Surgical management of follicular thyroid carcinoma in children and adolescents: A study of 30 cases

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ABSTRACT

Background/Purpose: The purpose of the study is to describe the anatomoclinical, diagnostic, therapeutic and prognostic aspects of pediatric follicular thyroid carcinoma (FTC) in order to choose the best therapeutic strategy.
Methods: Our study includes patients ≤18 years old surgically treated for FTC in four Italian Pediatric Surgery Centers from January 2000 to March 2017. The collected data were compared with those of 132 patients matched for age with a histological diagnosis of papillary thyroid carcinoma (PTC) surgically treated in the same institutions during the same period and with the data of patients diagnosed with FTC found in the literature; p-values <0.05 were considered significant.
Results: 21 (70%) of the 30 patients with a histological diagnosis of FTC underwent hemithyroidectomy while 9 (30%) underwent total thyroidectomy. 11 (55%) out of 21 patients were subjected to a completion of thyroidectomy. All patients are alive (OS = 100%) without recurrence or relapse of the disease. Compared with PTC, FTC is significant for capsule infiltration ($p < 0.0001$), vascular invasion ($p = 0.0014$) and T-stage T3-T4 ($p = 0.013$). However, multifocality ($p < 0.001$), extrathyroid extension ($p < 0.0001$) and lymph node metastasis ($p < 0.0001$) are more evident in PTC.
Conclusion: The conservative approach seems to be a valid surgical treatment for pediatric patients diagnosed with MI-FTC. For patients with wide vascular invasion and/or a tumor >4 cm, especially with high after-surgery Tg rate, a completion of thyroidectomy is recommended. In patients with multifocal neoplasia, and/or tumor size ≥4 cm, and/or extrathyroid extension, and/or lymph node metastasis, and/or distant metastasis, total thyroidectomy followed by radioiodine therapy is generally indicated.
Levels of Evidence: II.

Thyroid carcinoma represents the most common endocrine neoplasia during pediatric age, with an incidence of 0.4–0.7 cases out of 100,000 children and adolescents between 0 and 18 years old. The most common type (about 90%) in children and adolescents is papillary thyroid carcinoma (PTC), followed by follicular thyroid carcinoma. The incidence of both types increases by about 1% each year, while the prevalence decreases over time [1–12]. Iodine deficiency and exposure to ionizing radiations represent the main risk factors of FTC [13–17]. In patients treated with radiotherapy for Hodgkin's Lymphoma, leukemia or central nervous system tumors, the FTC incidence reaches 2% each year, with a peak occurring 15–25 years after exposure [18–24]. In some geographical areas, the FTC percentage of all the differentiated thyroid cancers (DTC) increases by 40 (for example, in Byelorussia and Ukraine after the nuclear disaster of Chernobyl) [13–16]. Alterations in RAS, PIK3CA, PAX8/PPARγ genes seem to have an important role especially in adult FTC [25–27]. FTC is included in the components of the PTEN Hamartoma Tumor Syndrome, including the Cowden Syndrome, caused by germinal mutations in PTEN [28–33].

Abbreviations: FTC, Follicular Thyroid Carcinoma; DTC, Differentiated Thyroid Carcinoma; PTC, Papillary Thyroid Carcinoma; LN, lymph node; FNAC, Fine Needle Aspiration Cytology; US, Ultrasonography; MI-FTC, Minimally Invasive Follicular Thyroid Carcinoma; WI-FTC Widely Invasive, Follicular Thyroid Carcinoma; RAI, Radioactive Iodine-Therapy; TT, Total Thyroidectomy; HT, Hemithyroidectomy; TC, Completion of Thyroidectomy.
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FTC is classified in Minimally Invasive-FTC (MI-FTC) and in Widely Invasive-FTC (WI-FTC). Encapsulated neoplasms with microscopic tumor capsule invasion and/or limited vascular invasion are defined as MI-FTC. Large invasive neoplasms, lack of complete tumor encapsulation, multifocality, extended vascular invasion, widespread invasion in thyroid parenchyma and/or adjacent tissues are features of WI-FTC [34–38]. The postoperative histological diagnosis is based on the identification of these features. Fine needle aspiration cytology (FNAC) is insufficient for the diagnosis of FTC, although diagnostic sensibility is included between 65% to 98% while specificity is 73% to 100% [37,39]. However, an intraoperative histological examination on frozen sections is not recommended for a diagnosis of MI-FTC owing to the difficulty in differentiating an MI-FTC from a follicular adenoma or from a PTC encapsulated follicular variant [40]. Although WI-FTC has generally a worse prognosis in adult patients, it is reported similar to MI-FTC in children and adolescents [11,12,41,42]. A bias owing to a misdiagnosis of PTC, a follicular variant, cannot be excluded.

