Time trends in the prevalence of diagnosed sialolithiasis from Taiwanese nationwide health insurance dental dataset

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Abstract  Background/Purpose: Sialolithiasis, the so-called salivary gland stone, is a condition forming salivary calculi within a salivary gland or ducts. Little is known about the epidemiological survey of sialolithiasis in Taiwanese population. In this study, we conducted an age-period-cohort (APC) analysis evaluating the prevalence of sialolithiasis.

Materials and methods: A retrospective study was conducted to analyze the registered database compiled by the Taiwanese National Health Insurance Research Database from 1996 to 2013. The APC analysis was performed to investigate the effects of age, diagnosis period, and birth cohort with sialolithiasis.

Results: We found that the prevalence of sialolithiasis varied from 1.4 (10^5) to 2.3 (10^5). The mean age ± standard deviation with sialolithiasis from 1996 to 2013 was 37.7 ± 18.5 and 46.2 ± 18.6 years old, respectively. The prevalence was higher among male than female (RR: 1.10; 95% CI: 1.05–1.15, p < 0.001). The age > 65 group had higher risk compared to age < 40 group (RR: 2.27; 95% CI: 2.13–2.43, p < 0.001). The relative risk for sialolithiasis demonstrated significant age effect (p < 0.001). The relative risk for sialolithiasis did not show the significant period effect (p = 0.742). The relative risk for sialolithiasis demonstrated significant cohort effect (p = 0.01). The relative risk for sialolithiasis demonstrated significant APC effect (p = 0.002).

Conclusion: From this nationwide population-based database, the prevalence of sialolithiasis occurs more frequently in male than in female. In addition, the relative risk for sialolithiasis demonstrated the significant APC effects.

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Introduction

Sialolithiasis is characterized by a calcified mass within a salivary gland or duct mainly in major salivary gland and very rare in minor salivary glands. This condition usually leads to the obstruction of salivary duct and subsequently results in increased risk of bacterial infections. The symptoms are swelling, inflammation, and pain caused by the obstruction of physiological salivary flow and commonly meal related.\textsuperscript{2,3}

The prevalence of sialolithiasis was between 1 and 2\%.\textsuperscript{4} From the literature review, the incidence rate of sialolithiasis was found about 2.9 and 5.5 per 100,000 person-years based on selected hospital data.\textsuperscript{5–7} Recently, the incidence rate of symptomatic sialolithiasis in Denmark was between 7.3 and 14.1 per 100,000 person-years.\textsuperscript{8}

Little is known about the status of sialolithiasis in Taiwan. In this study, the prevalence of sialolithiasis was investigated by using National Health Insurance Research Database (NHIRD) from 1996 to 2013. The age-period-cohort (APC) analysis was performed to investigate the effects of age, diagnosis period, and birth cohort on sialolithiasis.

Materials and methods

Data source and ethical consideration

This study was approved by the Ethics Review Board at the Chung Shan Medical University Hospital. Dental dataset (DN),\textsuperscript{9} dental original claim data for ambulatory care expenditures by dental visit, was used for this retrospective study. Due to this dataset was analyzed anonymously, no informed consent from participants was required. This DN has been used for the epidemiology survey for dental diseases\textsuperscript{10,11} and even the conditions of emergency dental visits.\textsuperscript{12}

Patient identification and measurements

The diagnosis of sialolithiasis was identified according to the International Classification of Disease, Ninth revision (ICD-9), code of 527.5. In this study, we identified dental visit patients with diagnosed sialolithiasis during the period between January 1, 1996 and December 31, 2013 for annual prevalence rate of sialolithiasis from DN.

APC analysis was performed to investigate the effects of age, diagnosis period, and birth cohort with sialolithiasis as described by Yu et al.\textsuperscript{13} Cases of sialolithiasis were categorized into 17 age groups (0–4 to 80–84), 3 period groups (1999–2004, 2005–2009, and 2010–2013), and 19 birth cohort groups (1918–2008) with a corresponding 5-year interval. Several models such as age alone, period alone, cohort alone, and age-period-cohort were generated. The goodness of fit for the specified model was evaluated by the deviance/degree of freedom (DF).

Statistical analysis

The relative risk of sialolithiasis from 1996 to 2013 after adjusting for year, age, and gender was evaluated by multivariate Poisson regression. Relative risk (RR), percent per year (PPY), and 95% confidence interval (CI) of sialolithiasis by APC analysis were calculated. All statistical analyses were performed with the SPSS version 18 (SPSS, Chicago, IL, USA).

