



Do changing trends in tonsil surgery affect hemorrhage rates? A longitudinal study covering 1,452,637 procedures

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Abstract

Purpose To evaluate whether changing trends in tonsil surgery between 2005 and 2017 in Germany were associated with different age- and gender-specific hemorrhage rates.

Methods A longitudinal population-based inpatient cohort study was performed including all patients who had undergone tonsillectomy (with or without adenoidectomy), tonsillotomy, abscess-tonsillectomy, removal of tonsillar remnants and surgical treatment to achieve hemostasis following tonsil surgery. The population was stratified by age (groups of 5 years) and gender. Operation rates were calculated in relation to the end-year population number according to the German Federal Office of Statistics.

Results The surgical rates per 100,000 had significantly decreased from 170.39 to 90.95 (46.62%) in female patients and from 147.33 to 88.19 (40.14%) in male patients within the study period ($p < 0.001$). A total of 42,352 female patients had required surgical treatment to achieve hemostasis following 783,005 procedures (5.41%). In contrast, only 669,632 operations were performed in male patients but were complicated by hemorrhage in 51,185 cases (7.64%) which was significantly different ($p < 0.001$). The male-to-female ratio of the surgical rates had increased from 0.86:1 to 0.93:1. Hemorrhage rates differed significantly between age groups ($p < 0.001$). Male gender is a significant risk factor for bleeding at all ages < 85 years with greatest differences in 20- to 25-year-old patients (12.19% male vs. 6.26% female).

Conclusions Changing trends in tonsil surgery are not associated with increased rates of bleeding complications. Hemorrhage following tonsil surgery is significantly related to age and gender and this should be noted when reported hemorrhage rates in the literature are appraised by the reader.

Keywords Tonsillectomy · Tonsillotomy · Tonsillitis · Pharyngitis · Abscess · Tonsil

Introduction

Tonsillectomy, with or without adenoidectomy, is commonly performed to resolve either recurrent episodes of acute tonsillitis or upper airway obstruction due to tonsillar hypertrophy [12, 29]. The total number of procedures is decreasing in most states of the European Union [2], including Germany [26]. Due to the low postoperative morbidity reported in the relevant literature [27], the proportion of patients scheduled for tonsillotomy is increasing in Germany [26]

and has become the procedure of choice at least in Sweden [9]. Despite the strongest efforts of all surgeons to avoid it, hemorrhage remains the most significant, sometimes life-threatening complication of tonsil surgery resulting either in re-admission or prolonged length of stay [16, 18, 28]. A significant number of abscess-tonsillectomies is performed in Germany, too. The rate seems gradually to decrease [26] although the procedure is not associated with an increased risk of postoperative hemorrhage [25, 31]. This population-based study was undertaken to longitudinally evaluate whether the aforementioned changing patterns in tonsil surgery had an impact on hemorrhage rates in male and female patients of different age groups.

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Materials and methods

A bespoke report was commissioned by the authors from the Federal Office for Statistics [32]. The database was interrogated for all patients who had undergone tonsillectomy (with or without adenoidectomy; code 5-282.0; 5-281.0), tonsillotomy (code 5-281.5), abscess-tonsillectomy (code 5-281.1), removal of tonsillar remnants (code 5-281.4) and surgical treatment to achieve hemostasis following tonsil surgery (code 5-289.1). All procedures were performed on an inpatient basis within German hospitals, outpatient procedures were not registered. The population was stratified by age (groups of 5 years) and gender. Operation rates per 100,000 were calculated for each calendar year as the total number of operations divided by the end-year population number according to the database of the German Federal Office of Statistics [33]. Indication for surgery was an invalid search criterion. Bleeding rates were calculated for each calendar year as the total number of procedures to achieve hemostasis (5-289.1) divided by the total number of operations (5-281.0+5-281.1+5-282.0+5-281.4+5-281.5). Bleeding rates were calculated for the entire population and for each age group.

A two-sided Chi square test was used to detect differences concerning age groups and gender (SPSS V 25 for Windows). A *p* value <0.05 was considered significant. The

study was exempt from ethic approval according to §15 of the Professional Code of Conduct of the regional medical Association (Nordrhein).

Results

The number of procedures had decreased significantly within the study period with an increasing male-to-female ratio from 0.83:1 in 2005 to 0.94:1 in 2017 (Fig. 1). Accordingly, the surgical rates per 100,000 had significantly decreased from 170.39 to 90.95 (– 46.62%) in female and from 147.33 to 88.19 (– 40.14%) in male patients within the study period (*p* < 0.001; Fig. 2). The male-to-female ratio of the surgical rates had increased from 0.86:1 in 2005 to 0.93:1 in 2017.

