Classification of the "human tail" : Correlation between position, associated anomalies, and causes

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Abstract

Introduction: Numerous case reports have indicated that the “human tail” is not always a harmless protrusion but can be associated with anomalies such as occult dysraphic malformations. However, the definition and classification of this anomaly have not been discussed. A prevailing hypothesis is that the “human tail” is a residual embryonic tail. Herein, we attempted to classify and define the human tail and investigate the frequency of this anomaly.

Materials and Methods: We first defined the human tail as a protrusion on the dorsal side of the lumbar, sacrococcygeal, and para-anal regions identified after birth. We collected case reports written in English, Japanese, French, German, and Italian that were published from the 1880s to the present.

Results: We discovered two important findings: (1) the cause of this anomaly may differ even though the “tails” resemble each other closely in appearance, and (2) its position tends to be correlated with the type of anomaly and its associated cause. We propose a new classification of the human tail based on these findings.

Conclusions: Our classification may facilitate more accurate treatment and precise case descriptions of the human tail.

Keywords: tail, congenital anomalies, spina bifida, diagnosis

INTRODUCTION

In vertebrates, a tail is generally defined as an elongated trunk posterior to the anus (or the cloaca). It contains musculoskeletal elements (caudal vertebrae and muscles) and neurovascular tissues providing innervation to the muscles. Naturally, a tail is relatively mobile. The caudal vertebrae are part of the skeletal system that maintains the tail, which articulates posterior to the sacrum (Tojima, 2013). Tails in vertebrates present as various morphological types and possess numerous roles. Humans still have a coccyx, which is homologous to the caudal vertebrae; however, it is typically curved anteriorly and does not protrude externally.

Extant hominoids (so-called apes), including humans, have lost their tails completely. The tail reduction process during evolution remains a mystery due to incomplete fossil records. At present, studies have clearly demonstrated that our ancestors lost their tails at some point during a 20-million-year period between the Oligocene and Miocene epochs. Unfortunately, no fossils connecting these ancestral species have ever been found (Fleagle, 2012; Ward et al., 1991; Nakatsukasa et al., 2003, 2004).

Human embryos have temporary tails, in which somites exist up to the tip of the tail. The number of caudal somites gradually increases by 8 weeks of pregnancy (Carnegie Stage [CS] 16). Just two days after the number peaks (CS17), it abruptly decreases by almost five pairs of somites (Tojima et al., 2018). Thus, human embryonic tail reduction is caused by an abrupt and dynamic decrease in the number of somites, which would have become the caudal vertebrae. Apoptosis is a possible cellular mechanism underpinning this phenomenon. A previous study reported an increase in macrophages at the tip of the embryonic tail and suggested that cell death may be related to embryonic tail reduction (Fallon & Simandl,

1978).

Clinically, the “human tail” is a congenital anomaly reported sporadically in case reports. As shown in Fig. 1, the shape, size, and location of this anomaly vary greatly. Several studies have attempted to classify it based on morphological differences and contents (Fig. 1, Table 1). However, since this anomaly is not fatal, its origins were considered unimportant. Thus, most classifications of this anomaly are not helpful to clinicians, and a definition of “human tail” has not been established. This has led to various anomalies being reported as “human tails.”

Several types of classification of the “human tail” have been proposed since Bartles first classified this anomaly from a medical point of view (Table 1). In 1901, Harrison classified the “human tail” into two types (Harrison, 1901): the true tail (containing vertebrae) and the caudal appendage (no vertebrae). Subsequently, Giroud (1966) proposed another classification that was similar to Harrison’s classification. However, Dao and Netsky proposed a different classification in 1984, wherein they classified the human tail into a true tail and a pseudotail. According to their definitions, the true tail is a residual of the embryonic tail and does not contain any vertebrae, whereas the pseudotail is a caudal protrusion containing other normal or abnormal tissues (Dao & Netsky, 1984). The terms “true tail” and “pseudotail,” which were used in both Harrison’s and Dao and Netsky’s classifications, became widespread and have since been used in many reports. However, this terminology has made the definitions and classification inconsistent, because these two classifications were completely opposite with respect to the presence of vertebrae.