Results

The sex-specific annual prevalence of sialolithiasis from 1996 to 2013 is presented in Table 1. The prevalence of sialolithiasis was ranged from 1.4 (per 10\(^5\)) to 2.3 (per 10\(^5\)). The average annual prevalence was 1.918 (per 10\(^5\)). As shown in Fig. 1, the mean age of patients with sialolithiasis was 46.24 years old. The prevalence of sialolithiasis stratified by age was shown in Fig. 2. The relative risk for sialolithiasis after APC analysis were calculated. All statistical analyses were performed with the SPSS version 18 (SPSS, Chicago, IL, USA).

In summary, the age and cohort effect were associated with the risk for sialolithiasis. As shown in Table 3, the relative risk for sialolithiasis demonstrated significant age effect (\(p < 0.001\)). In the period effect, there was not significant difference in the relative risk of sialolithiasis in different eras (Fig. 3B). As shown in Table 3, the relative risk for sialolithiasis did not show the significant period effect (\(p = 0.742\)).

In the cohort effect, the results demonstrated a significant higher sialolithiasis risk than the generation from 1978 to 2003 as compared with 1963 as a reference generation (Fig. 3C). As shown in Table 3, the relative risk for sialolithiasis demonstrated significant cohort effect (\(p = 0.01\)).

In summary, the age and cohort effect were associated with the risk for sialolithiasis. As shown in Table 3, the relative risk for sialolithiasis demonstrated significant APC effect (\(p = 0.002\)).
Discussion

In this study, the average annual prevalence of sialolithiasis was 1.918 (per 10^5) in Taiwan. The nationwide incidence of hospital-admitted sialolithiasis have been evaluated in Denmark based on ICD10 diagnosis.7,8 However, this is the first nationwide population based study to investigate the prevalence of sialolithiasis.

In this study, male had higher risk suffering from sialolithiasis than female. Similar results were found by Sigismund et al.3 in Germany, and Stelmach et al.14 in Poland. There was no significant gender difference in a University Hospital, San Francisco, USA. However, Schrøder SA et al.8

Table 1 Prevalence of sialolithiasis by gender.

| Year | Total | Male | Female |
|------|-------|------|--------|
| N    | No. of Sialolithiasis P | N    | No. of Sialolithiasis P | N    | No. of Sialolithiasis P |
| 1996 | 21,525,433 380 | 1.8 11,065,798 198 | 1.8 10,459,635 181 | 1.7 1.1 |
| 1997 | 21,742,815 502 | 2.3 11,163,764 248 | 2.2 10,579,051 253 | 2.4 1.0 |
| 1998 | 21,928,591 507 | 2.3 11,243,408 270 | 2.4 10,685,183 237 | 2.2 1.1 |
| 1999 | 22,092,387 355 | 1.6 11,312,728 179 | 1.6 10,779,659 176 | 1.6 1.0 |
| 2000 | 22,276,672 336 | 1.5 11,392,050 200 | 1.8 10,884,622 135 | 1.2 1.5 |
| 2001 | 22,405,568 376 | 1.7 11,441,651 215 | 1.9 10,963,917 158 | 1.4 1.4 |
| 2002 | 22,520,776 370 | 1.6 11,485,409 221 | 1.9 11,035,367 148 | 1.3 1.5 |
| 2003 | 22,604,550 327 | 1.4 11,515,062 192 | 1.4 11,089,488 166 | 1.5 1.0 |
| 2004 | 22,689,122 348 | 1.5 11,541,585 192 | 1.7 11,147,537 156 | 1.4 1.2 |
| 2005 | 22,770,383 372 | 1.6 11,562,440 199 | 1.7 11,207,943 173 | 1.5 1.2 |
| 2006 | 22,876,527 447 | 2.0 11,591,707 236 | 2.0 11,284,820 211 | 1.9 1.1 |
| 2007 | 22,958,360 396 | 1.7 11,608,767 196 | 1.7 11,349,593 200 | 1.8 1.0 |
| 2008 | 23,037,031 417 | 1.8 11,626,351 229 | 2.0 11,410,680 188 | 1.6 1.2 |
| 2009 | 23,119,772 443 | 1.9 11,636,734 221 | 1.9 11,483,038 222 | 1.9 1.0 |
| 2010 | 23,162,123 433 | 1.9 11,635,225 220 | 1.9 11,526,898 213 | 1.8 1.0 |
| 2011 | 23,224,912 460 | 2.0 11,645,674 225 | 1.9 11,579,238 235 | 2.0 1.0 |
| 2012 | 23,315,822 474 | 2.0 11,673,319 261 | 2.2 11,642,503 213 | 1.8 1.2 |
| 2013 | 23,373,517 470 | 2.0 11,684,674 245 | 2.1 11,688,843 225 | 1.9 1.1 |

P: prevalence rate per 100,000 population.