A total of 42,352 female patients had required surgical treatment to achieve hemostasis following 783,005 procedures (5.41%; Fig. 3; Table 1). In contrast, only 669,632 operations were performed in male patients but were complicated by hemorrhage in 51,185 cases (7.64%; Fig. 3; Table 2), which was significant (*p* < 0.001).

Hemorrhage rates differed significantly between each of the age groups (*p* < 0.001) and were similar in male and female patients below an age of 15 years (Fig. 4). Male gender was a significant risk factor for all ages < 85 years with a stepwise increase in patients, who were 15 years and older.

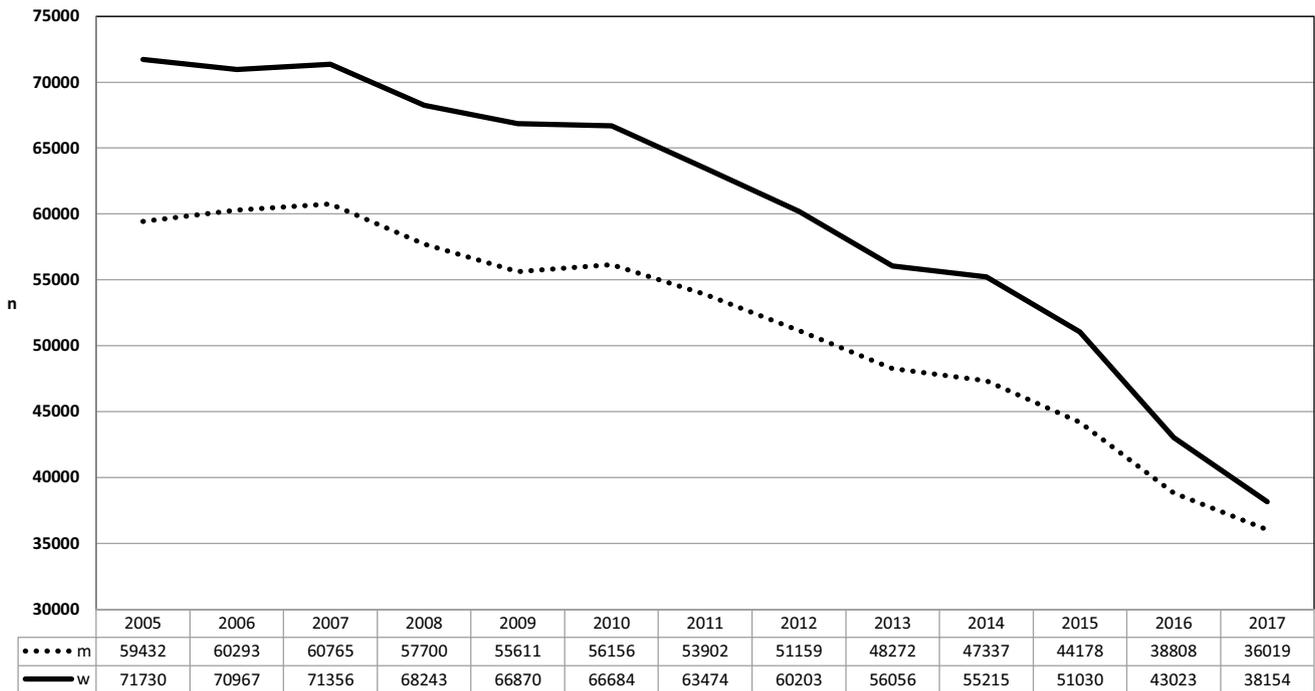


Fig. 1 Tonsil surgery: annual number of procedures stratified by gender. The total number of patients who underwent tonsillectomy (with or without adenoidectomy), tonsillotomy, abscess-tonsillectomy,

removal of tonsillar remnants had decreased gradually within the study period. The male-to-female ratio increased, but remained significantly different (*p* < 0.001)