Thus, the classification and definition of the anomaly have been inconsistent, particularly since the 1980s. A novel and clinically relevant definition and classification system is a critical unmet need. In this study, we attempted to classify, define, and investigate the

frequency of this anomaly.

MATERIALS AND METHODS

Among clinicians, a postero-dorsal protrusion tends to be reported as a “tail.” Thus, we defined the “human tail” as a protrusion on the dorsal side of the lumbar, sacrococcygeal, and para-anal regions found after birth. In this study, we also defined “sacrococcygeal” as the region below the iliac crest and above the natal cleft regions. This definition relied on the surface anatomy in order to incorporate previous reports without radiography or computed tomography (CT) observations. We collected case reports written in English, Japanese, French, German, and Italian that were published from the 1880s to the present. Case reports that did not meet the definition were excluded; for example, cases with caudal tenderness or pain caused by an insufficiently curved coccyx without an external protrusion (Bar-Maor et al., 1980; Hamoud, 2011; Zimmer and Bronshtein, 1996) or cases with a tail-like structure in the cervical region or upper limb (Gaskill and Marlin, 1989; Mohindra, 2007).

We summarized the information from the collected case reports focusing on sex, location (vertebral and lateral levels), contents, and associated anomalies. Their tendencies were investigated.

RESULTS

A total of 195 cases were identified, and we summarized the information in Supplementary Table 1. The number of cases reported in Japanese from 1941 to 2016 was 95 (68 articles). The number of cases reported in English from 1881 to 2017 was 97 (60 articles), and the patients’ nationalities varied (e.g., USA, UK, Canada, India, Israel, Turkey, Japan,

China, etc.).

Sex and age

Among 195 cases, 84 male patients and 79 female patients had the anomaly (Table 2). The frequency of the anomaly was not significantly different between sexes (chi-square test, $p>0.05$).

Except for 20 cases where patients were older than 11 years and five cases without information on age, most cases were reported in neonates and infants (Supplementary Table 1). This is simply due to the ease of identifying this anomaly and parents being eager to eliminate the "tail" as soon as possible.

Contents of the "tail" and its location

Among 195 cases collected in this study, tails in 35 cases contained bony or cartilaginous elements (Table 2). Since palpation and radiography can easily confirm the presence of bone or cartilage, human tails with bones have frequently been reported (Miller, 1881). The bone inside the tail can be divided into two types: coccyx and non-coccyx. In most cases, the bony human tail is caused by a protrusion of the coccyx (26/35 cases). In these cases, the human tail tends to be small and semi-spherical (Nitta et al., 2010). When the coccyx protrudes and forms the "human tail," the number of caudal vertebrae constituting the coccyx is normal (2–4 vertebrae), and there are no additional vertebrae. This type of human tail is likely observed on the midline at the sacrococcygeal level.

Human tails with non-coccyx bony elements were rare (Table 2). In many cases of the non-coccyx human tail, bones and cartilaginous elements were present. These bones and/or

cartilages did not articulate with the sacrum or coccyx, and their locations were often far from the vertebral column. Thus, these bones and cartilage were not considered additional vertebrae. This type of human tail is also observed on the midline in the lumbar or sacrococcygeal region, cephalad with respect to the natal cleft. In contrast, the majority of the 195 cases collected in this study were boneless (132 cases, Table 2).