Table 2 Relative risk (RR) of sialolithiasis by multivariate Poisson regression.

| RR | 95% C.I. | p value |
|----|---------|---------|
| Year (per 1 year) | 1.00 | 0.99 | 1.00 | 0.281 |
| Age (ref: <40) | 1.76 | 1.68 | 1.85 | <0.001 |
| ≥65 | 2.27 | 2.13 | 2.43 | <0.001 |
| Gender (ref: female) | Male | 1.10 | 1.05 | 1.15 | <0.001 |

a Adjusted for year, age and gender.

Table 3 The results of age-period-cohort model for sialolithiasis.

| Model | DF | Deviance | Deviance/DF | P-Value |
|-------|----|----------|-------------|---------|
| Age | 15 | 118.49 | 7.90 | <0.001 |
| Period | 1 | 0.11 | 0.11 | 0.742 |
| Cohort | 17 | 33.53 | 1.97 | 0.01 |
| Age-Period-Cohort | 1 | 9.57 | 9.57 | 0.002 |

DF: degree of freedom.

Figure 1 Time trends for the mean age of patients with sialolithiasis from 1996 to 2013.

Figure 2 Age-specific group in the prevalence of sialolithiasis in Taiwan from 1996 to 2013.
who reported female had higher risk suffering from sialolithiasis than male in Denmark. The reason is not quite clear. There may be due to different race, geography region, and the contents of drinking water.

APC model is as a parametric statistical model widely used in epidemiology research to estimate the independent effect of age, time period and birth cohort rates of a particular event. Age effects are associated with the outcome of time. Period effects can affect all ages simultaneously over time. Birth cohort effects involve changes across groups with the same birth year who presented the same outcome during the same period. APC provides important clues for social, historical, and environmental factors that impacts disease morbidity or mortality. To the best of our knowledge, this is the first APC analysis of sialolithiasis in the world. The relative risk for sialolithiasis demonstrated significant APC effect.

The strength of this study was the use of same methodology to investigate the prevalence of sialolithiasis in data available from cross-sectional analysis conducted from 1996 to 2013. The use of a nationwide population-based database can provide sufficient sample size, generalizability, and statistical power to assess the status of sialolithiasis in Taiwan.

Birth cohort effects involve the changes across groups with the same birth year who presented the same outcome during the same period. The birth cohorts showed the highest ratio of sialolithiasis from 1998 to 2003. The reason may explain as following. In Taiwan, the National Health Insurance (NHI) program launched in 1995. Therefore, it is speculated that the NHI system has successfully improved the early diagnosis and the treatment demand of this disease. Taken together, this result can be a reference for developing the relevant oral health policies or promoting the prevention of sialolithiasis in specific age groups. It may assist in treatment strategies in this national dental care system for sialolithiasis.

However, there are still some limitations in this study. First, the prevalence of sialolithiasis might be underestimated by using DN database. It would miss to collect the diagnosis of sialolithiasis from medical doctors, especially the specialty on ear, nose, and throat. However, DN is the records of all dental visit per year from 1996 to 2013. This could provide the long-term monitor of diagnosed sialolithiasis from dental treatment. Second, the diagnosis of sialolithiasis was based on ICD-9 code. It could not obtain the actual locations of sialolithiasis form which salivary glands, either major or minor. Third, sialolithiasis can be difficult to diagnose because the sialolith is not always possible to visualize and the variation in the severity of symptoms. Therefore, further studies are required to identify the histopathological, examination with X-ray or sialography to improve the accurate diagnosis of sialolithiasis. Finally, one of the proposed factors is tobacco smoking. The DN dataset without the status of smoking should be noted.
Although the above limitations raise that may need future investigations, this study still remains valuable because it provides the first nationwide population-based survey in Taiwan currently. Our study revealed the prevalence of sialolithiasis occurs more frequently in male than in female. The relative risk for sialolithiasis demonstrated significant APC effects.

Conflicts of interest

The authors declare no conflict of interest.

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