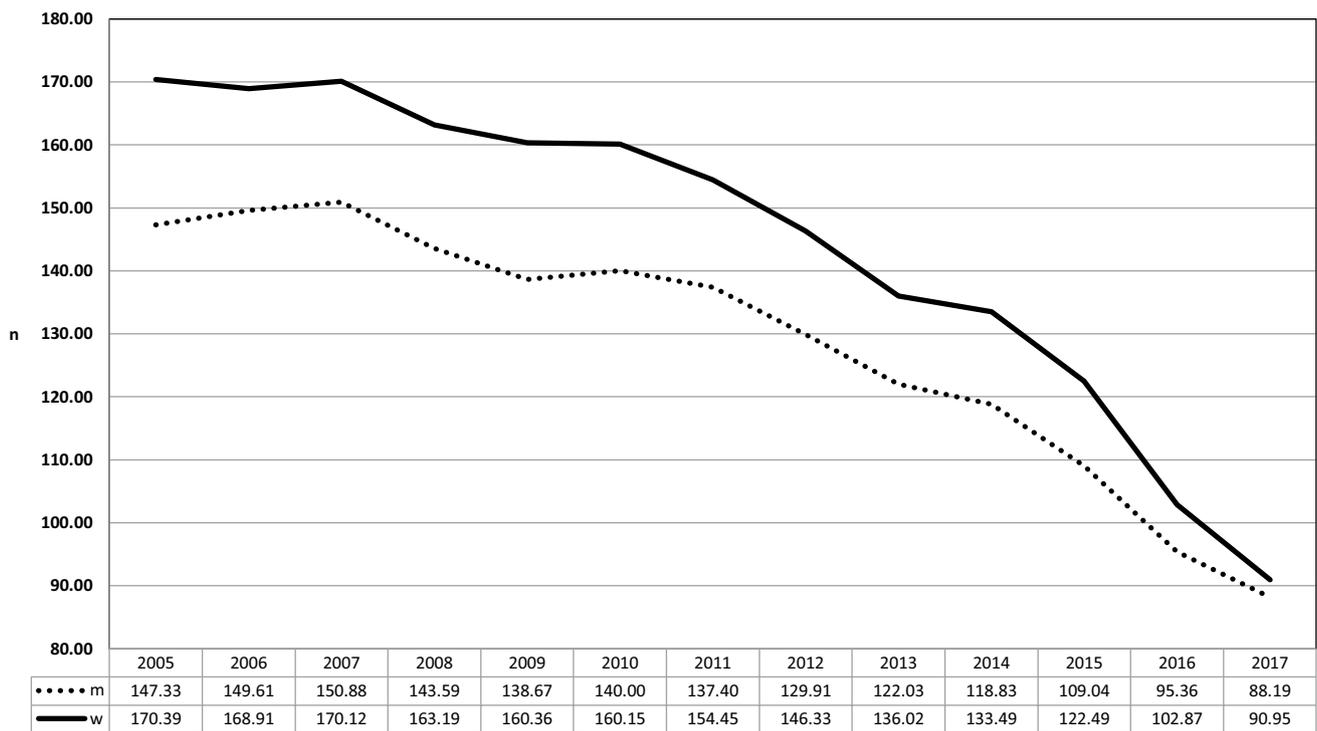


Fig. 2 Tonsil surgery: annual rates per 100.000 stratified by gender. The operation rate per 100.000 was significantly different with a preponderance of female patients ($p < 0.001$) between 2005 and 2017

