Comparison Between Neocone, Alvogyl and Zinc Oxide Eugenol Packing for the Treatment of Dry Socket: A Double Blind Randomised Control Trial

Sayed Faizel · Shaji Thomas · V. Yuvaraj ·
S. Prabhu · Geetha Tripathi

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Abstract

Objectives To prospectively evaluate and compare the effectiveness of Neocone, Alvogyl and Zinc Oxide Eugenol (ZOE) intra alveolar dressings for the management of dry socket and to study the epidemiological factors associated with the condition.

Study Design All the patients who underwent extraction of teeth and who fulfilled our inclusion and exclusion criteria from 1st January 2012 to February 28th 2013 were included in our study. Patients who were diagnosed to suffer from dry socket were randomly allocated to three groups namely Group A (Alvogyl), Group B (ZOE), Group C (Neocone). Pain relief and healing of the socket were compared between these groups. The collected data were subjected to statistical analysis by Chi Square test, Z test of proportionality.

Results and Conclusion Alvogyl is superior to the other two medications for providing initial pain relief. Neocone provides complete pain relief and the healing was fastest with Neocone. Neocone emerged as the most suitable dressing material for the management of dry socket by virtue of shorter time required for complete pain relief, fewer visits and faster clinical healing.

Keywords Dry socket · Post extraction complication · Alvogyl · Zinc Oxide Eugenol · Neocone

Introduction

Dry socket/alveolar osteitis (AO) is one of the most common and unpleasant postoperative complications following extraction of permanent teeth. The term “dry socket” has been used in literature since 1896, when it was first described by Crawford [1]. Efforts have been made to define dry socket more accurately through the use of terms such as AO, localized osteitis, post extraction osteomyelitis syndrome, alveolgia, avascular socket, alveolitis sicca dolorosa, delayed extraction wound healing, and fibrinolytic alveolitis. However the term dry socket continues to be used popularly [2].

A great clinical challenge ever since the first case was reported has been the inconsistency in documentation of etiology, risk factors, prevention and treatment modalities. Most authors believe dry socket to have a multifactorial etiology, which can be divided into general factors such as age, sex, decreased body resistance due to systemic disease, nutritional deficiency, etc., and local factors such as anatomical location, traumatic surgery, smoking, fibrinolysis of clot, local circulation, local anesthesia, and vasoconstrictors [3, 4]. Several studies suggest a direct correlation between contraceptive use and dry socket [5]. Contraceptives contain estrogen, which is believed to affect the coagulation system [6].

The role of bacteria in predisposing patients with poor oral hygiene and pre-existing infections to develop dry socket has long been recognized [2]. Nitzan in an exhaustive review advocated the role of anaerobic organisms in the pathogenesis of dry socket. He substantiated this argument on the basis of multiple reports that suggested significant extracellular plasmin like activity of *Treponema denticola*, an organism found abundantly in association with gingival disease [7]. Razanis et al. [8]

S. Faizel · S. Thomas · S. Prabhu · G. Tripathi
Department of Oral and Maxillofacial Surgery, Peoples College
of Dental Sciences, Bhopal, India

V. Yuvaraj (✉)
Department of Oral and Maxillofacial Surgery, Indira Gandhi
Institute of Dental Science, Cuddalore Main Road,
Pillaiyarkuppam Post Office, Puducherry 607402, India
e-mail: getyuv@gmail.com

narrated the association of *Actinomyces viscosus* and *Streptococcus mutans* with this condition by showing delayed healing of socket after inoculation of the organisms in animal models.

Since dry socket is the most common post extraction complication, many researchers have attempted to find a successful method for its prevention. Systemic antibiotics, topical antibiotics, chlorhexidine, para-hydroxybenzoic acid, tranexemic acid, polylactic acid, steroids, eugenol containing dressings, lavage, 9-aminoacridine, etc., have been proposed to assist in the prevention of dry socket. However, this area remains controversial as no single method has gained universal acceptance [9].

The management of dry socket is as controversial as its etiology and prevention. Recommending any “treatment” is probably misleading as the condition cannot be treated as long as the etiology has not been firmly established. Most agree that the primary aim of dry socket management, as indicated by Fazakerlev and Field [10], is pain control until commencement of normal healing, and in the majority, local measures alone are satisfactory. In some instances, systemic analgesics or antibiotics may be necessary. The use of intra-alveolar dressing materials is widely suggested in the literature, although it is generally acknowledged that dressings delay healing of the extraction socket. Different medicaments and carrier systems are commercially available with little scientific evidence to guide a selection process for their use [9].

