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ORIGINAL ARTICLE

Evolution of Epiphysiodesis Surgery

Evolución de la Cirugía de Epifisiodesis

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What do we know about the subject matter of this study?

"Guided Growth" is currently a common procedure for the treatment of length differences or alterations in the axes of the lower limbs, whose use is considered increasing due to the development of less invasive techniques, with no published evidence to date about this.

What does this study contribute to what is already known?

This study demonstrates a steady increase in the performance of this procedure in Chile between 2015 and 2019, with a progressive decrease in the number of days of hospitalization.

Abstract

Surgical modulation of physeal growth, currently better known as "Guided Growth", is a procedure used as a treatment for length differences or axis alterations of the extremities. Although its use is increasing due to the development of new less invasive techniques, there are no statistical analyzes in the literature that support this. **Objective**: To evaluate the incidence of the surgery codified as "Epiphysiodesis (Femur and/or Tibia)" in the Chilean population, from January 1st, 2010 to December 31, 2019, the days of hospital stay associated with that code and the demographic data of the analyzed population. **Patients and Method:** We obtained from the Chilean Department of Statistics and Health Information (DEIS) database, all hospital discharges from January 1st, 2010 to December 31, 2019, from which we extracted the results with the code "Epiphysiodesis (Femur and/or Tibia)", in children under 15 years. The number of procedures per year, days of hospital stay, age, and sex were analyzed. **Results:** In Chile, the number of procedures coded as "Epiphysiodesis (Femur and/or Tibia)" increased during the period analyzed. The days of hospital stay decreased progressively between 2012 and 2017. The procedure was performed mostly in women, and in the 5-9 years age group, showing an upward trend in children of the group of 10-14 years between 2015 and 2019. **Conclusions:** Further analysis must be carried out to determine the factors that produce these results, which are probably related to access to more efficient and simple techniques, with less morbidity.

Keywords:
Growth Plate;
Surgery;
Orthopedic Procedures;
Epiphysiodesis

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Introduction

Epiphysiodesis is a surgical procedure performed to alter or decrease the longitudinal growth rate of long bones in the immature skeleton by structurally altering the physis. This procedure can be transitory or definitive, and is currently called "Guided Growth"[1].

In 1933, Phemister[2] introduced physiological growth inhibition by resecting a bone block with part of the metaphysis, physis, and epiphysis, and reinserting it rotated by 180º. This generates a permanent bone bridge at the level of the physis. The technique evolved to a percutaneous curettage of the physis at the peripheral level, which generates the same effect[3]. The irreversibility of the procedure determined that its indication was reserved for children close to the end of growth.

In 1947, Blount[4] introduced the reversible epiphysiodesis with epiphyseal staples. This technique allowed alteration of the physis, without permanent damage, thus expanding its indication. However, reports of material failure and staple extrusion limited its use[5]. In 1998, Metaizeau[6] published the transient epiphysiodesis technique using percutaneous transphyseal screws, which is a less invasive procedure, with rapid postoperative recovery, but not complication-free due to crossing the physis with osteosynthesis[4,7]. In 2007, Stevens[5] published the use of a tension band plate with 2 screws, around the physis. This technique quickly became popular due to its proven efficacy and safetySS[8]. In 2017, Martinez[9,10] described tension band hemiepiphysiodesis using screws and non-absorbable sutures for correcting genu valgum, in order to reduce the costs of the technique.

The increase in the indication of "guided growth" surgery after the emergence of the tension band techniques has been described in multiple articles and publications[1,7], which is related to lower postoperative morbidity and higher efficacy. However, to our knowledge, there are no published statistical records on this claim. The available literature before 2010 mainly describes epiphysiodesis through the Phemister procedure, curettage, and percutaneous screws[8,11]. After this date, scientific articles refer more frequently to the tension band plate procedure[7,12].