There are only a few articles on FTC in pediatric and adolescent age in the literature. Many studies associate FTC to PTC in their surgical approach, although the two neoplasms have different clinical and pathological characteristics. Furthermore, thyroidectomy extension in FTC treatment is still debated [9,42,43]. Our study describes the anatomoclinical, therapeutic and prognostic characteristics of pediatric and adolescent patients affected by FTC compared with our pediatric patients affected by PTC and with pediatric patients affected by FTC reported in the literature from 1997 to 2017. The most relevant articles published in Pubmed and/or Google Scholar on pediatric FTC consist mostly of case reports [43,44] with the exception of Enomoto et al. [42], who report the surgical experience of 20 patients aged between 11 and 20 years old. The purpose of our study is to significantly contribute to the surgical approach of FTC in pediatric and adolescent patients.

1. Materials and methods

This retrospective study is based on the observation of FTC patient ≤18 years old, in a 17 year period (January 2000–March 2017), operated at the Pediatric and Adolescent Surgery Division of the University of Pisa, the Pediatric Surgery Division of the University of Padua, the Pediatric Surgery Division of Bambino Gesù Children Hospital in Rome and the Surgery Division of "Istituto Nazionale dei Tumori" in Milan. The studied variables were: age at diagnosis, sex, medical history, clinical presentation, diagnostic tests (thyroid US; chest X-Ray; FNAC; thyroid scintigraphy; neck MRI), surgical therapy (total thyroidectomy TT; hemithyroidectomy HT; completion of thyroidectomy TC), cervical lymphadenectomy (central lymph nodes compartment and lateral lymph nodes compartment), histological type (FTC classical form, FTC Hürtle cell variant), WHO classification (minimally invasive MI-FTC, widely invasive WI-FTC), tumor capsule invasion, vascular invasion, multifocality and TNM staging [45]. Furthermore, postoperative complications (transitory hypoparathyroidism; definitive hypoparathyroidism; injury of the recurrent laryngeal nerve), postoperative treatment (hormonal manipulation and radioactive iodine-therapy, RAI) and follow up were analyzed. All patients, after both radical and conservative surgery, were subjected to hormonal therapy (thyroid-stimulating hormone suppression) with a Levo-Thyroxin dose (according to the patients' age and weight) to obtain an optimal value of TSH <0.3 UI/ml, to control neoplastic proliferation and to prevent the progression and recovery of disease [46]. Radioactive iodine remnant ablation was performed within 6 weeks after radical surgery, following ATA guidelines [47].

The follow-up after TT consisted in laboratory tests and instrumental exams: calcium serum level, dosage of thyroid hormones (TSH, FT3, FT4, Tg, anti-Tg Ab), thyroid US and total-body scintigraphy. The monitoring of thyroglobulin (Tg) levels was employed for the detection of disease recurrences [48].