A need was therefore felt for a prospective randomized study to objectively assess the relative efficacy of different dressings for the management of pain and promotion of healing in AO.

Materials and Method

This study was carried out in the Department of oral and Maxillofacial Surgery, Peoples College of Dental Sciences and Research Centre, Bhopal, during the period from 1 January 2012 to 28 February 2013.

Method of Collection of Data

After obtaining approval from the research and ethical committee, all patients who reported to the department for dental extraction from 1 January 2012 to 28 February 2013 were included in the study. Exclusion criteria included conditions such as pregnancy, history of radiotherapy, and coexisting cellulitis/fascial space infections. A detailed case history was obtained from all patients in the standardized proforma designed to accumulate the various parameters required for meeting the objectives of the study.

Patients who reported with pain after tooth extraction were evaluated to ascertain the cause for this complaint. Diagnosis of AO was clinically established on the basis of the following features by a blinded assessor:

1. Pain in and around the extraction socket with or without radiation that increases in severity for some period from 1 and 3 days after extraction.
2. Partial or total clot loss in the interior of the alveolus with or without halitosis.

Any other associated findings such as halitosis, lymphadenopathy, etc., were also recorded. Patients were randomly assigned using randomization table to one of the three groups A, B, and C in order to receive treatment for their affliction. Patients within these groups were managed as follows:

- Group A: Management of dry socket by Alvogyl®. (Manufactured by Septodont India Pvt. Limited. Content—iodoform 15.8 gm, eugenol B.P. 13.7 gm, and butamben 25.7 gm)
- Group B: Management of dry socket by Zinc Oxide Eugenol (ZOE). (Manufactured by Septodont India Pvt. Limited)
- Group C: Management of dry socket by Neocone®. (Manufactured by Septodont India Pvt. Limited. Content—polymyxine B sulfate, tyrothricin, neomycin sulfate, tetracaine hydrochloride).

Procedure

The socket was irrigated with warm sterile saline solution. Curettage was avoided. Loose debris was removed, taking care to avoid dislodging any residual clot present in the socket.

Method of Placing Alvogyl®

A few fibers of Alvogyl® were placed with the help of a sterile instrument deep into the socket ensuring that the denuded bone was completely covered followed by the placement of sterile gauze. The gauze was removed after 5 min.

Method of Placing Standard Zinc Oxide Eugenol pack

A gauze piece soaked with freshly prepared ZOE paste was placed in the extraction socket under aseptic precautions.

Method of Placing Neocone®

A single pellet of Neocone® was placed inside the socket followed by the placement of a sterile gauze piece to cover the socket. The gauze was removed after 5 min.

The pain levels were assessed on the basis of Wong Baker Visual Analogue Scale after 5 min, 30 min, 1 h, day 1, day 2, day 3, day 5, day 7, and day 10 after placement of the medicament. The dressings were evaluated by a blinded assessor at every follow-up visit and were changed in case of persistence of pain. No further dressings were done if the patients had sustained pain relief for more than 48 h.

Clinical examinations for the signs of healing of dry socket were performed on 1st, 3rd, 5th, 7th, and 10th day by a blinded assessor. Persistence of parameters such as empty socket, bare bone, and erythema around the socket were noted after removal of the pack. For assessment of pain relief as well as healing, the patients were followed up on a daily basis if signs and symptoms persisted beyond 10 days.

The results of collected data were subjected to statistical analysis by Chi square test and Z test of proportionality. The results are depicted in the form of tables and graphs. The probability value (*P* value) gives the test of significance. In Chi square test and Z test, a *P* value <0.05 was considered as significant.

Results

A total of 7,106 teeth were extracted during the study period, of which 3,097 (43.59 %) were extracted in males and 4,009 (56.41 %) in females. 117 sockets in 105 patients (1.64 %) returned with signs and symptoms of dry socket. Of these, 69 (2.22 %) dry sockets were noted in females and 48 (1.19 %) dry sockets in males (male to female ratio was 1.86:1). For this difference, $\chi^2 = 11.076$, d.f. = 1, *P* = 0.0008 was found to be statistically significant.

