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Original Article

Impact of stringent *versus* moderate glycaemic control on the outcome of necrotizing otitis externa

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Abstract

Glycaemic control is an essential component in necrotizing otitis externa (NOE) management. The aim of this study was to compare the impact of stringent *versus* moderate glycaemic control on the outcome of NOE. A retrospective cohort study carried out among 94 diabetic patients with NOE divided into 2 groups A&B. Patients in group A had stringent glycaemic control while those in group B had moderate glycaemic control. The two groups were then compared to each other as regards age, gender, culture results, cranial nerve palsy, HbA1C level, inflammatory markers including ESR and CRP levels, duration of hospitalization and surgical intervention. Groups A and B comprised 41 and 53 patients respectively. Pseudomonas aeruginosa was significantly lower in group A (P-value 0.04). Cranial nerve palsy was significantly lower in group A (P-value 0. 04). The mean HbA1c level±SD was significantly lower in group A (P-value<0.001). The mean ESR level±SD after 2 weeks of medical treatment was significantly lower in group A (P-value<0.001). Similarly, the mean CRP level±SD after 2 weeks of medical treatment was significantly lower in the group A (P-value 0.03). Patients in group A were associated with significantly less hospital stay (P-value<0.001) and less need for surgical intervention (P-value 0.03). Despite the risk of hypoglycaemia, stringent glycaemic control appeared to improve the outcome of NOE in comparison to moderate glycaemic control.

Keywords: stringent, moderate, glycaemic control, necrotizing otitis externa

Introduction

Necrotizing otitis externa (NOE) is a severe form of otitis externa where the inflammatory process extends beyond the external ear canal to reach the skull base resulting in skull base osteomyelitis which may be complicated by cranial nerve palsy or intracranial extension [1, 2]. The condition is mostly diagnosed among elderly diabetic patients [3, 4]. The most common causative organism of NOE is pseudomonas aeruginosa [5, 6]. In the past, surgery was the main line of treatment with high morbidity and mortality. When antipseudomonal antibiotics were introduced, medical treatment became the main line of treatment [7].

The pathophysiology of NOE includes microangiopathy as well as neuropathy which are associated with longstanding diabetes and old age. Such pathophysiology is someway identical to the pathophysiology of diabetic foot. Accordingly, NOE and diabetic foot share many similarities both in diagnosis and treatment [8].

Moderate glycaemic control targeting blood glucose level to be 140–180 mg/dl is recommended in most critically ill patients. Stringent glycaemic control targeting blood glucose level to be 110–140 mg/dl carries the risk of hypoglycaemia [9]. Although such stringent control appeared to be beneficial in certain situations, recent randomized control trials and metanalytic studies showed no significant benefits for targeting blood glucose level to be less than 140 mg/dl [10, 11].

Since glycaemic control is an essential component in management of NOE, we aimed to compare the impact of stringent *versus* moderate glycaemic control on

the outcome of NOE. Such comparison had never been discussed in the literature. Our study is the first study in literature that compared impact of stringent *versus* moderate glycaemic control on the outcome of NOE.

Material and methods

A retrospective cohort study that was carried out among 94 consecutive diabetic patients with NOE who were hospitalized at our tertiary referral centre in the period between December 2010 and December 2025. The study was approved by institutional ethics committee prior to its conduction (Code R.26.01.3524). Patients' medical records were collected and analysed. All involved patients were diabetic with moderate or stringent glycaemic control and had NOE meeting Cohen and Friedman criteria of obligatory (pain, oedema, exudate, granulations, microabscess, positive bone scan or failure of local treatment >1 week) and occasional clinical parameters (diabetes, cranial nerve involvement, positive radiograph, debilitating condition and old age). All patients were free from middle ear disease with no history of previous ear surgeries. Patients with incomplete medical records, non-diabetic patients, patients with poor glycaemic control, patients with middle ear disease and patients with history of previous ear surgery were all excluded. The data collected included patients' age, gender, main complaint at time of hospitalization, main finding at time of hospitalization, culture results, Glycated Haemoglobin (HbA1C) level, associated cranial nerve palsy, inflammatory markers including Erythrocyte Sedimentation Rate (ESR) and C-reactive protein (CRP) levels (at time of admission and after 2 weeks of medical treatment), duration of hospitalization and the need for surgical intervention.