The first postoperative follow-up was done after about 6 weeks in a hypothyroid state using a total-body scintigraphy with iodine-131. A total body scintigraphy was repeated after 6–12 months from the first one, after an appropriate suspension of the suppressive therapy. At the end of the follow-up, patients were considered without clinic evidence of disease if they had: serum suppression of the thyroglobulin (Tg <1 ng/mL), lack of antithyroglobulin antibodies (anti-Tg Ab), total lack of local or distant disease at imaging (US, CT, X-Ray) and/or positivity of disease to control biopsy. The follow-up after-HT included: a clinical test, a yearly chest X-Ray and a serum dosage of thyroid hormones (FT3, FT4, TSH, Tg and anti-Tg Ab) every 6 months during the first 2 years, then annually. The reference value for Tg obtained one month after surgical treatment was considered between 0 and 5 ng/mL. The thyroid US was performed two times a year during the first 5 years, then yearly [6]. The data of patients diagnosed with FTC were compared with those of 132 patients of the same age with histological diagnosis of PTC, subjected to TT in the same institutes and during the same years and with the data of 20 young patients operated for FTC found in the literature [42].

1.1. Data analysis

Categorical data were described by frequency, whereas continuous data were described by mean and standard deviation. To evaluate the normality of the quantitative data distributions, the Kolmogorov–Smirnov test was performed. The assessment of the qualitative variables was realized by the z-test for proportions and by the chi-square test, whereas the quantitative variables were analyzed with the t test (two-tailed). Finally, a correlation analysis between tumor size and age was carried out with the Pearson Method. The value of $p < 0.05$ was considered statistically significant and the p-value between 0.05 and 0.1 indicated a "trend toward significance". All analyses, descriptive and inferential, were performed using SPSS v.24 technology.

2. Theory

To date, surgical indications for FTC and PTC in pediatric age have not been very dissimilar. An in-depth knowledge of the anatomoclinical and prognostic aspects of both carcinomas, obtained through our statistical correlation on patients treated in the same period in four major university centers, contributes to a more appropriate management of these neoplasms and helps select patients who need to be treated with a conservative approach from those who need to be treated with a radical surgical one. This study also deals with the relevant issues concerning the evaluation and treatment of cervical lymph nodes and the postoperative radioiodine therapy adopted. Moreover, it lays the groundwork for further investigation so that every pediatric patient affected by thyroid carcinoma may have a tailored surgical treatment.

3. Results

Between January 2000 and March 2017, 30 patients with a histological diagnosis of FTC were surgically treated and diagnosed in referral centers for thyroid pathologies. Dedicated pediatric thyroid pathologists performed all diagnoses. There were 8 (27%) males and 22 (73%) females. The age range was 5–18 years: 18 cases (60%) ≤15 years old and 12 (40%) >15 years old. Mean age at the time of diagnosis was 13.73 ± 3.83 years: 13.75 ± 4.86 years old for males, and 13.73 ± 3.52 years old for females. The age division is reported in Table 1. Nine patients (30%) were familiar to thyroid disease and all of them reported a history of multinodular goiter.

At the objective examination, 21 patients (70%) had a cervical tumefaction in the anterolateral region of the neck, while the diagnosis was accidental in the remaining 9 patients (30%), because a thyroid examination was performed during **total body screening US**. These patients did not present a statistically significant difference from the rest of the

Table 1
Frequency of patients for age at diagnosis and sex.

Age (years)	Number of patients	Pts %	Males %	Females %
0–5	2	7	50	50
6–10	5	17	20	80
11–15	11	36	18	82
16–18	12	40	33	67

cohort, either by gender, age or familiarity. The size of the follicular lesion was generally smaller in patients with an incidental diagnosis: average size of tumor was 16.1 mm (range 7–24 mm) vs. 25.8 mm (range 7–75 mm).

All 30 patients underwent thyroid US (100%), and 25 of them also underwent FNAC (83%), 13 patients (43.3%) had a chest X-Ray, one patient (0,03%) had a thyroid scintigraphy and one patient (0,03%) had an MRI. Patients were surgically treated by four pediatric surgeon, each belonging to one of the four hospitals; 21 patients were operated in Pisa, 4 patients in Padua, 3 in Milan and 2 in Rome.