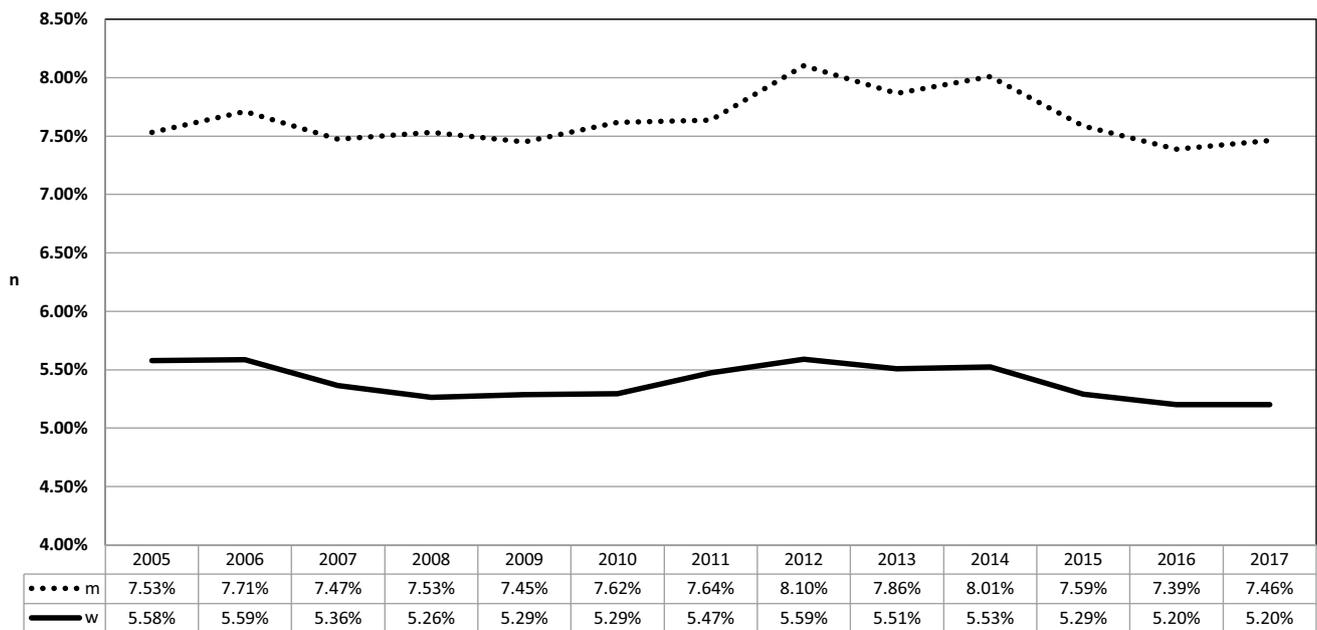


Fig. 3 Annual postoperative hemorrhage rates stratified by gender. Within the study period, the hemorrhage rates remained stable in male and female patients. The higher prevalence in male patients was significant ($p < 0.001$)

Table 1 Age-specific hemorrhage rates in 783,005 female patients, stratified by age and year

	All ages (%)	<5 (%)	5–10 (%)	10–15 (%)	15–20 (%)	20–25 (%)	25–30 (%)	30–35 (%)	35–40 (%)	40–45 (%)	45–50 (%)	50–55 (%)	55–60 (%)	60–65 (%)	65–70 (%)	70–75 (%)	75–80 (%)	80–85 (%)	85–90 (%)	90–95 (%)
2005	5.58	4.65	5.21	5.26	5.81	5.71	6.57	6.18	5.61	5.06	5.23	4.75	5.10	6.41	4.86	9.13	6.92	6.82	0.00	0.00
2006	5.59	3.75	4.97	5.33	5.67	6.34	6.61	7.02	5.97	5.24	3.88	5.66	4.94	5.57	7.61	9.05	5.38	12.00	4.17	0.00
2007	5.36	3.32	4.56	5.23	5.77	6.35	6.17	5.59	4.97	5.89	4.61	5.84	6.29	6.57	6.68	9.77	6.80	6.67	5.26	0.00
2008	5.26	3.14	4.81	5.76	5.23	5.94	5.92	5.32	5.51	5.08	4.52	6.60	6.02	6.26	7.77	7.81	10.34	2.70	10.34	0.00
2009	5.29	3.23	4.70	5.39	5.43	5.76	6.04	5.78	4.98	5.41	5.29	7.07	5.48	6.24	8.28	5.28	5.30	6.90	11.43	40.00
2010	5.29	2.89	4.44	5.31	5.57	6.24	6.35	5.23	5.63	4.81	5.31	5.44	5.53	6.72	6.16	9.27	13.95	9.72	15.79	0.00
2011	5.47	3.04	4.48	5.62	5.89	6.07	6.54	5.83	5.84	4.80	5.73	5.78	6.22	6.01	5.38	8.82	10.69	10.96	13.16	0.00
2012	5.59	3.44	4.95	5.42	6.13	6.45	5.81	5.44	6.34	5.63	5.74	5.81	6.40	6.30	4.01	7.17	6.36	9.46	9.52	0.00
2013	5.51	2.79	3.98	5.59	5.82	6.32	6.58	6.83	6.30	5.74	5.44	6.06	6.07	5.91	5.63	4.95	6.08	7.02	20.00	0.00
2014	5.53	2.65	4.08	5.83	5.95	6.62	6.84	5.95	5.74	5.47	5.16	5.19	5.88	5.95	6.36	8.99	7.18	6.06	13.51	14.29
2015	5.29	1.70	3.28	4.26	5.88	6.44	7.20	6.58	6.97	5.89	4.37	5.21	5.60	5.33	5.62	5.42	10.05	4.35	2.04	0.00
2016	5.20	1.25	2.62	5.50	6.44	7.03	6.35	6.69	6.35	4.39	4.96	4.29	5.38	6.70	9.33	5.70	10.38	2.53	3.70	7.14
2017	5.20	1.91	3.26	4.93	6.49	6.59	7.20	6.39	6.28	4.90	3.83	6.13	4.08	4.45	4.58	4.26	8.67	2.50	0.00	20.00
Mean	5.40	2.91	4.26	5.34	5.85	6.30	6.48	6.06	5.89	5.26	4.93	5.68	5.61	6.03	6.33	7.35	8.32	6.74	8.38	6.26
Median	5.36	3.04	4.48	5.39	5.82	6.34	6.54	5.95	5.84	5.24	5.16	5.78	5.60	6.24	6.16	7.81	7.18	6.82	9.52	0.00
STD	0.15	0.90	0.78	0.40	0.36	0.37	0.44	0.60	0.57	0.47	0.64	0.73	0.65	0.63	1.56	1.97	2.60	3.16	6.35	12.06

The annual hemorrhage rates did not differ significantly within individual age groups and all ages. Maximum mean and median values were identified for two age groups (20–25 years; 85–90 years). With the exception of two age groups (85–90 years; 90–95 years) rates were significantly lower in all individual age groups compared to male patients ($p < 0.001$).