Associated anomalies

In most cases, the human tail was associated with anomalies. Among them, spinal dysraphism (including both skeletal and neural anomalies) were the most common, present in 80 cases (Table 3). Dysraphic spinal cord malformation was reported in 63 cases. Previously, spinal cord malformations have been classified in various ways. In this study, we referred to Raimond (1998) and the "Clinical guidelines for lower urinary tract dysfunction in patients with spina bifida," which was presented in 2017 by the Japanese Continence Society and the Japanese Urological Association. As a result, myelomeningocele (cyst which involves the inside of the spinal cord) was observed in 13 cases. Meningocele (cyst which involves just the meninges and the spinal fluid) was lesser reported than myelomeningocele (6 cases). Spinal lipoma (24 cases) and tethered cord syndrome (28 cases) were also commonly observed. In several cases, multiple spinal anomalies were noted. Especially, tethered cord syndrome is accompanied with lipoma or myelomeningocele. Additionally, brain and craniofacial anomalies or cardiovascular anomalies tended to be associated with spinal anomalies. In these cases, the human tail was observed on the midline from the lumbar to the sacrococcygeal region, cephalad to the natal cleft. The number of cases was not significantly different between sexes.

With the exception of spinal cord malformations, para-anal anomalies including imperforate anus and anovestibular fistula were observed. These anomalies were not associated with spinal anomalies. In cases with para-anal anomalies, the human tail tended to occur at the para-anal level. The number of cases was not significantly different between sexes.

The remainder of the 49 cases did not have any associated anomalies, according to the descriptions in the articles. However, these reports were written in the 1980s, before the use of CT and magnetic resonance imaging (MRI) became widespread. As such, associated anomalies may have been overlooked. For example, the case reported by Harrison (1901) showed a potential sign of tethered cord syndrome, although this was not mentioned. The actual incidence of associated anomalies is thus expected to be higher than the number of cases reported in this study.

A new classification of the "human tail"

We summarized the findings of 195 cases and observed that the human tail can be classified into four types based on its contents and location (Fig. 2). The anomalies associated with the human tail tended to vary among types (Table 4). As described above, the human tail is not merely a cutaneous appendage in most cases. Careless surgical ablation may cause serious effects that could significantly damage patients' quality of life. Therefore, the results of this study supports a novel classification scheme based upon the cranio-caudal location and intrinsic architecture of the tail that may facilitate clinical management.

Type I: Human tail containing bones or cartilage

Palpation and radiography can correctly and easily diagnose type I “human tail.” Type I can be divided into two types based on the characteristics of the coccyx (type Ia) and non-coccyx (type Ib) bony elements.

Type Ia: Human tail caused by the protrusion of the coccyx

Most type I cases are classified into type Ia with protrusion of the coccyx. The number of caudal vertebrae (constituting the coccyx) are normal (4–6 at most), the coccyx protrudes, and a small and semi-spherical structure is formed on the midline of the sacrococcygeal region, predominantly just above the natal cleft. These signs are likely observed when the size of the coccyx is larger than the body size or when the curve of the coccyx is deformed naturally or by subluxation. Patients typically have tenderness in the sitting position and visit outpatient clinics for evaluation. This type of human tail is hard, and it barely contains any tissues other than the coccyx. As a result, almost half of these cases were not associated with other anomalies (14/26 cases, Table 4), but there were some cases associated with spinal cord malformations (tethered cord syndrome and lipoma) and brain anomalies. As for clinical management, partial or complete surgical ablation of the coccyx was performed in many cases, and the tenderness in the sitting position was improved. However, this type is possibly associated with neural anomalies (although the incidence is lower compared with other tail type). Thus, preoperative examinations using radiography, CT, and spinal MRI are essential for exploring abnormal vertebral morphology.

Type Ib: Human tail with non-coccyx bony or cartilaginous elements

If bony or cartilaginous elements contained in the human tail are not part of the coccyx,

such cases are defined as type Ib. This type can easily be distinguished from type Ia because the bony elements do not articulate with the vertebrae in this type. The incidence of dysraphic spinal cord malformations (lipoma, myelomeningocele with tethered cord) or teratomas is higher than that of type Ia. In type Ib, ectopic bones or cartilage are derived from aberrant mesodermal tissues around the unclosed neural tube or excessively formed in teratomas or lipomas. Half of the cases of this type are observed in the lumbar region, and the other half are observed in the sacrococcygeal region. If dysraphic spinal cord malformations are observed on radiography or CT, additional MRI is recommended because the incidence of tethered cord syndrome is high in this type.