The surgical therapy was conservative (HT) in 21 patients (70%) and radical (TT) in 9 patients (30%). For the 21 patients subjected to a conservative surgical treatment as a first approach, 11 (52%) were operated a second time with completion of thyroidectomy (TC) after their definitive histological report. A lymphadenectomy of the central and lateral cervical section was performed in 3 patients (10%) owing to clinically suspected metastatic lesions. Postoperative complications occurred in 7 patients (23%), 5 (71.4%) after a TT and 2 (28.6%) after a TC; a transitory hypoparathyroidism occurred in 4 patients (57%); a definitive hypoparathyroidism occurred in 2 (28%) and a lesion of the recurrent laryngeal nerve occurred in one patient (15%). As detailed in Table 2, 28 were MI-FTCs (93.4%) and 2 (6.6%) were WI-FTCs. Of the MI-FTCs, tumor capsule invasion was present in all cases, while vascular invasion was present in 9 patients (30%). There weren't any cases of multifocality in the thyroid parenchyma. The 2 cases of WI-FTC were diagnosed on the basis of large invasive neoplasms tumor size, lack of complete tumor encapsulation, multifocality, extended vascular invasion (>3 vascular foci), widespread invasion into thyroid parenchyma and/or adjacent tissue characterization. None of the three patients subjected to lymph nodal dissection had lymph nodal metastasis at the histological examination. The average size of tumor was 25.81 ± 16.92 mm (range: 7–75 mm). According to TNM [45], classification of T was: T1a (Tumor ≤1 cm, limited to the thyroid) in 3 patients (10%); T1b (Tumor >1 cm but ≤2 cm in greatest dimension, limited to the thyroid) in 10 (33%); T2 (Tumor size >2 cm but ≤4 cm, limited to the thyroid) in 12 (40%); T3 (Tumor size >4 cm, limited to the thyroid or any tumor with minimal extrathyroidal extension to sternothyroid muscle or perithyroid soft tissues) in 5 (17%) [45]. The correlation between tumor size and age at time of diagnosis was not statistically significant

Table 2
FTC and PTC histological types and classification.

FTC type	Number of cases (%)
Minimally Invasive Follicular thyroid carcinoma (MI-FTC)	28 (93,4)
Minimally Invasive Follicular Carcinoma, NOS	20 (66.7)
Minimally Invasive Follicular Carcinoma, Hürtle-cell variant	8 (26.7)
Widely Invasive Follicular thyroid carcinoma (WI-FTC)	2 (6.6)

PTC type	Number of cases (%)
Conventional variant of PTC	75 (56.8)
Follicular variant of PTC	37 (28)
Diffuse sclerosing variant	7 (5.3)
Tall cell variant	7 (5.3)
Trabecular variant	4 (3)
Poorly differentiated variant	2 (1.6)

(p = 0,277). None of the cases had lymph nodal metastasis (N0) and/or distant metastasis (M0). The mean follow-up was 72.8 ± 34.62 months (6–120 months range). All our patients are alive and well (OS = 100%). No patient has shown any recurrence of disease or after-surgery relapse. Regarding postoperative treatments, 8 patients (27%) executed an adjuvant RAI treatment after TT. All patients have been treated with TSH-suppressive action substitutive Levo-Thyroxin. The statistical analysis of 30 FTC patients (18.5%) and 132 PTC patients (81.5%) is reported in Table 3. Starting from hypothesis zero which states that PTC and FTC have identical clinical characteristics in patients and the hypothesis that there are overlapping data in terms of clinical characteristics and treatment, we made adequate statistical tests. P-values >0.05 did not result significant and confirmed the similarity between the compared patients, while p-values ≤0.05 showed the substantial differences between the two groups. Compared to the PTC, FTC was significantly associated with tumor capsule invasion (p < 0.0001), vascular invasion (p = 0.014) and T stage T3-T4 (p = 0.013).