The patients were then divided into 2 groups A&B according to the level of glycaemic control based on American Diabetic Association Guidelines [9]. Patients in group A had stringent glycaemic control with blood glucose maintained between 110–140 mg/dl. Patients in group B, on the other hand, had moderate glycaemic control with blood glucose level maintained between 140–180 mg/dl. The two groups were then compared to each other as regards age, gender, culture results, HbA1C level, associated cranial nerve palsy, ESR and CRP levels (at time of admission and after 2 weeks of medical treatment), duration of hospitalization and the need for surgical intervention.

Better outcome was considered ESR and CRP levels were low (after 2 weeks of medical treatment) together with less hospital stay and the less need for surgical intervention.

Statistical analysis

Data analysis was carried out using SPSS version 30 (SPSS Inc., Chicago, IL). Continuous variables were presented as mean±standard deviation (SD). Categorical variables were presented as frequency and percentages. Parametric variables were compared using t tests while categorical variables were compared using Chi-square test. All P-values were based on a two-tailed test of significance, with a P-value<0.05 considered as significant.

Results

Figure 1 shows the study diagram of the retrospective cohort. In the period between December 2010 and December 2025, 126 patients with NOE were hospitalized at our tertiary referral centre. Thirty-two patients were excluded (6 patients with incomplete medical records, 3 non-diabetic patients, 14 patients with poor glycaemic control, 5 patients with associated middle ear diseases and 4 patients with previous ear surgeries). After exclusion of those 32 patients, the remaining 94 patients were enrolled in the study.

The mean age±SD was 63.78±8.36 years. Fifty-eight patients were males (61.70%) and 36 patients were females (38.30%). The most common complaint at the time of hospitalization was pain, which was reported in 86 patients (91.94%). The most common finding at the time of hospitalization was oedema of external ear which was reported in 79 patients (84.04%). Pseudomonas aeruginosa was the most common isolated organism that was reported in 61 patients (64.89%). Sixteen patients (17.02%) had associated cranial nerve palsy. The mean HbA1C±SD was 8.28±1.33. The mean ESR level±SD at the time of admission was 65.98± 10.03 mm/hr. The mean ESR level±SD after 2 weeks of medical treatment was 54.71±10.44 mm/hr. The mean CRP level±SD at the time of admission was 27.53± 5.82 mg/L. The mean CRP level±SD after 2 weeks of medical treatment was 17.55±5.64 mg/L. The mean duration of hospital stay±SD was 20.64±3.53 days. Surgical intervention was indicated in 34 patients (36.17%) (Table 1).

The patients were then divided into 2 groups A and B based on the level of glycaemic control. Patients in group A had stringent glycaemic control while those