Table 2 Age-specific hemorrhage rates in 669,632 male patients, stratified by age and year

	All ages (%)	<5 (%)	5–10 (%)	10–15 (%)	15–20 (%)	20–25 (%)	25–30 (%)	30–35 (%)	35–40 (%)	40–45 (%)	45–50 (%)	50–55 (%)	55–60 (%)	60–65 (%)	65–70 (%)	70–75 (%)	75–80 (%)	80–85 (%)	85–90 (%)	90–95 (%)
2005	7.53	4.66	4.96	6.25	8.27	11.12	11.71	9.53	9.31	8.36	7.90	8.50	7.09	10.41	7.75	13.13	12.03	17.78	6.67	0.00
2006	7.71	4.02	5.29	5.93	9.89	11.90	11.62	10.17	9.54	7.64	8.54	9.05	10.60	7.90	10.38	11.78	8.09	15.25	15.38	66.67
2007	7.47	3.60	4.60	6.00	9.11	11.99	12.19	10.42	9.71	7.55	9.78	8.11	9.79	7.13	8.75	10.68	12.16	8.70	17.65	0.00
2008	7.53	3.41	4.71	6.61	9.57	10.98	10.75	9.43	9.66	8.53	9.55	8.39	7.86	9.58	10.68	10.27	15.11	14.47	11.11	0.00
2009	7.45	3.33	4.48	5.17	9.21	11.69	10.89	9.46	10.01	8.62	7.49	8.95	9.17	9.71	10.21	13.78	8.92	10.98	21.43	0.00
2010	7.62	3.13	4.70	5.58	9.87	11.84	12.23	9.77	9.90	8.81	8.87	9.11	8.73	7.96	9.40	11.16	9.63	12.36	38.89	0.00
2011	7.64	3.05	4.48	5.51	10.59	11.69	11.64	9.98	9.94	8.22	8.19	8.17	7.65	10.07	11.43	11.41	13.12	4.94	17.65	0.00
2012	8.10	3.65	5.50	5.92	9.70	13.03	11.74	11.28	9.21	8.52	7.43	7.87	8.35	11.02	9.74	13.84	8.86	7.14	38.46	33.33
2013	7.86	3.26	4.31	6.55	10.31	11.66	12.11	10.33	9.24	8.96	7.61	7.75	8.90	10.45	15.27	10.69	14.29	16.67	19.23	0.00
2014	8.01	2.83	4.17	5.83	10.80	13.63	11.38	11.09	10.97	9.10	8.02	9.02	8.32	9.56	9.32	13.83	9.64	10.64	34.38	16.67
2015	7.59	1.76	3.34	4.82	10.74	12.48	12.01	10.76	10.24	8.93	9.60	8.05	8.31	9.84	12.61	10.39	15.15	14.15	7.69	50.00
2016	7.39	1.61	2.90	3.99	11.59	13.18	12.50	11.37	11.21	8.34	8.82	8.60	8.28	9.65	9.02	13.83	9.09	21.52	7.41	33.33
2017	7.46	1.72	3.23	5.62	10.61	15.04	12.25	11.69	10.84	9.02	7.96	7.33	9.31	10.34	10.69	7.57	13.52	11.29	14.81	37.50
Mean	7.64	3.08	4.36	5.67	10.02	12.32	11.77	10.41	9.98	8.51	8.44	8.38	8.64	9.51	10.41	11.72	11.51	12.76	19.29	18.27
Median	7.59	3.26	4.48	5.83	9.89	11.90	11.74	10.33	9.90	8.53	8.19	8.39	8.35	9.71	10.21	11.41	12.03	12.36	17.65	0.00
STD	0.22	0.91	0.78	0.71	0.88	1.13	0.53	0.77	0.66	0.49	0.82	0.56	0.93	1.15	1.92	1.90	2.58	4.54	11.28	23.29