Type II: Human tail without bones or cartilage

The human tail without bones or cartilage is defined as type II. Type II human tail is soft with more varied morphology than that of type I. Its location also tends to vary from lumbar to para-anal, and this is related to the associated anomalies. Type II can be further subdivided based on location.

Type IIa: Human tail (without bones/cartilages) located higher than the natal cleft

In this study, most human tails were classified under this type, which usually occurs in the lumbar or sacrococcygeal region and is higher than the natal cleft. In many cases, the tail is positioned on the midline, but is sometimes located to the left or right. Thin and long cylinder-like or conical shapes are frequent. Histologically, the tail is mainly formed by mature adipose tissue, and fibrous cord-like structures are often present.

This type is highly associated with dysraphic spinal cord malformations (44/92 cases).

Lipoma was the most commonly observed (19 cases), and myelomeningocele (8 cases) or meningocele (6 cases) was also observed. Tethered cord syndrome was reported in 29 cases, and it was accompanied with lipoma (14/29 cases) and myelomeningocele (5/29 cases). A tumor or dimple at the base of the tail or a groove near the tail and/or tuft of hair on the dorsal side increase the possibility of associated spinal cord malformations. Clinically, if the patient has a tail-like structure higher than the natal cleft, the clinician must not cut the tail without a full preoperative examination. This type of tail is highly associated with tethered cord syndrome. Simple ablation can cause serious damage, which may significantly diminish the patients' quality of life, such as development of bowel/bladder dysfunction or movement/neurological disorders of the hind limbs. Moreover, these after-effects may not necessarily occur during the postoperative follow-up period. Although the tail is mostly ablated during infancy, tethered cord syndrome is possibly caused by the radical increase in height during the growth period, 10 years or more after surgery (Erşahin and Gezen, 1993).

Type IIb: Human tail (without bones/cartilages) positioned lower than the natal cleft

Type IIb tails develop around the para-anal region, which is lower than the origin of the natal cleft. This type is often positioned to the left or right. Its morphology tends to be short with a small cylinder or cone shape. In contrast to type IIa, which is highly associated with dysraphic spinal cord malformations, this type tends to be associated with concurrent para-anal anomalies (10/33 cases), such as imperforate anus and perineum dysplasia. This type of tail occasionally contains muscle fibers, some of which are striated and connected to the external anal sphincter muscle. In such cases, the tail may exhibit voluntary movements. Another main component of the tail tends to be mature adipose tissue similar to that in type

IIa. This tail rarely involves cord-like structures. In cases with a cord-like structure, the cord is mostly muscular and not fibrous. When muscular elements are present in the tail, the nervous and vascular systems are often present in the muscle but never invade into the vertebral canal. Although this type of tail is rarely associated with spinal anomalies, angioplasty of the anus or perineum is required in some cases.

DISCUSSION

Main findings

As stated in the results section, the "human tail" can be classified into four different types. A more detailed summary of previous case reports uncovered two important findings: (1) the cause of this anomaly possibly differs even though the "tails" closely resemble each other in appearance, and (2) its position tends to correlate with certain anomalies and associated causes.

Possible reasons for various types of "human tail"

Distinguishing these four types by morphology alone may be difficult, but they are assumed to be caused by completely different factors.

Type Ia: Protrusion of the coccyx

As stated above, type Ia tails could be distinguished from others relatively easily. Although the number of coccyx is normal, oversize or mal-curvature of the coccyx could cause this type of tail. Since it is caused by a protrusion of the coccyx, the tail is usually on the midline and rarely associated with other anomalies.