The patients in this series were divided into seven age groups. Mean age of the patients was 34.6 years. The highest incidence of dry socket was seen in the age group of 21–40 years. For this difference, $\chi^2 = 30.658$ (d.f. = 6, *P* < 0.0001), the relation of age group and dry socket was found to be statistically significant.

Pain was present in 117 (100 %) cases, empty socket was present in 57 (48.71 %), bare bone (partially denuded socket) was present in 53 (45.20 %), halitosis in 61 (52.10 %), and redness around socket was found in 45 (38.60 %) cases. The time for onset of dry socket was calculated from the time lag between extraction and onset of pain. The analysis of data revealed that the largest number of cases [55 (47.10 %)] had an onset on the 3rd day after extraction. In 22 (18.80 %) cases, symptoms manifested on the 2nd day, while 24 (20.51 %) cases noted symptoms on the 4th day. 16 cases had an onset on the 5th day after extraction. Mean time for onset of the complication was 3.2 days. Teeth were grouped into anatomical

sites for the purpose of analyzing dry socket distribution. Higher incidence of dry socket was found in the lower jaw (63.24 %), as compared to the upper jaw (36.75 %). The difference was found to be statistically significant, ($Z > 1.96$) (*P* < 0.05).

Highest incidence of dry socket in mandibular arch was seen in the third molar region (6.91 %). The highest incidence in maxillary arch was seen in the second molar region (1.97 %). No cases were identified in the anterior region of either jaw. Chi square analysis of these data showed that for this difference, $\chi^2 = 100.926$ (d.f. = 7; *P* < 0.0001), incidence of dry socket was significantly influenced by the site in mandibular arch but not in maxillary arch [$\chi^2 = 13.97$ (d.f. = 7; *P* > 0.05)].

It was observed that the incidence of dry socket in patients who underwent single tooth extraction was much higher than those who underwent multiple extractions (single extraction to multiple extraction ratio was 4.4:1). This was in spite of the fact that more teeth were extracted in the multiple extraction subgroup. By applying Z test of proportionality, it was evident that the difference in incidence was statistically significant [$Z > 1.96$ and *P* < 0.05].

The incidence of dry socket was found to be higher in cases of trans-alveolar extraction than in intra-alveolar extraction (trans-alveolar extraction to intra-alveolar extraction ratio was 8.36:1). Chi square analysis revealed that this difference $\chi^2 = 121.79$ (d.f. = 1; *P* < 0.0001) to be statistically significant.

When the reasons for extraction of teeth were analyzed and correlated with incidence of dry socket, it was apparent that the highest incidence was noted in teeth which were extracted for recurrent pericoronitis (13.9 %), while the lowest incidence was noted in patients who underwent preprosthetic extractions (0.75 %). Chi square analysis revealed this difference $\chi^2 = 142.89$ (d.f. = 5; *P* < 0.0001) to be statistically significant.

Of the 7,106 extractions, 1,020 were performed in patients with medical comorbidities including those on oral contraceptives and 6,086 extractions were performed in otherwise healthy individuals. The incidence of dry socket in the former set of patients 57 (5.58 %) was higher than the latter 60 (0.98 %). Among the patients with coexisting medically compromised states, higher incidence was noted in asthmatics (4/19 extractions), hypertensives (12/389 extractions), and those consuming oral contraceptive pills (14/110 extractions). These differences were again statistically significant [$\chi^2 = 43.67$].

A total of 1,085 teeth were extracted in smokers. The number of dry socket in this subset was 30, an incidence of 2.76 %. A total of 6,021 teeth were extracted in non-smokers. This subset had 87 dry sockets, an incidence of 1.44 %. Chi square analysis showed the difference to be statistically significant [$\chi^2 = 9.49$ (d.f. = 1; *P* = 0.02)].

Table 1 Pain relief with various medicament

Medicament	No. of sockets	Mean time for initial pain relief (in min)	Mean time for complete resolution of pain (in days)	Average number of dressing required
Alvogyl®	39	7.35	6.47	3
ZOE pack	39	25.02	8.64	4
Neocone®	39	17.23	4.85	2

Out of 7,106 teeth, 1,540 teeth were extracted in patients with good oral hygiene. The number of dry sockets in these patients was 9, an incidence of 0.58 %. A total of 2,156 teeth were extracted in patients having fair oral hygiene; 31 dry sockets were encountered, an incidence of 1.43 %. A total of 3,310 teeth were extracted in patients with poor oral hygiene. The incidence of dry socket was 2.32 % (77 dry sockets). By using Chi square test to analyze these data, the difference was seen to be statistically significant [$\chi^2 = 19.8$ (d.f. = 2; $P < 0.0001$)].