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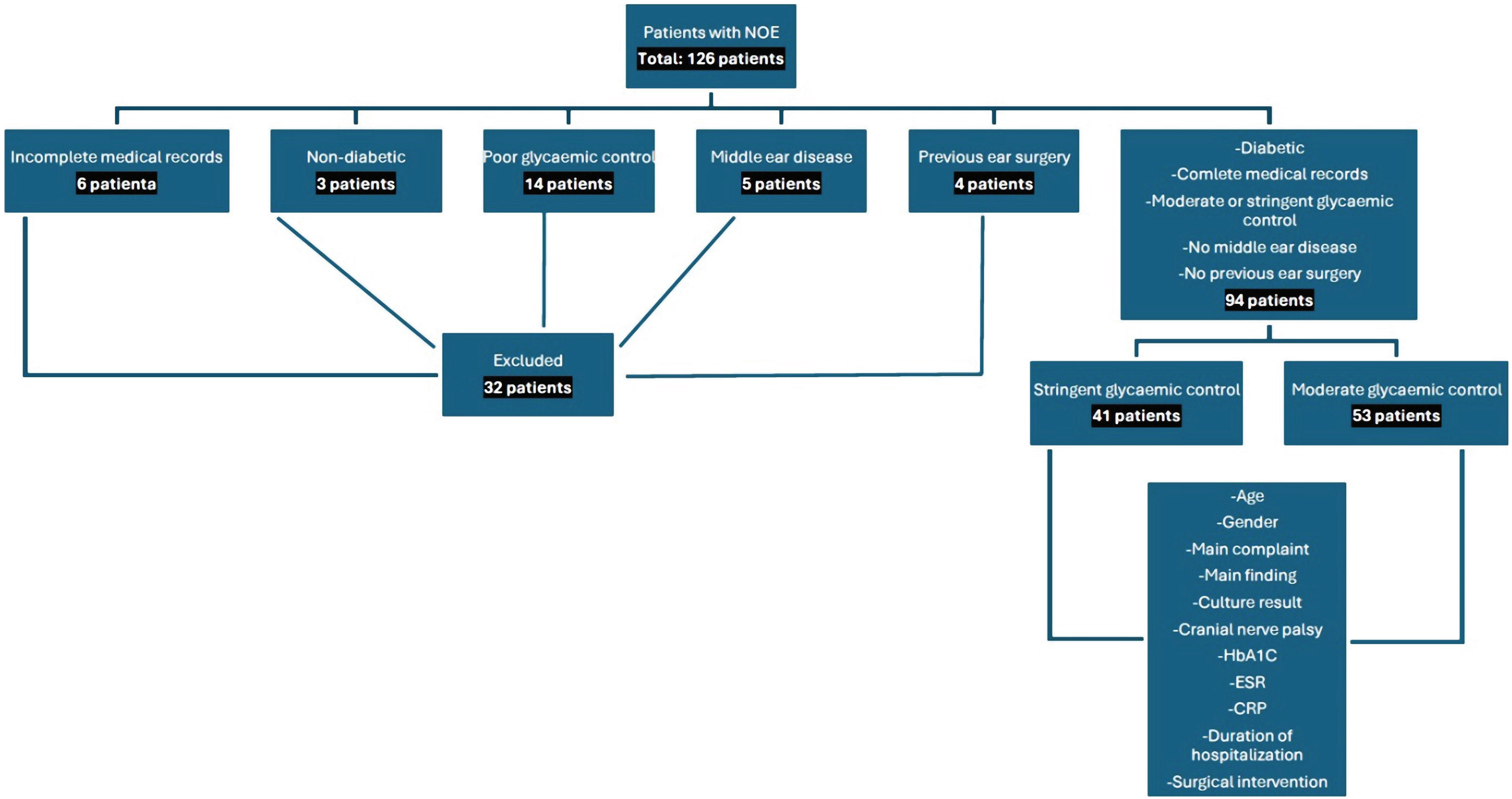

Figure 1: Study diagram of the retrospective cohort.