Multifocality (p < 0.0001), extrathyroid extension (p < 0.0001) and lymph-nodal metastasis (p < 0.0001) were associated with PTC. Compared to the data we found in the literature, the type of surgical treatment is significant (p = 0.071; p = 0.037). This fact shows the clear difference in the choice of surgical treatment in our study; that is, we performed more primary TT and more TC compared to Enomoto [42] (Table 4).

4. Discussion

FTC in pediatric and adolescent age is very rare and there are not enough studies on it. It represents 10%–20% of the DTCs and the most frequent variant after PTC [3,45]. Current guidelines and scientific articles often group the two neoplasms together, even though they behave differently in terms of aggressiveness, nodal and distant metastasis pattern and recurrence of disease. The choice of the surgical treatment (HT vs. TT and completion vs. not completion) is still controversial owing to the limited amount of studies in the literature. Enomoto study [42] has the biggest case series found in the literature, with 20 cases of FTC (aged between 11 and 20 years). Thus, to our knowledge, our current study on 30 cases (aged between 5 and 18 years) is the most extensive and its results contribute to our knowledge of FTC during pediatric and adolescent age. In our series, FTC represents 18.5% of DTC, with a peak incidence in 16–18 year olds and a prevalence in females (M:F = 1:3). In addition, our patients are highly familiar with multinodular goiter (30% of patients). We believe that this datum deserves attention because there is a potential genetic interest both for multinodular goiter and follicular cell-derived well-differentiated thyroid cancer, as reported in the recent literature [49,50]. Our study confirms the different clinical–pathologic scenario between FTC and PTC in pediatric age with respect to PTC; pediatric FTC may be less aggressive and associated with less advanced disease, fewer distant metastases and a lower rate of recurrence. FTC exceptionally spreads to regional lymph nodes, but it is subjected to vascular spread and distant metastases mainly at lung and bone without contemporaneous lymph nodal involvement [44]. MI-FTC is typically uninodular while WI-FTC largely involves the thyroid parenchyma [37]. Neoplasia is often present in remarkable dimensions: in fact, more than 50% of our cases presented a neoplastic mass > 2 cm. Behavior is dramatically different between the two forms: MI-FTC is a quite indolent tumor, whereas WI-FTC can be an ominous tumor. In accordance with the literature and at variance with adult age, MI-FTC represents about 90% of cases, with good outcome. This fact explains the very good prognosis of FTC in pediatric age, similar to PTC [37,42,51,52]. Regarding lymph nodal metastasis, our patients and Enomoto et al. study patients are similar enough with a nonsignificant p-value (p = 0.803). All patients with MI-FTC presented a tumor capsular invasion which essentially differentiates a follicular adenoma from a FTC. 30%–45% of the patients presented a vascular invasion, but

Table 3
Clinical and pathological correlations between PTC patients' and FTC patients' characteristics.