The annual hemorrhage rates did not differ significantly within individual age groups and all ages. Maximum mean and median values were identified for two age groups (20–25 years; 85–90 years). With the exception of two age groups (85–90 years; 90–95 years) rates were significantly higher in all individual age groups compared to female patients ($p < 0.001$)

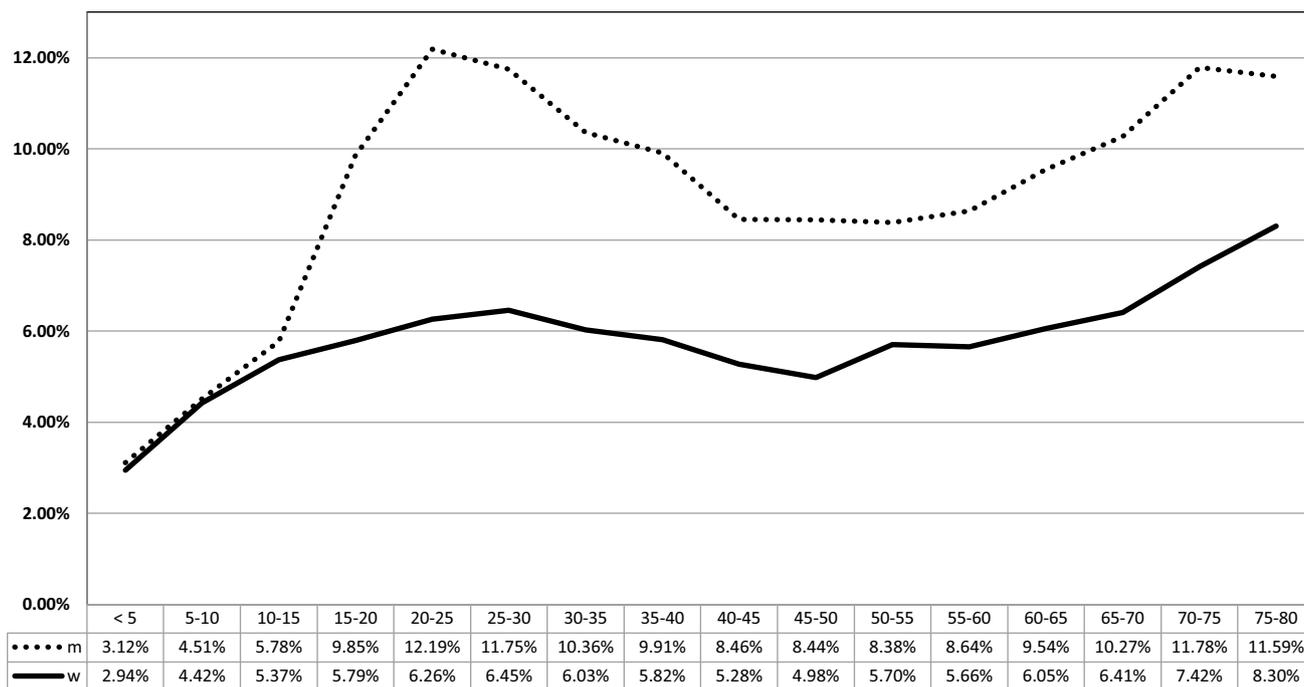


Fig. 4 Hemorrhage rates stratified by age and gender for the total patient population ($n=1,452,637$). The prevalence of postoperative bleeding was clearly related to age. Similar rates in male and female patients were identified only below an age of 15 years. Due to the large number of patients in these age groups, the difference

was statistically significant. Male patients, who were 15 years and older had a significantly higher bleeding risk, culminating at an age of 20–25 years. Bleeding rates of patients older than 80 years of age were not included in the figure because tonsillectomy at this age is uncommon

The greatest difference was registered for 20- to 25-year-old patients (12.19% male vs. 6.26% female).

Discussion

Hemorrhage remains the most significant complication of tonsillectomy with rates of primary bleeding (< 24 h) ranging from 0.2 to 2.2% and rates of secondary bleeding (> 2 h) ranging from 0.1% to 3% [12]. The authors of the updated tonsillectomy guideline recommended outcome assessment for bleeding, including annual analyses of bleeding rates in a key action statement [12]. Hemorrhage rates should be analyzed not only at individual institutions but on a national basis to react early [14] in case of surprising results [17, 23]. Unfortunately, a national tonsil surgery register does not exist in Germany. However, tonsillectomy is based on an inpatient basis in Germany and all inpatient procedures are uniformly reported by the hospitals to the Federal Office of Statistics. It is, therefore, unlikely, that our data material missed any patient. An exception exists only for the unknown proportion of outpatient tonsillectomies, but we estimate the number to be 8.000 in 2017, according to personal correspondence of the first author with health insurance companies.