Type Ib: Ectopically generated cartilaginous/bony elements by tumors

The cartilaginous/bony elements contained in this type of tail are not part of the vertebrae. Since these cases are often associated with spinal lipoma or teratoma, the non-coccyx bony elements may be derived from aberrant mesodermal tissue around the defective neural tube and could then be ectopically formed. In cases associated with teratoma, the human tail contains ectopic smooth muscle or digestive tract tissue as well as cartilage (Ishikura and Tsukada, 1989; Mori, 1993; Kawashima et al., 2004).

Type IIa: Cutaneous marker of dysraphic spinal cord malformations

It is assumed that this type of tail, highly associated with spinal cord malformations, is generated by neural tube closure defects. When vertebral hypoplasia occurs, epidermal ectoderm or surrounding mesodermal tissues possibly enter the vertebral canal from the bifid region. Such aberrant tissues differentiate into cord-like structures and should cause tethered cord syndrome when they connect to the spinal cord.

Type IIb: Cutaneous marker of rectal/anal anomalies such as imperforate anus

Notably, this type of tail contains muscular fibers. In some cases, the muscle fibers render the tail mobile. Considering the components, associated anomalies, and location of this type of human tail, the tail is not directly related to neural tube closure; rather, it is possibly derived from a residual of the anal tubercle during perineum formation. Based on these features, it is assumed that this is a form of tissue malformation is related to rectal or anal anomalies such as imperforate anus. When these anomalies occur, striated muscle fibers derived from the sphincter anus or smooth muscle fibers from the dermis of the scrotum/labium or hindgut

interfuse. A tail-like structure containing muscle fibers may then be generated. Recently, several cases have reported that striated muscle fibers inside the tail were connected to the external anal sphincter muscle (Katsuno and Horisawa, 2008; Saka et al., 2010).

Postnatal and prenatal diagnosis

From the 1880s to 1970s, preoperative diagnosis was made primarily by palpation only, and radiographs were occasionally taken. In most cases, tail-like structures were simply ablated. Thus, there have been many cases of ablation without substantial preoperative examinations. Among these cases, serious sequelae are possibly caused by the operation. As reported by Kabata et al. (1986), the tail was ablated on the 43rd day after birth based on information gathered from preoperative radiography studies. However, after 7 months, the patient claimed to feel some tenderness at the affected area and weak muscle strength and decreased tendon reflex of the hind limbs. A repeat examination indicated that the patient had tethered cord syndrome.

The first CT report of the human tail was in 1980 (Ohhara, 1980), and the first MRI report was in 1988 (Dubrow et al., 1988). MRI is readily available for preoperative evaluation of the human tail. For instance, the condition of the tethered cord can be accurately diagnosed when complicated with meningocele (Chakrabotty et al., 1993) or lipoma (Lu et al., 1998; Donovan and Pedersen, 2005).

Ultrasound sonography (USG) for fetal assessment was developed in the 1980s, and prenatal diagnosis of the human tail has been performed by USG. The first case of prenatal USG was performed in 1992 (Abott et al., 1992). Many case reports using USG have been published to date. In routine fetal assessment of the second and/or third trimester, no spinal

defects or masses should be observed in transverse and sagittal views (Salomon et al. 2011; American Institute of Ultrasound in Medicine, 2013). The human tail can be detected during observation of the lower spinal part; however, it is still necessary to examine the presence of the human tail. The natural courses of the human tail are varied; the tails get smaller naturally in some cases (Efrat et al., 2001; Grangé et al., 2001; Zimmer and Bronshtein, 1996). To conclude, the human tail should be assessed in regular screening by USG following prenatal and/or postnatal MRI scan for further diagnosis (Mohindra et al., 2007). Sequential assessment during prenatal to postnatal periods will reduce unwanted sequelae.

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Statement of Ethics

The authors have nothing to declare.

Disclosure Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Dr. Sayaka Tojima undertook the main part of this study (such as data accumulation, analyses, and proposal of the new classification of the human tail). Professor Shigehito Yamada contributed to a part of the discussion on post- and prenatal diagnosis from a clinical point of view.

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Legends

Figure 1. Diversity of the “human tail.”