	Value PTC	Value FTC	p-value
Patients, n	132	30	
Gender, n (%)			
Female	100 (75.8)	22 (73.3)	0.965
Male	32 (24.2)	8 (26.7)	
Female/male Ratio	3.1	2.7	
Age, years			
Mean +/− SD	14.3 ± 3.5	13.7 ± 3.8	0.405
Range	4–18	5–18	
≤15	69 (52.3)	18 (60)	0.573
>15	63 (47.7)	12 (40)	
Tumor size, (cm)			
Mean ± SD	2.4 ± 1.7	2.58 ± 1.69	0.562
≤1	17 (12.9)	3 (10)	
1.1–2	52 (39.4)	11 (36.6)	0.999
2.1–4	45 (34.1)	12 (40)	
>4	18 (13.6)	4 (13,4)	
Infiltration of the thyroid capsule, n (%)			<**0.01**
Yes	73 (55.3)	30 (100)	
No	59 (44.7)	0	
Vascular invasion, n (%)			**0.014**
Yes	14 (10.6)	9 (30)	
No	118 (89.4)	21 (70)	
Multifocality, n (%)			<**0.0001**
Yes	51 (38.6)	0 (0)	
No	81 (61.4)	30 (100)	
Homolateral	16 (12.1)	0 (0)	
Bilateral	35 (26.5)	0 (0)	
Extrathyroid Extension			
Yes	63 (47,7)	0 (0)	<**0.0001**
No	69 (53,3)	30 (100)	
T stage, n (%)			
T1	41 (31.1)	13 (43)	0.301
T2	28 (21.2)	12 (40)	0.055
T3	54 (40.9)	5 (17)	**0.025**
T4	9 (6.8)	0 (0)	0.304
T3-T4	63 (47.7)	5 (16.7)	**0.013**
N stage, n (%)			
N0	59 (44.7)	30 (100)	<**0.0001**
N1	73 (55.3)	0 (0)	
Lymph node metastasis, n (%)	73 (55.3)	0 (0)	
Central only	17 (12.9)	0 (0)	
Lateral only	25 (18.9)	0 (0)	
Central and lateral	31 (23.5)	0 (0)	
M stage, n (%)			
M0	122 (92.4)	30 (100)	0.256
M1	10 (7.6)	0 (0)	
Radioiodine Treatment, n (%)			
Yes	130 (98.5)	8 (27)	<**0.0001**
No	2 (1.5)	22 (73)	
Follow up, (years)			
Mean ± SD	4.7 ± 2.3	6 ± 3.46	**0.013**
Range	1–14	0.5–10	
Persistence, n (%)			
Complete remission	119 (90.2)	30 (100)	0.156
Persistence of disease	13 (9.8)	0	
Recurrence, n (%)			
Thyroid bed	5 (3.8)	0 (0)	0.617
Lymph nodal	6 (4.5)	0 (0)	0.518
Lung	2 (1.5)	0 (0)	0.806
Total	13 (9.8)	0 (0)	0.157

Table 4
Clinical and pathological correlations between our FTC patients' and Enomoto et al. [42] FTC patients' characteristics.

	Value FTC	Value FTC Enomoto	p-value
Patients, n	30	20	
Gender, n (%)			
Female	22 (73)	18 (90)	0.279
Male	8 (27)	2 (10)	
Female/Male Ratio	2.7	9	
Age, (years)			
Mean +/− SD	13.7 ± 3.8	17.3 ± 2.7	<**0.0001**
Range	5–18	11–20	
≤15	18 (60)	5 (25)	**0.032**
>15	12 (40)	15 (75)	
Tumor size, (cm)			
Mean ± SD	2.6 ± 1.7	2.94 ± 2.2	0.590
≤1	3 (10)	3 (15)	
1.1–2	11 (36.6)	6 (30)	
2.1–4	12 (40)	6 (30)	0.888
>4	4 (13.4)	5 (25)	
Histologic feature, n (%)			
Minimally invasive FTC	28 (93.4)	16 (80)	**0.025**
Widely invasive FTC	2 (6.6)	4 (20)	
Infiltration of the thyroid capsule, n (%)			
Yes	30 (100)	20 (100)	0.999
No	0	0	
Vascular invasion, n (%)			
Yes	9 (30)	9 (45)	0.434
No	21 (70)	11 (55)	
T stage, n (%)			
T1	13 (43.3)	9 (45)	0.863
T2	12 (40)	6 (30)	0.674
T3	5 (16.7)	5 (25)	0.720
T4	0	0	
N stage, n (%)			
N0	30 (100)	19 (95)	0.803
N1	0 (0)	1 (5)	
Central only	0 (0)	1 (100)	
Lateral only	0 (0)	0	
Central and lateral	0 (0)	0	
M stage, n (%)			
M0	30 (100)	20 (100)	0.999
M1	0 (0)	0	
Surgical treatment, n (%)			
Lobectomy or subtotal thyroidectomy	21 (70)	19 (95)	0.071
Total Thyroidectomy	9 (30)	1 (5)	
Completion Thyroidectomy	11 (53)	3 (15)	**0.037**
No completion	10 (47)	16 (80)	
Lymph Node dissection, n (%)			
Yes	3 (10)	1 (5)	0.630
No	27 (90)	19 (95)	
Follow up, (years)			
Mean ± SD	6 ± 3.5	2 ± 0.2	<**0.0001**
Persistence, n (%)			
Complete remission	30 (100)	19 (95)	0.837
Persistence of disease	0	1 (5)	
Recurrence, n (%)			
Yes	0 (0)	3 (15)	0.114
No	30 (100)	17 (85)	
Thyroid bed, Bone	0 (0)	1 (5)	
Neck LNs	0 (0)	1 (5)	
Thyroid Remnant, Neck LNs, Lung	0 (0)	1 (5)	