The mean time to obtain initial pain relief with Alvogyl®, Neocone®, and ZOE were 7.35, 17.23, and 25.02 min respectively (i.e., Alvogyl® < Neocone® < ZOE pack). The difference in initial pain relief between all three groups was statically significant ($P < 0.0001$). Further, statistically significant difference was observed using student *t* test comparing Alvogyl® and ZOE pack, Alvogyl® and Neocone®, and ZOE pack and Neocone®. Results suggest that Alvogyl® is superior to the other two medicaments for providing initial pain relief (Tables 1, 2).

The mean time for complete pain relief with Alvogyl®, ZOE, and Neocone® were 6.47, 8.64, and 4.85 days, respectively (i.e., Neocone® < Alvogyl® < ZOE). The difference in complete pain relief between all three groups

was statistically significant ($P < 0.0001$). Also a statistically significant difference was observed when comparing Alvogyl® and ZOE pack, Alvogyl® and Neocone®, and ZOE pack and Neocone® using the Student *t* test. Results show that Neocone® provided complete pain relief sooner than the others (Table 1).

The baseline clinical examination prior to initiation of treatment revealed severe pain in all patients ($n = 117$; 100 %). Other signs and symptoms included halitosis ($n = 61$, 52.10 %), empty socket, i.e., completely denuded socket ($n = 57$, 47.50 %), bare bone, i.e., partially denuded socket ($n = 53$, 45.20 %), and redness around socket ($n = 45$, 38.60 %).

Out of 117 sockets with AO, 57 presented with empty sockets. Numbers of sockets treated for this sign with Alvogyl®, ZOE, and Neocone®, were 19, 18, and 20, respectively. Of the 19 sockets treated with Alvogyl®, 12 (63.15 %) remained empty on the 3rd day of follow up, and this was a significant reduction ($P < 0.05$). Disappearance of this sign in all the sockets was seen on 10th day of follow up. Of the 18 sockets treated with ZOE, significant reduction was noted only on the 5th day, with persistence of sign being noted in only 12 of the 18 patients [(66.6 %), ($P < 0.05$)]. Disappearance of this sign in all the sockets was seen on the 11th day of follow up. Of the 20 sockets treated with Neocone®, 8 (40 %) remained empty on the 3rd day of follow up, and this reduction was significant ($P < 0.05$). Disappearance of this sign in all sockets was seen on the 7th day of follow up. The complete disappearance of this sign was therefore fastest with Neocone® and slowest with ZOE (Tables 3, 4).

Out of 117 sockets with AO, 53 presented with bare bone. Numbers of sockets treated for this sign with Alvogyl®, ZOE, and Neocone®, were 19, 16, and 18,

Table 2 Pain relief with various medicament

Component	Mean	SD	N	T value	D.F.	P value (5 % Level)	Result
Initial pain relief (in mins)							
Alvogyl®	7.358	1.798	39	30.9211	76	<0.0001	S
ZOE pack	25.025	3.082	39				
Alvogyl®	7.358	1.798	39	25.4104	76	<0.0001	S
Neocone®	17.230	1.629	39				
ZOE pack	25.025	3.082	39	13.9643	76	<0.0001	S
Neocone®	17.230	1.629	39				
Final pain relief (in days)							
Alvogyl®	6.478	0.456	39	20.0857	76	<0.0001	S
ZOE pack	8.645	0.469	39				
Alvogyl®	6.478	0.456	39	13.0382	76	<0.0001	S
Neocone®	4.856	0.629	39				
ZOE pack	8.645	0.469	39	30.1583	76	<0.0001	S
Neocone®	4.856	0.629	39				

Table 3 Signs of healing (seen as resolution of signs)

