS = retractor/separator; JS = jet-spray handpiece; LS = low-speed handpiece; H_2O_2 = hydrogen peroxide.

† RPX = retropharynx.

‡ The present case report.

Table 2 Summary of characteristics of 75 case reports of emphysematous complications

	Variable	Incidence
Gender	(F/M)	37/38
Arch	(max/mandib)	18/57
Side	(L/R)	25/45
Tooth	Central incisor	3 (0/3)*
	Lateral incisor	2 (0/2)
	Canine	5 (2/3)
	First premolar	1 (1/0)
	Second premolar	10 (7/3)
	First molar	10 (5/5)
	Second molar	17 (13/4)
	Third molar	27 (26/1)
Procedure	Extraction	33†
	Restoration	25
	Root canal	9
	Periodontal	7
	Other‡	1
Equipment	Air syringe	27
	High-speed	42
	Retractor/Separator	6
	Spray/Jet devices§	7
	Hydrogen peroxide irrigation	5
	Low-speed	3
Gas Distribution	Cervical subcutaneous	71
	Orbital subcutaneous	34
	Retropharyngeal	6
	Mediastinal	25
	Other‖	4

* Numbers in parentheses represent mandibular-maxillary ratio.

† Twenty-four of 33 were third molars.

‡ Cleaning of dental implants.

§ Air, water, or powder irrigators.

‖ Two pneumoperitoneum, one pneumopericardium, and one pneumothorax.

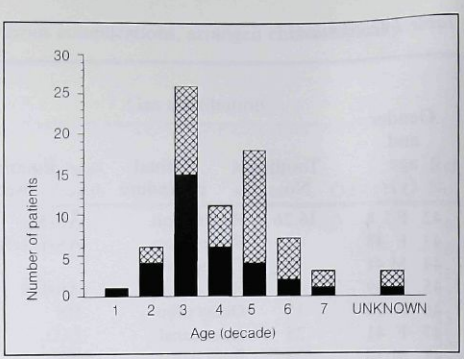

Fig 2 Age distribution of reported cases of emphysematous complications in ambulatory dental patients, 1960 to 1993. The solid portion of the bars represents complications that followed tooth extraction. The hatched portion of the bars represents cases induced by other dental procedures. Note the two peaks occurring at the third and fifth decades. The majority of extraction-related complications are found in the younger age groups.

of earache with transient eustachian tube dysfunction[38] and visual loss,[61] probably related to spread of gas to peripharyngeal and preseptal lid spaces.

Fifty-five patients (73%) received antibiotics following diagnosis, penicillin or ampicillin being the treatment of choice in most instances. Infection developed in three patients, two of whom were receiving antibiotic treatment. In one of these patients cervical subcutaneous emphysema became infected,[28] while local infection at the site of the dental procedure occurred in the other two.[8,27] One of these patients, who had an odontogenic infection prior to the dental procedure, died of disseminated infection, and gas collection may have been related to gas-forming bacteria.[8]

Discussion

The review of published cases indicated that the widespread use of new technologies, including high-speed, water-cooled equipment and air-driven handpieces, is currently the leading cause of air emphysema. In the series published during the mid-1950s,[3] emphysematous complications often followed actions by the patient that raised intraoral pressure; however, only two such incidents were reported in the present series. The majority of cases were associated with the use of dental equipment that directed pressurized air, water, abrasive particles or their combinations into gingival defects produced by dental procedures.

The American Dental Association Council on Dental Materials, Instruments and Equipment recommends that the use of these handpieces be avoided during surgical procedures associated with bone removal and sectioning of teeth for extraction.[4] The present case report demonstrated that relatively minor proce-

dures, such as the drying of a packed retraction cord with compressed air, also harbor the risk for such a complication.

The occurrence of emphysematous complications after irrigation of root canals with hydrogen peroxide is diminishing, compared with the incidence reported in the previous series.[3] This may result from abandonment of the technique, as recommended by Bhat.[33] The fact that no other risk factor could be identified in four of five patients treated by hydrogen peroxide irrigation, supports the contention that hydrogen peroxide and gas collection in the soft tissues are connected.

By far the most common procedure associated with emphysematous complications is tooth extraction, particularly of mandibular molars. This may result from more extensive damage to soft tissue and bone, the exposure of deeply seated structures with low resistance to penetration of pressurized air or fluid, and prolonged procedures that may increase the risk of air penetration. The absence of emphysematous complications in the very young and elderly populations may reflect the rarity or relative ease of tooth extractions in these age groups.

Four patients were treated by dental students, probably involving prolonged sessions. However, this number may be biased by the better diagnostic skills and greater awareness of clinicians in teaching centers as well as their initiative for seeking publication. The unexpected predilection of emphysematous complications to procedures on the right side may be related to bioengineering or ergonomic causes.

Tooth extraction was the strongest predictor of deep centripetal gas distribution. This may be due to the exposure of deeply placed anatomic routes for air penetration. It is conceivable that gas propagation into the mediastinum takes place along the peripharyngeal and retropharyngeal loose areolar tissues. The paucity of reports of retropharyngeal emphysema may result from the lack of thorough radiographic evaluation. A swelling sensation in the throat, reported by the patient in this report, may suggest this gas distribution.

Gas dissection into deep cervical and intrathoracic structures occurs mainly, but not exclusively,[8,61] in relation to mandibular procedures. The higher incidence of retropharyngeal and mediastinal emphysema in males probably results from the much higher incidence of tooth extractions in males (23 males versus 10 females) in the present cohort.

The occurrence of emphysematous complications in dental patients is probably higher than can be appreciated from this retrospective study of case reports. Many cases may be unnoticed, unreported, or misdiagnosed (in particular as hypersensitivity reactions). The experiences of the present patient and those in some of the other reports prove that many primary care and emergency room physicians, as well as dentists, are unfamiliar with this condition.

Emphysematous complications in dentistry usually run a benign course. The only fatality reported may not have been directly related,[8] because the patient had been gravely ill with widespread infection before the dental procedure and the development of emphysema. In another nondetailed case report of soft tissue emphysema, not included in the present series, fatality appeared to result from air embolus following the use of pressurized air during an endodontic procedure to a mandibular anterior tooth, in which the air tip was inserted and held in the root canal.[68]

Prophylactic antibiotic treatment has often been recommended to prevent dissemination of oral flora along the emphysematous tracts. The absence of infection in patients not prescribed antimicrobial therapy in the present series and in Shovelton's review[3] challenges this routine.

The danger of upper airway obstruction is probably low, as well, because air dissection would preferentially take place along loose, low-resistance structures and not the relatively tight submucosa of the glottis and trachea. In the only case in which tracheostomy was performed, retropharyngeal emphysema was substantial enough to cause respiratory distress.[6] The potential low-resistance communications of the retropharynx with adjacent loose areolar and serosal tissues should prevent such a condition but may lead to pneumoperitoneum, pneumoretroperitoneum, pneumopericardium, or pneumothorax.[5,7] Accumulation of air in the last two sites could be life threatening, requiring drainage procedures.

Dentists and health-care personnel should be well aware of the possibility of subcutaneous emphysema, because early recognition and initiation of treatment may be of supreme importance. A short in-hospital observation period is required in patients with gas distribution into deep intrathoracic structures. The routine administration of prophylactic antibiotics may not be necessary but should not be discouraged.

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