National standards concerning hospitalization of tonsillectomy patients not only vary across countries [3, 8, 12] but may also change with time [5, 15]. Independent of the inpatient or outpatient philosophy we assume that hemorrhage requiring revision surgery (return-to-theatre) is internationally accepted as a good indication for hospitalization. Due to the specified coding (5-281.9), we could select all surgical procedures to achieve hemostasis following inpatient as well as outpatient tonsil surgery and calculate bleeding rates for a large patient population. Unfortunately, it was impossible to elaborate details about the onset of bleeding. However, there are usually two options associated with post-tonsillectomy hemorrhage: re-admission or prolonged length of stay. Besides planning of hospital beds for these emergency cases, an escalation of total healthcare costs has to be taken into account (not subject of this study) [19]. Our study was initiated to clarify whether changing trends in tonsil surgery [26] had an impact on bleeding complications. The finding of a significant decline in tonsillectomy cases was reported also for 16 of 24 EU Member States. Small increases were reported only for Spain and the United Kingdom, and increases over 20% were reported for Croatia (2012–2016), Cyprus (2012–2016), Sweden and Slovenia [8].

Surgical technique

It is noteworthy to emphasize that the prevalence of post-tonsillectomy hemorrhage depends on the surgical technique used for dissection and to achieve hemostasis [11, 20, 22]. A national survey in Germany covering 54,572 operations had revealed that cold dissection was performed in 84.73% of all cases with transoral suture ligation in combination with bipolar coagulation to achieve hemostasis in 65.9% [30]. In Austria, this technique was applied to 87.3% of all 5913 operations [21]. In Sweden, 65.3% of 15,734 procedures were undertaken with this technique. In contrast, cold dissection of the tonsils was performed in only 35% of 33,921 operations in England and Northern Ireland [20]. The latter, large-scale study clearly identified electrosurgery to be a risk factor for post-tonsillectomy hemorrhage, particularly secondary bleeding. Our finding of constant bleeding rates within each age group and within each gender group within the study period supports the idea that the surgical standard has not significantly changed in Germany.

Epidemiology

While some studies are limited by age [4, 7, 10], our study population included all ages comparable to others [13, 17, 20, 23]. There was a preponderance of female gender in our study which was also reported for other studies [17, 20,

24] while some authors identified a male preponderance [13, 23]. Our study revealed also that the male-to-female ratio increased which has not been reported before and remains open for scientific explanation. Male gender was a significant risk factor for bleeding complication throughout the entire study period (Fig. 3). While this confirms earlier findings either in children [5, 6], adults [1, 7] or a general patient population [13, 20, 23, 25], we identified this phenomenon not only for the entire study population (Fig. 3) but also for 17 of 19 age groups (Tables 1, 2). These two age groups encompassed patients who were 85 years and older.

The most striking point of our study is the age- and gender-specific risk profile for hemorrhage following tonsil surgery (Fig. 4). To the best of our knowledge, this scientifically unexplainable phenomenon has never been disclosed by other authors; previous research had included other procedures to resolve tonsil-related diseases [26]. Figure 4 reveals a clear cutoff value at an age of 15 years with a peak between the ages of 20 and 30 years when differences between male and female hemorrhage rates were greatest. Even if the hemorrhage rates seem to be similar in male and female patients younger than 15 years of age, the difference was statistically still significant ($p < 0.001$) due to the large number of patients in these age groups (Fig. 5). The comprehensive national data material of our study appears suitable to improve comparison with surgical results