	Empty socket	Exposed bone	Redness around socket
At diagnosis			
Alvogyl®	19	19	16
ZOE	18	16	14
Neocone®	20	18	15
3rd day			
Alvogyl®	12	10	10
ZOE	17	12	12
Neocone®	08	07	07
5th day			
Alvogyl®	9	7	6
ZOE	12	9	8
Neocone®	3	0	3
7th day			
Alvogyl®	4	2	3
ZOE	6	5	5
Neocone®	0	0	1
10th day			
Alvogyl®	0	0	0
ZOE	2	2	0
Neocone®	0	0	0

respectively. Of the 19 sockets treated with Alvogyl®, only 10 (52.63 %) still showed bare bone on the 3rd day of follow up. This reduction was significant ($P < 0.05$). Disappearance of this sign in all the sockets was seen on the 10th day of follow up. Of the 16 sockets treated with ZOE, 12 (75 %) still exhibited bare bone on the 3rd day of follow up, and this reduction was significant ($P < 0.05$). On the 10th day, 12.5 % of the sockets still had bare bone, which resolved by the 12th day of follow up. Of the 18 sockets treated with Neocone®, only 7 (38.89 %) were noted to have persistent bare bone on the 3rd day of follow up, and this was a significant reduction ($P < 0.05$). Disappearance of this sign in all sockets was seen on the 5th day of follow up itself. The resolution of this sign was fastest with Neocone® and slowest with ZOE (Table 5).

Of the 117 sockets with AO, 57 had redness around the socket. Numbers of sockets treated for this sign with Alvogyl®, ZOE, and Neocone® were 16, 14, and 15, respectively. Of the 16 sockets treated with Alvogyl®, 10 (62.5 %) continued to show redness around the socket on the 3rd day of follow up, but this reduction was significant ($P < 0.05$). Disappearance of this sign in all the sockets was seen on the 10th day of follow up. Of the 14 sockets treated with ZOE, 12 (85.71 %) still had persistent sign on the 3rd day of follow up, and this reduction was also found to be significant ($P > 0.05$). Disappearance of this sign in all the sockets was seen on the 10 day of follow up. Of the

15 sockets treated with Neocone®, only 7 (46.67 %) had persistent redness around the socket on the 3rd day of follow up. This was considered a significant reduction ($P < 0.05$). Disappearance of this sign in all sockets was seen on the 10th day of follow up. In so far as the resolution of this sign is concerned, all three dressings had similar positive outcomes. However, in comparison, it is evident that majority of cases treated with Neocone® had shorter time to resolution (Table 6).

Discussion

Dry socket is a clinical complication of considerable importance. It remains the most commonly encountered complication following extraction of teeth by general dentists and specialists. Occurrence of dry socket in everyday practice may not be completely avoidable. Studies by Archer [11] and MacGregor [12] have reported an incidence in the range of 1–4 %. In the present study incidence of dry socket was 1.64 %. Milhon et al. [13] and Quinely et al. [14] found the incidence to be in the range of 16.8–31.2 % in case of mandibular third molar extractions. This, however, was much lower (11.38 %) in the present study.

According to Blum [3], MacGregor [15], Nusair and Abu Younis [16], Birn [17], Lilly et al. [18], Sweet and Butler [19], Torres et al. [20] and Ygge et al. [21], this great variability in the reported incidence of dry socket may largely be due to differences in diagnostic criteria and methods of assessment [3], intra-operative and post-operative treatment [3], patient age [3], gender [15], surgical technique [17], smoking [19], medical status [18], operator experience [20], and use of oral contraceptives [21].

According to the present study the most consistent clinical finding was pain, as this was noted in all 117 sockets (100 %). This is consistent with the observations of Larsen [22] and Nusair and Abu Younis [16]. Nusair and Abu Younis [16] in addition also documented empty socket in all the cases and bare bone in 70 % cases, while Larsen [22] places these two findings at 58 and 48 %, respectively. The present study, however, does not support such a common presentation of these two findings as empty sockets were noted in only 48.71 %, while bare bone was seen in 45.2 % cases. Likewise, Larsen [22] and Upadhyaya and Humagain [23] documented halitosis in 75 % and 58 % cases, respectively, while this was found in only 52 % cases in the present study. Based on the results of the present study, it is evident that more than 50 % of the patients had only pain as the prominent clinical finding. It may therefore be inappropriate to term the condition “dry socket”, and we would prefer the term post extraction alveolgia or post extraction alveolitis. The appearance of the dry socket may therefore at best be considered a form of

Table 4 Effect on signs of dry socket (empty socket)