this was not statistically significant (p = 0.434) compared to the Enomoto et al. study FTCs, while it was significant compared to the PTCs (p = 0.014). In the literature, the negative impact of the vascular invasion is not the same for all the authors [53,54]. The histotype, tumor size, capsular and/or vascular invasion, age, sex, prognosis and survival rate of our patients were excellent. We registered an OS = 100% with absence of recurrence, while in the Enomoto et al. study [42] all the patients were alive (OS = 100%) but 15% of them had

relapse. There was a different and significant surgical approach in the two studies (p = 0.071) for TT and HT. The percentage of patients subjected to a TT, including thyroidectomy completion, was significantly greater in our cases compared to the Enomoto et al. study patients. In our series, the histological examination of the residual lobe, after thyroidectomy completion, did not reveal neoplastic spread in any of the 11 cases. Therefore, we believe that the choice of the initial surgical procedure between a radical approach and a conservative one must be tailored to each pediatric patient. A precise presurgical ultrasonography is needed to estimate dimensions, localization, multifocality, lymph nodal metastasis and extrathyroid extension. The presurgical sensibility of this evaluation method for these parameters is low while US sensibility in the evaluation of regional lymph nodes is high. These parameters are known postoperatively in the histopathological reports and they are essential for the surgeon when choosing a thyroidectomy completion after a conservative approach [55–60]. Based on our excellent results in terms of the absence of relapses (compared with the results of Enomoto) it is preferable to perform a hemithyroidectomy and then a CT, instead of performing an immediate TT, because there is a lower frequency of complications. According to Francis GL et al. [37], conservative surgery can be indicated in patients with lesions microscopically bounded to a lobe, with dimensions ≤4 cm, without evident extrathyroid extension and minimal vascular invasion (≤3 vascular foci). In patients with wide vascular invasion (>3 vascular foci) and/or if the tumor size is >4 cm, especially with high postoperative Tg levels, a thyroidectomy completion is recommended. Patients with multifocal neoplasm and/or dimensions >4 cm and/or lymph nodal metastasis and/or distant metastasis should be treated with TT and staged postoperatively with RAI.

5. Conclusions

Regardless of the surgical approach, the FTC prognosis in the children and adolescents of our study (about 90%) by MI-FTC was excellent. Despite the limitations of our study, which are our limited series of cases and the very few cases reported in the literature, loboisthmectomy seems to represent a valid surgical approach in pediatric patients diagnosed with MI-FTC. Moreover, the conservative surgical choice has the advantage of reducing the risk of postoperative complications, which can be particularly severe in children. The follow-up of young patients diagnosed with FTC and treated with TT includes: RAI therapy, postoperative scan, neck US and thyroid serum levels monitoring. After a conservative treatment (HT), a postoperative RAI therapy is no longer requested and the follow-up includes clinical exams, an annual chest X-ray, thyroid US and specific laboratory tests every six months in the first 2 years and then annually in the following 5 years. The use of thyroid hormone (Levo-thyroxin) for the suppression of TSH secretion, owing to the high sensibility of the pediatric DTC to hormonal manipulation, represents an efficient therapeutic aid after conservative surgical treatment [6].

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