in group B had moderate glycaemic control. Group A comprised 41 patients (28 males and 13 females) while group B comprised 53 patients (30 males and 23 females). No statistically significant difference in gender distribution was reported between the two groups (P-value 0.84). The mean ages±SD of the patients in groups A and B were 65.41±8.40 and 62.66±8.51 respectively with statistically non-significant difference (P-value 0.08). Pseudomonas aeruginosa was the causative organism in 23 patients in group A (56.10%) and 38 patients in group B (71.70%) with statistically significant difference (P-value 0.04). Cranial nerve palsy was reported in 4 patients in group A (9.76%) and 12 patients in group B (22.64%) with statistically significant difference (P-value 0. 04). The mean HbA1c level±SD in group A was 7.32±1.05 while in group B it was 9.04±1.14 with statistically significant difference (P-value<0.001). The mean ESR levels±SD at the time of admission and after 2 weeks of medical treatment in group A were 64.29±10.70 mm/hr and 49.71±9.44 mm/hr respectively with statistically significant difference (P-value<0.001). The mean ESR levels±SD at the time of admission and after 2 weeks of medical treatment in group B were 67.28±9.37 mm/hr and 57.04±9.56 mm/hr respectively with statistically significant difference (P-value<0.001). When the mean ESR levels±SD at the time of admission was compared between groups A and B, no statistically significant difference was reported (P-value 0.22). On the other hand, when the mean ESR levels±SD after 2 weeks of medical treatment was compared, a statistically significant difference was reported (P-value<0.001). The mean CRP levels ±SD at the time of admission and after 2 weeks of medical treatment in group A were 26.27±5.80 mg/L and 15.64±5.67 mg/L respectively with statistically significant difference (P-value<0.001). The mean CRP levels ±SD at the time of admission and after 2 weeks of medical treatment in group B were 28.51±5.71 mg/L and 19.17±5.10 mg/L respectively with statistically significant difference (P-value<0.001). When the mean CRP levels±SD at the time of admission was compared between groups A and B, no statistically significant difference was reported (P-value 0.31). On the other hand, when the mean CRP levels±SD after 2 weeks of medical treatment was compared, a statistically significant difference was reported (P-value 0.03). The mean duration of hospital stay in group A was 18.83±3.75 days while in group B, it was 22.04±2.62 days with statistically significant difference (P-value<0.001). Twelve patients in group A (29.27%) needed surgical intervention in comparison to 22 patients in group B (41.51%) with statistically significant difference (P-value 0.03) (Table 2).

Discussion

Necrotizing otitis externa is a severe form of otitis externa where the inflammatory process extends beyond the external ear canal to reach skull base resulting in skull base osteomyelitis [12, 13]. The pathophysiology of NOE shares common features with diabetic foot. Both NOE and diabetic foot are caused by spread

Table 1: Patient's characteristics.

Age		63.78±8.36 years
Sex		Male: 58 (61.70%) Female: 36 (38.30%)
Organism		Pseudomonas: 61 (64.89%) Non pseudomonas: 33 (35.11%)
Cranial palsy		Yes: 16 (17.02%) No: 78 (82.98%)
HbA1c		8.28±1.33
ESR	At admission	65.98±10.03 mm/hr
	After 2 weeks of medical treatment	54.71±10.44 mm/hr
CRP	At admission	27.53±5.82 mg/L
	After 2 weeks of medical treatment	17.55±5.64 mg/L
Duration of hospitalization		20.64±3.53 days
Surgical intervention		34 (36.17%)

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Table 2: Comparison between Groups A and B.

		Group A (41 patients)	Group B (53 patients)	P-value
Age		65.41±8.40 years	62.66±8.51 years	0.08
Sex		Male: 28 (68.29%) Female: 13 (31.71%)	Male: 30 (56.60%) Female: 23 (43.40%)	0.84
Organism		Pseudomonas: 23 (56.10%) Non pseudomonas: 18 (43.90%)	Pseudomonas 38: (71.70%) Non pseudomonas: 15 (28.30%)	0.04
Cranial palsy		Yes: 4 (9.76%) No: 37 (90.24%)	Yes: 12 (22.64%) No: 41 (77.36%)	0. 04
HbA1c		7.32±1.05	9.04±1.14	<0.001
ESR	At admission	64.29±10.70 mm/hr	67.28±9.37 mm/hr	0.22
	After 2 weeks of medical treatment	49.71±9.44 mm/hr	57.04±9.56 mm/hr	<0.001
	P-value	<0.001	<0.001	
CRP	At admission	26.27±5.80 mg/L	28.51±5.71 mg/L	0.31
	After 2 weeks of medical treatment	15.64±5.67 mg/L	19.17±5.10 mg/L	0.03
	P-value	<0.001	<0.001	
Duration of hospitalization		18.83±3.75 days	22.04±2.62 days	<0.001
Surgical intervention		12 (29.27%)	22 (41.51%)	0.03