This study aims to evaluate if there has been an increase in the incidence of "Epiphysiodesis (Femur and/or Tibia)" surgery in Chile, between January 1, 2010, and December 31, 2019, to determine a possible decrease in the days of hospitalization associated with the procedure, and to show the distribution by sex and age of the patients.

Patients and Method

From the databases of the Department of Statistics and Health Information (DEIS)[13], an open repository of information from the Chilean Ministry of Health, we obtained all hospital discharges from January 1, 2010, to December 31, 2019. This includes all patients admitted to a health care center in Chile, whether public or private, during that period.

From these data, the patients that had undergone the surgical intervention with the code "Epiphysiodesis (Femur and/or Tibia)" (Code 2104143-8) during their hospitalization were selected. Data on the number of days hospitalized, age, and sex were recorded.

The incidence of surgery per year was calculated (number of annual procedures/populations of the age group, per 100,000). The age group considered children under 15 years of age for each year, based on data published by the National Institute of Statistics (INE), a public agency under the Ministry of Economy, Development, and Reconstruction[12], which is responsible for the official registration of data in Chile.

Arithmetic mean and standard deviation were used to calculate the number of days of stay. A normality test was performed with the Shapiro-Wilk test, and since the distribution was nonparametric, the Kruskal-Wallis test was used to compare each year. The post-hoc analysis was performed with Dunn's test. Additionally, Welch's ANOVA test was performed, with post-hoc analysis with the Games-Howell test. The distribution by sex and age group was described as percentages.

Results

The number of "Epiphysiodesis (Femur and/or Tibia)" procedures in Chile increased between January 1, 2010, and December 31, 2019 (Table 1), and the incidence of the procedure per year shows a similar progressive increase (Figure 1).

There was a decrease when comparing the number of days of hospitalization for each year, with a p-value of 0.003799. Since the p-value is less than 0.05, we can affirm that there are statistically significant differences between the groups. By performing the post-hoc analysis with Dunn's test, we observed that the difference occurred between the years 2012-2017 (p-adj = 0.00190) and 2012-2018 (p-adj = 0.0463). This test compares ranges assuming a symmetrical distribution of all groups, so additionally the Welch's ANOVA was performed which showed a significant difference ($p = 0.000444$). The post-hoc analysis was performed with the Games-Howell test, showing that the difference occurred between 2013 and 2017 ($p = 0.039$), with a decrease in the number of days of hospitalization (Figure 2).

The procedure was performed more frequently in females, with 52% of cases (Figure 3), and in the 5-9 years age group, but with an upward trend in the 10-14 years age group since 2015 (Figure 4).

Discussion

This study demonstrates a rising incidence in the performance of the "Epiphysiodesis (Femur and/or Tibia)" procedure in Chile during the analyzed period. This is in line with what is described in the literature, which is probably related to the development of less invasive techniques and a better opportunity for access to treatment. On the other hand, the decrease in hospital stay related to this procedure could reflect that it is an intervention with less morbidity associated with this hospitalization. Barret[15] conducted a retrospective cohort study in 79 patients undergoing hemiepiphysiodesis around the knee, determining that the number of plates placed, the use of ischemia and intraoperative local anesthesia infiltration may independently influence the required level of analgesia, length of postoperative stay, and time of discharge.

Currently, the techniques of "Guided Growth" are common procedures for correcting angular deformities or limb length inequality, based on their effectiveness, simplicity, and few problems or complications, and requiring proper planning[16].

A search in Pubmed[17] using the terms "epiphysiodesis", "procedure", and "knee" showed about 90 results, of which over 50% were recorded in the last 10 years, related to the tension band plate technique, indicating a growing interest in this procedure.

Makarov[18] conducted a demographic analysis of 863 patients undergoing epiphysiodesis due to lower extremity length difference from 1980 to 2011, showing that it was performed in 56% of men, the most frequently treated etiology was acquired, 41% was performed in the femur, and the procedure by curettage was the most used. In 100 knees treated for percutaneous distal femoral hemiepiphysiodesis using transphyseal cannulated screws[19], the average age at the time of surgery for males and females was 14 years and 7 months and 13 years and 6 months, respectively.