(A) The human tail can be divided into three types based on its location: lumbar, sacrococcygeal, and para-anal.

(B) The morphology of the human tail varies significantly.

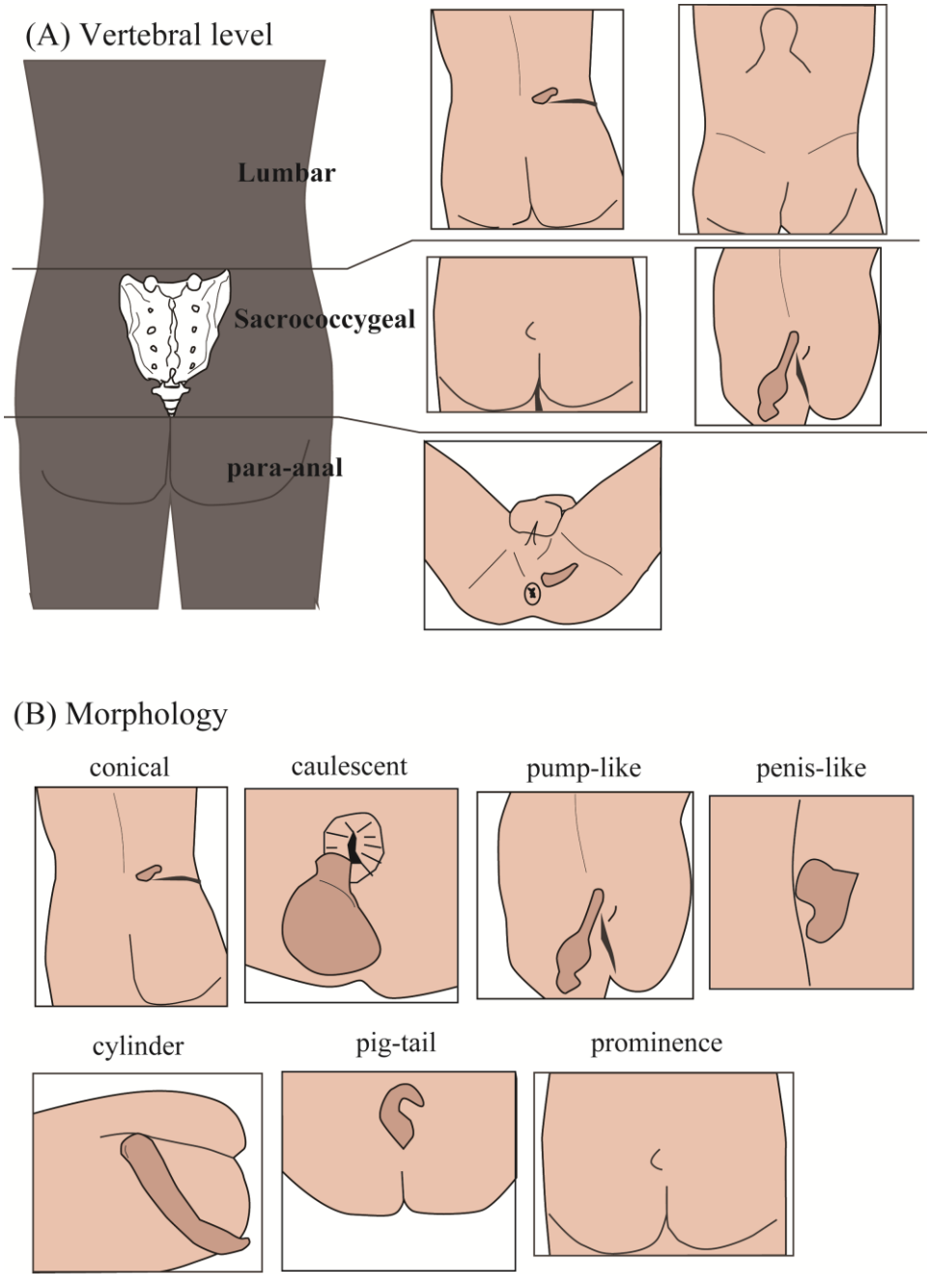

Figure 2. A flow chart for quick diagnosis of “human tail” for clinicians.