of the soft tissue inflammatory process into the underlying bone resulting in osteomyelitis. In addition, pseudomonas aeruginosa is the most common offending organism in both. Furthermore, microangiopathy is the most common pathological finding. Moreover, the lines of treatment are apparently similar and include glycaemic control, prolonged antibiotic therapy with surgery for patients unresponsive to medical treatment [8].

In most critically ill individuals, moderate glycaemic control targeting blood glucose level to be 140–180 mg/dl is usually sufficient [9]. Stringent glycaemic control targeting blood glucose level to be 110–140mg/dl is recommended in certain critically ill patients as those undergoing cardiac surgery [14, 15]. Moreover, stringent glycaemic control was found to enhance the healing of diabetic foot ulcers [16, 17] and decrease the risk of lower limb amputation [18, 19]. The main drawback of stringent glycaemic control is the risk of hypoglycaemia. Accordingly, continuous monitoring of blood glucose level is mandatory to avoid hypoglycaemia.

In our study, all involved patients were elderly diabetic patients with male predominance. The main complaint at the time of presentation was pain. The main finding at the time of presentation was diffuse oedema of the external ear canal. Pseudomonas aeruginosa was the most common causative organism. Associated cranial nerve palsy was reported in 17.02% of cases. All these findings were in agreement with the previously published studies [20–24].

When we compared patients with stringent glycaemic control with those with moderate control, no statistically significant differences in age or sex were found between the two groups.

HbA1C level was significantly lower in the stringent control group, and this was associated with less hospital stay and less need for surgical treatment. This finding was in agreement with Peled *et al*. and was explained by the fact that low HbA1C level at the time of disease onset indicates good diabetic control with less insemination of bacteria into the surrounding bone resulting in limited skull base osteomyelitis with better outcome [7].

Pseudomonas aeruginosa was the most common causative organism in both groups but with significantly higher prevalence among those with moderate control. This could be explained by the fact that the lower the glycaemic control the higher the dysfunction of polymorphonuclear leukocytes with more liability for pseudomonal infection [25].

Cranial nerve palsy is one of the complications of NOE and is an indicator of poor prognosis [26]. Such cranial nerve palsy is attributed to pseudomonal-produced neurotoxins as well as extensive skull base osteomyelitis [27]. In our study, the incidence of cranial nerve palsy was significantly lower in patients with stringent glycaemic control than in those with moderate control. This could be attributed to the lower prevalence of pseudomonal infection and hence pseudomonal-produced neurotoxins among patients with stringent control in addition to the less extensive skull base osteomyelitis in stringent glycaemic control if compared to those with moderate control.

Inflammatory markers including ESR and CRP levels are important parameters in NOE since they reflect the extent of inflammatory process as well as the response to medical treatment [28, 29]. In this study, the mean ESR and CRP levels±SD after 2 weeks of medical treatment were significantly lower in the stringent control group. This could reflect that stringent control reduced the inflammatory process due to limited skull base osteomyelitis. In addition, stringent glycaemic control was associated with greater response to medical treatment.

Accordingly, it is unsurprising to find that stringent glycaemic control was associated with less hospital stay and less need for surgical interventions owing to limited skull base osteomyelitis and better response to medical treatment. All these findings indicated that stringent glycaemic control could improve the outcome of NOE in comparison to moderate glycaemic control.

Conclusion

Despite the expected risk of hypoglycaemia associated with stringent glycaemic control, the improvement of the outcome in NOE could encourage its utilization with close monitoring of blood sugar to avoid hypoglycaemia.

Conflict of interest

The authors declare no conflict of interest.

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