Day	Medicament	Persistence of sign	Percent	Z-value	P value	Result
3rd	Alvogyl®	12	63.15	$Z > 1.96$	$P < 0.05$	S
	ZOE	17	94.44	$Z < 1.96$	$P > 0.05$	NS
	Neocone®	8	40	$Z > 1.96$	$P < 0.05$	S
5th	Alvogyl®	9	47.36	$Z > 1.96$	$P < 0.05$	S
	ZOE	12	66.60	$Z > 1.96$	$P < 0.05$	S
	Neocone®	13	15	$Z > 1.96$	$P < 0.05$	S
7th	Alvogyl®	4	21.05	$Z > 1.96$	$P < 0.05$	S
	ZOE	6	33.33	$Z > 1.96$	$P < 0.05$	S
	Neocone®	0	0	$Z > 1.96$	$P < 0.05$	S
10th	Alvogyl®	0	0	$Z > 1.96$	$P < 0.05$	S
	ZOE	2	11.11	$Z > 1.96$	$P < 0.05$	S
	Neocone®	0	0	$Z > 1.96$	$P < 0.05$	S

S Significant, NS Non significant

Table 5 Effect on signs of dry socket (exposed bone)

Day	Medicament	Persistence of sign	Percent	Z-value	P value	Result
3rd	Alvogyl®	10	52.63	$Z > 1.96$	$P < 0.05$	S
	ZOE	12	75	$Z > 1.96$	$P < 0.05$	S
	Neocone®	7	38.89	$Z > 1.96$	$P < 0.05$	S
5th	Alvogyl®	7	36.84	$Z > 1.96$	$P < 0.05$	S
	ZOE	9	56.25	$Z > 1.96$	$P < 0.05$	S
	Neocone®	0	0	$Z > 1.96$	$P < 0.05$	S
7th	Alvogyl®	2	10.52	$Z > 1.96$	$P < 0.05$	S
	ZOE	5	31.25	$Z > 1.96$	$P < 0.05$	S
	Neocone®	0	0	$Z > 1.96$	$P < 0.05$	S
10th	Alvogyl®	0	0	$Z > 1.96$	$P < 0.05$	S
	ZOE	2	12.50	$Z > 1.96$	$P < 0.05$	S
	Neocone®	0	0	$Z > 1.96$	$P < 0.05$	S

S Significant

post extraction alveolitis where the clot disintegrates substantially or completely.

Study by MacGregor [15] showed a higher incidence of dry socket in females, which is consistent with the finding of the present study. This may be due to the fact that prior to 1960 oral contraceptives were not appreciably used [3]. Ygge et al. [21] and also Sweet and Butler [19] reported that oral contraceptive pills increased fibrinolytic activity in the blood and saliva of women during the menstrual phase. In our study there was a significantly higher incidence of AO among contraceptive users.

Nusair and Abu Younis [16] and Amaratunga and Senaratne [24] reported highest incidence of dry socket in 3rd and 4th decades of life. Krogh [25] reported a dramatic reduction in later decades. Most surgical extractions in these studies were performed in patients who were in their 3rd and 4th decades. Surgical extractions are generally associated with higher incidence of dry socket [16, 18]. Findings of the present study correlate well with the above.

With regard to the etiology responsible for tooth extraction and its plausible impact on the incidence of dry socket, the results of this study show a significant association ($P < 0.0001$). The incidence of dry socket was higher in cases of pericoronitis (13.9 %). These observations are in conformity with Nitzan [7] and Rozanis et al. [8], who have mentioned a higher incidence in situations with pre-existing local infection. Rud [26], Rozanis et al. [8], and Nitzan [7] reported that the frequency of dry socket increases in patients with poor oral hygiene. Results of the present study also appear to suggest the same. It would be reasonable to assume that oral bacterial load would be higher in patients with poor oral hygiene and as anaerobes, particularly *T. denticola*, are present in significant numbers in sites of pericoronitis, the risk of AO in these situations are high. These issues point towards the role of spirochetes such as *T. denticola* in the pathogenesis of this condition, even though they are known to multiply and lyse blood clots without eliciting clinical symptoms [7].