Kummar[12] conducted a systematic review of the literature on the use of tension band plates. Of the 215 patients analyzed, the mean age at the time of the intervention was 9.5 years and was more frequent in men (1.1:1). The etiology was idiopathic in 33% and syndromic in 67% of cases.

Table 1. Number of "Epiphysiodesis (Femur and / or Tibia)" procedures performed in Chile, in children under 15 years of age, per year, reflected in the rate per 100,000 children under 15 years of age

Year	N° of Procedures	Total Children	rate/100,000
2010	107	3814756	2.80489761
2011	162	3800846	4.26220899
2012	214	3786936	5.65100651
2013	217	3773028	5.75134878
2014	227	3759119	6.03864895
2015	278	3745210	7.42281474
2016	266	3746479	7.09999976
2017	341	3747749	9.09879504
2018	319	3749019	8.50889259
2019	313	3750289	8.34602347

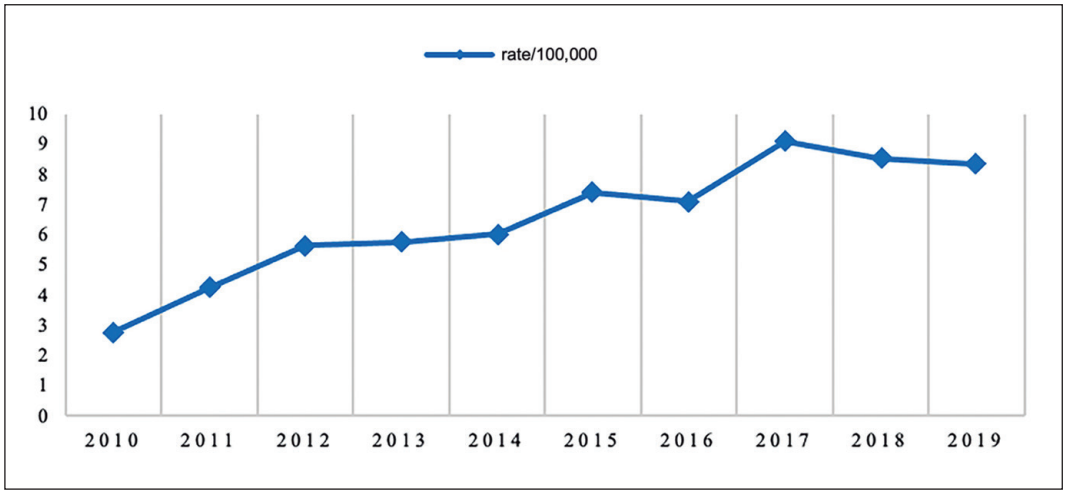

Figure 1. Incidence of "Epiphysiodesis (Femur and / or Tibia)" procedure in Chile (per 100,000 children under 15 years of age), years 2010-2019.