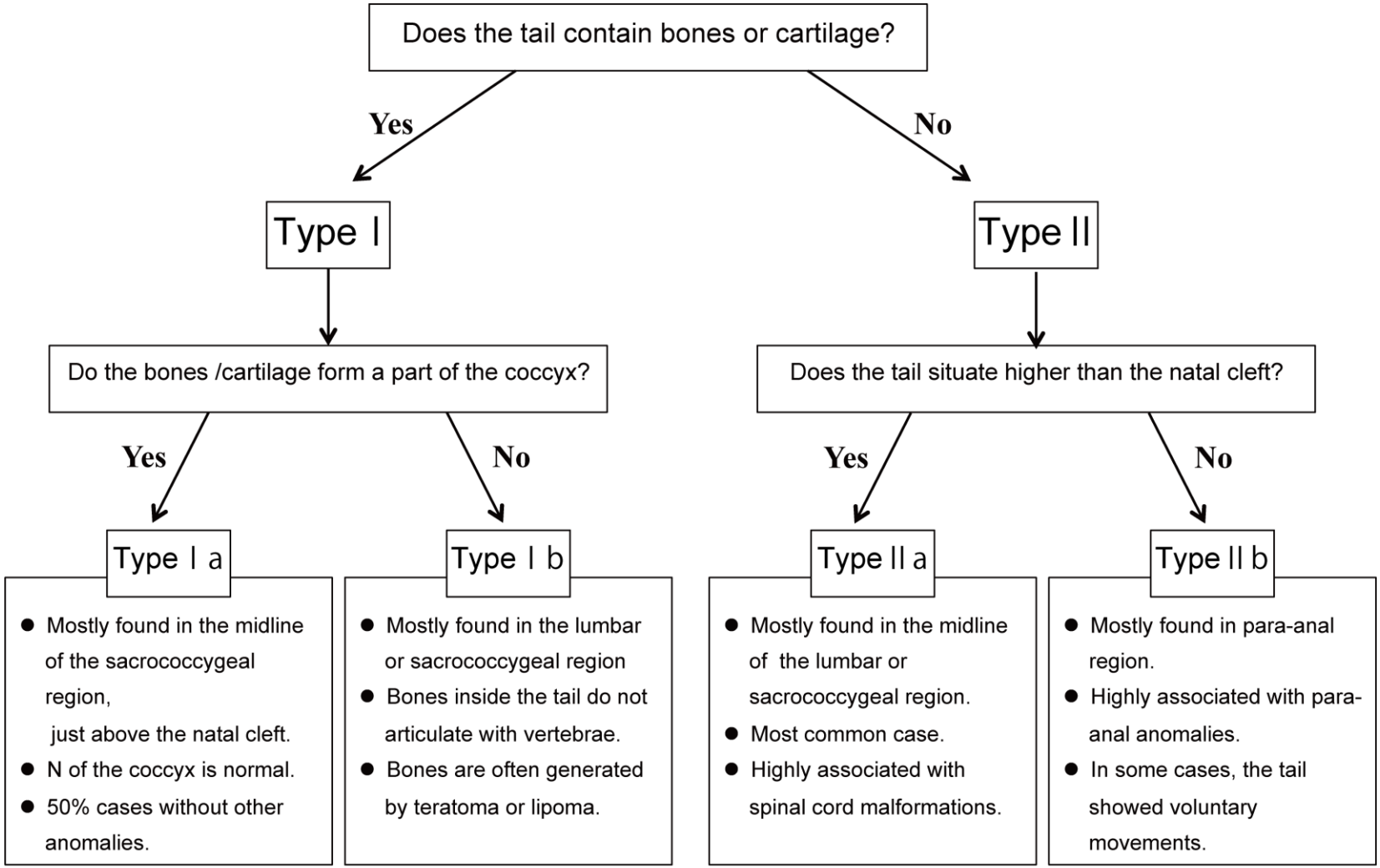

Table 1 Classifications of “human tail” in previous studies.