Table 6 Effect on signs of dry socket (redness around the socket)

Day	Medicament	Persistence of sign	Percent	Z-value	P value	Result
3rd day	Alvogyl®	10	62.50	$Z > 1.96$	$P < 0.05$	S
	ZOE	12	85.71	$Z < 1.96$	$P > 0.05$	S
	Neocone®	7	46.67	$Z > 1.96$	$P < 0.05$	S
5th day	Alvogyl®	6	37.50	$Z > 1.96$	$P < 0.05$	S
	ZOE	8	57.14	$Z > 1.96$	$P < 0.05$	S
	Neocone®	3	20	$Z > 1.96$	$P < 0.05$	S
7th day	Alvogyl®	3	18.75	$Z > 1.96$	$P < 0.05$	S
	ZOE	5	35.71	$Z > 1.96$	$P < 0.05$	S
	Neocone®	1	6.67	$Z > 1.96$	$P < 0.05$	S
10th day	Alvogyl®	0	0	$Z > 1.96$	$P < 0.05$	S
	ZOE	0	0	$Z > 1.96$	$P < 0.05$	S
	Neocone®	0	0	$Z > 1.96$	$P < 0.05$	S

S Significant

Nusair and Abu Younis [16] and Amaratunga and Senaratne [24] reported a higher incidence of dry socket in the mandibular arch when compared to maxillary arch. These tally well with the observations in the present study which show higher incidence in the mandibular arch (63.24 %), particularly the molar region. Further, it was noted that within the mandibular and maxillary arches, the third molar region (6.91 %) in the former and second molar region (1.97 %) in the latter had the highest incidence of dry socket. Anterior regions do not appear to be susceptible to this condition. Some authors believe that increased bone density and a reduced capacity for granulation tissue formation could be responsible for preponderance in the mandibular arch. However, there is no evidence suggesting a link between AO and insufficient blood supply. The area specificity is probably due to the large percentage of surgically extracted mandibular molars and may reflect the effect of surgical trauma rather than the anatomical site.

Nusair and Abu Younis [16] reported a lower incidence of dry socket after multiple extractions than after single tooth extractions, and these findings are consistent with the present study in which dry socket incidence was 0.62 % for multiple extractions and 2.70 % for single tooth extractions. It has been suggested that this difference could possibly be due to less pain tolerance in patients with single extractions compared to patients with multiple extractions, whose teeth have deteriorated significantly [16]. Moreover, multiple extractions involving periodontally diseased teeth may be less traumatic, and it is not infrequent in such situations to opt for primary alveoloplasty and primary closure. The latter may confer some clot protection benefits.

Birn [17], Nusair and Abu Younis [16], and Torres et al. [20] report that the incidence of dry socket was higher after trans-alveolar extraction than intra-alveolar extractions. This also correlates with results of the present study which show a much higher incidence after trans-alveolar

extraction (11.38 %) than intra-alveolar (1.36 %) extraction. This could be due to more liberation of direct tissue activators secondary to bone marrow inflammation that occurs after traumatic extractions.

The role of general health in dry socket is still controversial. Lilly et al. [18] and Torres et al. [20] believe that certain diseases (e.g., diabetes, bronchial asthma, liver diseases) result in impairment of immune system of the body and increase the possibility of dry socket following tooth extraction. Results of the present study appear to support earlier reports, as the difference in incidence between patients with medical comorbidities and otherwise healthy individuals was markedly high. Patients suffering from bronchial asthma displayed the highest incidence of dry socket followed by those with hyperthyroidism and diabetes mellitus. Higher incidence of AO in these patients might be due to the fact that these ailments generally affect wound healing adversely. Since AO also represents a state of adverse wound healing, it is not surprising to find a greater occurrence of this complication in such patients.

It has been proposed that smoking has a role in the pathogenesis of dry socket. Sweet and Butler [19] reported that smokers were four times likely to develop dry socket than non-smokers. In contrast, Gersel-Pedersen [27] denied such an effect. The results of the present study show a two times higher incidence in smokers in comparison with non-smokers. Whether a systemic mechanism or direct local affect (heat or suction) at the extraction site is responsible for this increase is unclear [9]. This phenomenon may also be due to the introduction of foreign substance that could act as a contaminant in the surgical site [3].

Pain relief remains the primary goal of treatment in cases of AO. Both Alvogyl® and ZOE contain eugenol, which has sedative and anodyne effects as well as anti-bacterial properties. Alvogyl® in addition contains butamben (anesthetic) and iodoform (antimicrobial).