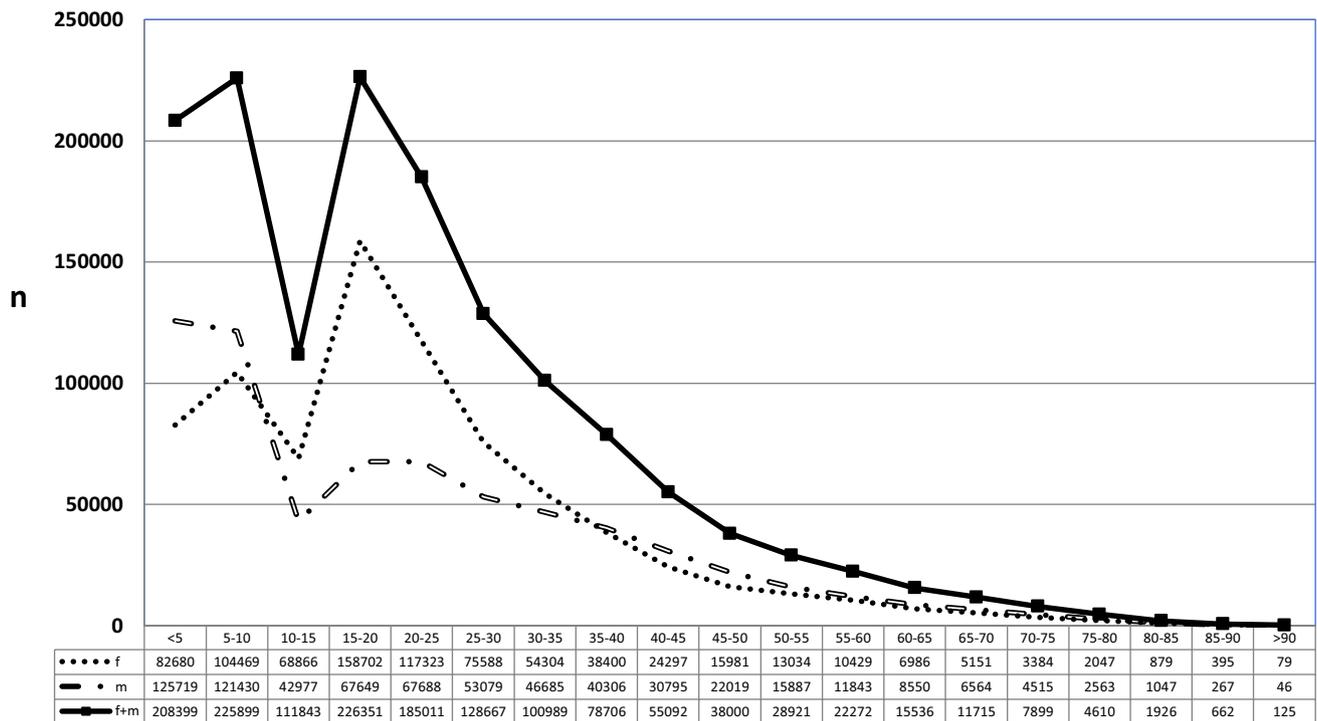


Fig. 5 Distribution of age groups stratified by gender for the total patient population ($n = 1,452,637$). Preponderance of female gender changed and peaked in patients who were 15 to 20 years of age. Male preponderance was registered in patients < 10 , > 35 and < 85 years of age

Limitations

The power of our study was limited by the quality of data provided by the Federal Office of Statistics. Therefore, information was obtainable only for the years 2005–2017. Nevertheless, we thought the database is sufficient enough to draw firm conclusions.

The number of outpatient procedures is not available from the Federal Office of Statistics and unfortunately not obtainable from the Health Insurance Companies (> 100 in Germany). However, tonsil surgery is commonly performed on an inpatient basis in Germany and tonsillotomy is only in part performed on an outpatient basis.

Coding problems may have occurred: a secondary tonsillectomy as a result of regrowth after tonsillotomy could have been coded either as tonsillectomy (5-281.0) or removal of tonsillar remnants (5-281.4). However, this is not a confounding factor concerning the population size in our study. Although not recommended by the current guideline [29], we cannot exclude that some institutions may have performed a secondary TE after incision and drainage to resolve a peritonsillar abscess. However, we estimate the number to be insignificant.

The data material does provide information on a patient level. Therefore, we are unable to say whether procedures to achieve hemostasis resulted from our patient population or from outpatient procedures. In the light of the population size, we estimate this to be insignificant.

Our study does not provide information about the prevalence of repeated bleeding episodes requiring revision surgery. Furthermore, we are unable to give information about the prevalence of minor bleeding episodes that did not require revision surgery (coded as 5-289.1) but justified inpatient observation. Finally, the surgical techniques may have changed within the study period, each associated with an individual “bleeding profile” in terms of primary (< 24 h) and secondary (> 24 h) bleeding. Unfortunately, the data quality was insufficient to provide information about this the surgical techniques and the onset of bleeding. Finally, information on indications for surgery on a patient level was not obtainable from the database.

Conclusions

The total number and rates of tonsil surgery is gradually decreasing in Germany. Male gender is associated with an increased risk of postoperative bleeding and this was significant for all ages < 85 with a sharp and stepwise increase in male patients who are 15 years and older. Postoperative hemorrhage is clearly related to age and gender. Further

studies should include indications, surgical instruments and onset of bleeding to facilitate benchmarking of results of individual surgeons

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Research involving human participants This article does not contain any studies with human participants or animals performed by any of the authors. The study was exempt from ethical approval according to §15 of the Professional Code of Conduct of the regional medical Association (Nordrhein).

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