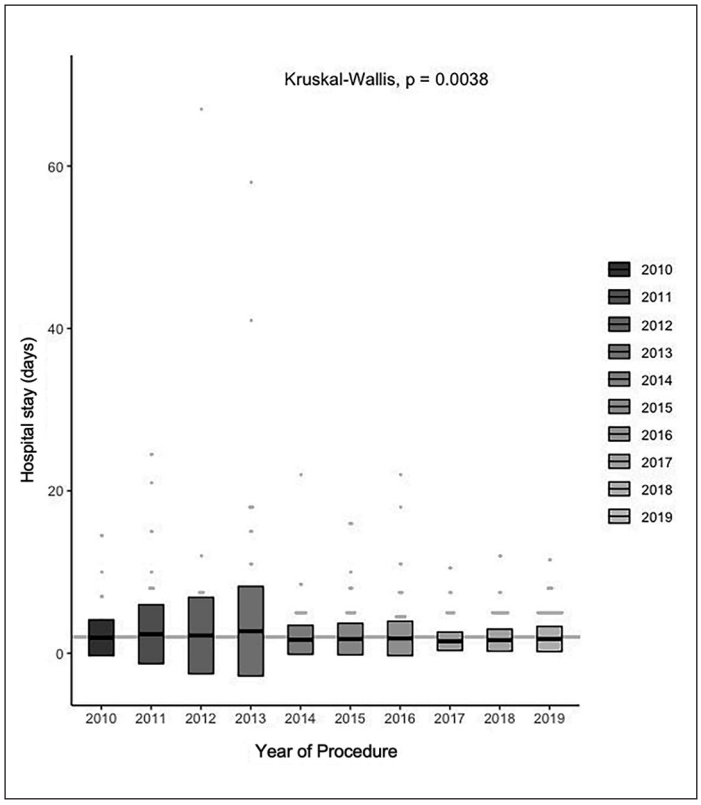

Figure 2. Days of hospital stay associated with "Epiphysiodesis (Femur and / or Tibia)" procedure in Chile, years 2010-2019.

Based on the results of this study, in Chile, the "Epiphysiodesis (Femur and/or Tibia)" procedure during the analyzed period was performed more frequently in women.

In the systematic review by Kummar[12], the hospital stay was 1 day in most patients, a trend similar to that found in this analysis.

This study has limitations due to its method. Since it is a retrospective database review, there are many uncontrolled variables and limitations in the records. In addition, the data obtained do not specify the type of procedure performed or its instrumentation, so no conclusions can be drawn on this technical aspect. Finally, the anatomical topography of the procedure is not specified. However, this is the first national epidemiological analysis, and probably the first published at the international level, which demonstrates the increasing trend for the indication of the procedure, confirming what has been reported in the literature.

In conclusion, the use of the "Epiphysiodesis (Femur and/or Tibia)" procedure in Chile was increasing between January 1, 2012, and December 31, 2019, indicating a steady decrease in the number of days of hospitalization. Further analysis should be carried out to determine the factors that produce this trend, which are probably related to the access to more effective and simpler techniques, with less morbidity.