Neocone[®] is an antibiotic-analgesic medicament containing polymyxine B sulfate, which has an effect on gram negative bacteria; tyrothricin, which has an effect on gram positive bacteria and spirochetes; neomycin sulfate, which has a wide range of impact; and tetracaine hydrochloride as local anesthetic.

Blum [3], Ahmad [6], and Bloomer [28] suggested the management of dry socket using ZOE.

Alexander [29] and Bloomer [28] recommend Alvogyl[®] for the management of dry socket. Syrjanen and Syrjanen [30] reported retardation of healing and inflammation when sockets were packed with Alvogyl[®]. Davor Katanec [31] encourage the use of Neocone[®] for the management of dry socket.

To the best of our knowledge, a comparative assessment of two or more medicaments has not been published thus far. One therefore remains confused with different articles in the literature propounding the merits of individual medicaments alone. A comparative assessment is therefore essential in order to make a rational choice. In the present study efficacy of medicaments was evaluated on the basis of ability to provide pain relief and clinical evidence of socket healing.

Statistically significant differences were observed in the pain scores among patients treated with Alvogyl[®], ZOE, and Neocone[®]. Results showed that initial onset of analgesia was quicker with Alvogyl[®], but Neocone[®] was able to provide early and lasting pain relief. Further, fewer change of dressings were required with Neocone[®] as compared to the other two.

The aim of treatment in dry socket has generally been palliation. However, pain is subjective and can vary in degree from person to person. It is important to evaluate other clinical parameters to provide a more objective comparison of treatment methods.

On evaluation of the improvement in signs of dry socket after dressings with the three medicaments under consideration, it was observed that the signs of empty socket and exposed bare bone completely subsided by the 7th day in the Neocone[®] treatment group. Only 1 (6.67 %) socket in this group had persistent redness around the affected area beyond the 7th day. In contrast, 33.33 % sockets in ZOE group and 21.05 % sockets in Alvogyl[®] group had persistence of emptiness of socket beyond the 7th day. Likewise, 31.25 % sockets in the ZOE group and 10.52 % sockets in Alvogyl[®] group continued to have exposed bone beyond 7 days after initiation of treatment. Redness around the socket also persisted beyond 7 days in 35.71 % of sockets treated with ZOE dressings and 18.75 % in those treated with Alvogyl[®].

These findings suggest a statistically significant difference in outcome between the three groups, with Neocone[®] clearly showing superior pain relief and healing potential as evidenced by improvement in clinical signs. However, the aspect of healing cannot be judged by clinical criteria alone. This aspect therefore needs histologic validation.

Conclusion

This study was undertaken to evaluate and compare the effectiveness of Neocone[®], Alvogyl[®], and ZOE dressings for the management of dry socket and to study epidemiological factors associated with the condition. From the results obtained, and comparing it with other studies conducted universally, it may be concluded that:

1. In order to establish the diagnosis of AO one probably needs to place emphasis upon the presence of pain following extraction that either appears or increases in severity within 2–5 days of the procedure. Further, this pain is poorly controlled with systemic NSAIDs. Other aspects such as clot disintegration with exposure of bone, halitosis, and redness around the socket may be found in only about 50 % cases, and while their presence is helpful in diagnosis of condition their absence either independently or collectively does not exclude AO.
2. Neocone[®] emerged as the most suitable dressing material for the management of dry socket by virtue of shorter time required for complete pain relief, fewer visits for dressing change, and faster clinical healing of the socket. Onset of pain relief with Alvogyl[®] was faster but not sustained. ZOE was most cost effective and easily available medicament for dressing. Intervention is preferably initiated immediately upon diagnosis. While all the three tested medicaments showed positive outcomes, Neocone[®] required the least replacement and was quicker in providing lasting pain relief. It may therefore be advantageous to use Neocone[®] dressings to facilitate faster recovery. To the patients, this may translate into earlier return to work and productivity.
3. Alveolar osteitis is more likely in young adults, females, smokers, patients with medical comorbidities, particularly asthmatics, and patients with poor oral hygiene and local infection such as pericoronitis. The likelihood is also higher in the mandibular molar region, particularly after trans-alveolar extractions and after singleton extraction rather than multiple. It is unclear whether these factors contribute to the risk independently or collectively. Further studies are

required to clarify this aspect in order to implement effective preventive strategy.

Conflict of Interest None.

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