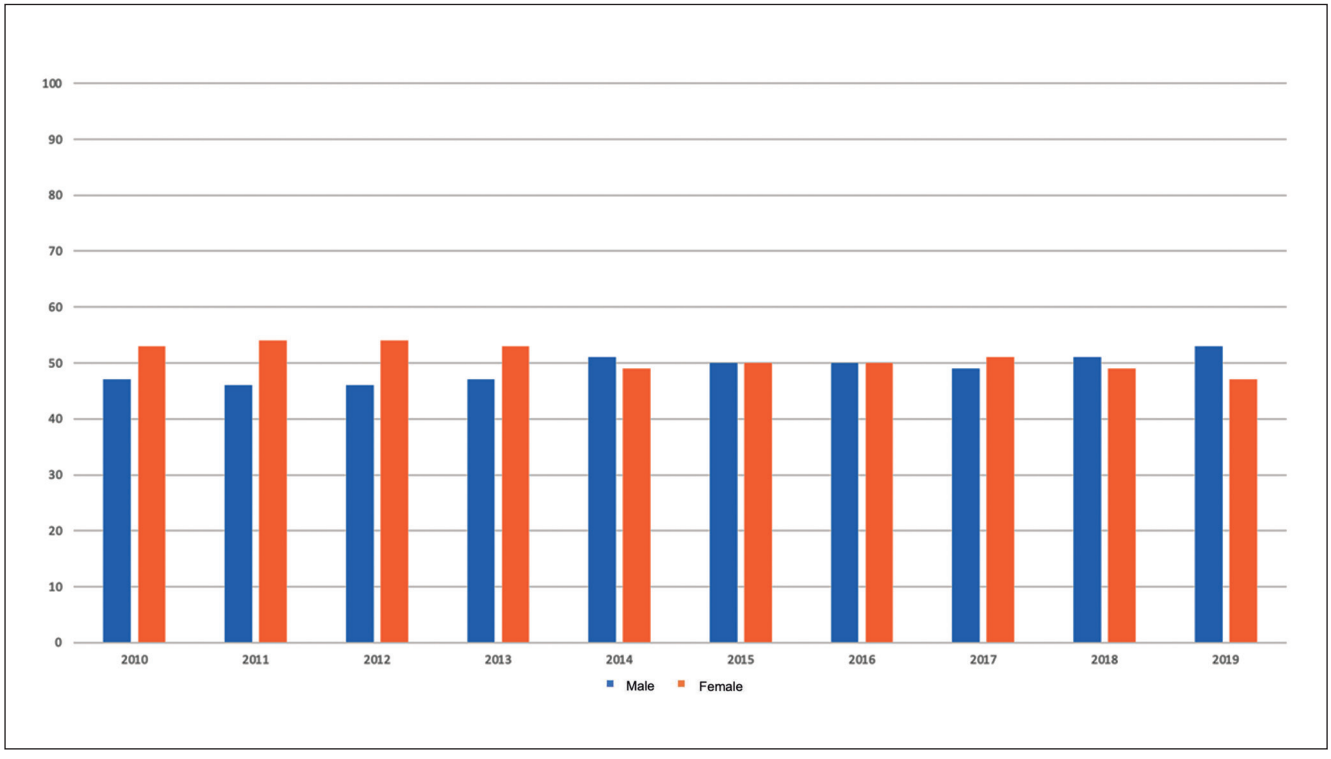

Figure 3. Percentage distribution by sex of "Epiphysiodesis (Femur and / or Tibia)" procedure in Chile, years 2010-2019.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: This study was approved by the respective Research Ethics Committee, which, according to the study's characteristics, has accepted the non-use of Informed Consent.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

Authors state that no economic support has been associated with the present study.

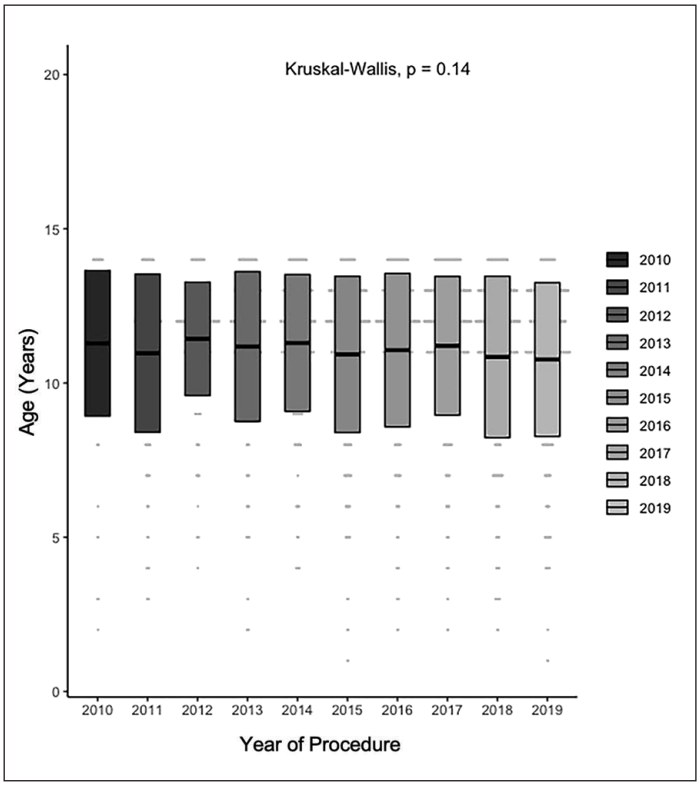

Figure 4. Age distribution of "Epiphysiodesis (Femur and / or Tibia)" procedure in Chile, years 2010-2019.

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