Bartles (1884)	
Type I	Echte Tierschwanze: of real animal type, containing additional vertebrae
Type II	Stummelschwanze: stumpy-conical shaped resembling the embryonic tail
Type III	Angewachseneschwanze: contains soft tissue only, with a distally directed apex, the base completely fused with the coccygeal region
Type IV	Schweineschwanzeform: long, thin, boneless, sometimes twisted, like a pig’s tail
Type V	Stummelschwanze Mit Knocherneminhalt: conical shape, like Type II, but containing vertebrae
Virchow (1884)	
Type 1	Cauda perfecta, with multiplied vertebrae
Type 2	Cauda imperfecta, soft tail without vertebrae
Type 3	Various skin stumps unduly resembling a tail
Harrison (1901)	
True human tail	The tail consists of a portion containing vertebrae and a portion without vertebrae (caudal filament)
Caudal appendage	contains only notochord and medullary cord
Giroud (1966)	
Type 1	l'appendice caudal avec squelette: caudal appendage with bones
Type 2	l'appendice caudal sans squelette: caudal appendage without bones
Dao & Netsky (1984)	
True tail	vertebrates, caudal, midline protrusion capable of spontaneous or reflex motion, consisting of skin covering a combination of muscle, adipose and connective tissue, and normal blood vessels and nerves
Pseudotail	caudal protrusion composed of other normal and abnormal tissues
Katsuno & Horisawa (2008)	
True tail	Tsuikotsu wo fukumu: human tail with vertebrae
Pseudotail/caudal appendage	Tsuikotsu wo fukumanai: human tail without vertebrae

Table 2 Summary of “human tail” in the literature from 1880s to 2017.

			Sex			Vertebral level				Laterality			
			male	female	NA	lumbar	sacrococcygeal	para-anal	NA	left	midline	right	NA
Human tail with bones/cartilages	**35**	**cases**	**11**	**22**	**2**	**3**	**25**	**6**	**1**	**2**	**27**	**1**	**5**
Protrusion of the coccyx	26	cases	9	17	0	0	22	4	0	2	22	1	1
with associated anomalies	7	cases	2	5	0	0	6	1	0	0	7	0	0
without any anomalies	14	cases	4	10	0	0	13	1	0	0	14	0	0
unknown	5	cases	3	2	0	0	2	3	0	2	2	0	1
Non-coccyx	9	cases	2	5	2	3	3	2	1	0	5	0	4
with associated anomalies	6	cases	1	4	1	3	1	2	0	0	3	0	3
without any anomalies	1	cases	0	1	0	0	1	0	0	0	1	0	0
unknown	2	cases	1	0	1	0	1	0	1	0	1	0	1
Human tail without bones/cartilages	132	**cases**	**65**	**50**	**17**	**19**	**69**	**33**	**11**	**27**	**50**	**24**	**31**
with spinal dysraphism	64	cases	35	27	2	14	41	7	2	14	29	14	7
with para-anal anomalies	11	cases	4	5*	2	0	1	10	0	2*	2	2	5
with other anomalies	9	cases	3	6*	0	1	4	4	0	1*	5	2	1
without any anomalies	30	cases	19	9	2	3	15	12	0	9	12	4	5
unknown	19	cases	4	4	11	1	9	0	9	2	2	2	13
Unknown	**28**	**cases**	**8**	**7**	**13**	**2**	**13**	**0**	**13**	**3**	**3**	**1**	**21**
Total	**195**	**cases**	**84**	**79**	**32**	**24**	**107**	**39**	**25**	**32**	**80**	**26**	**57**

Table 3 Congenital anomalies associated with “human tail”

Associated anomalies				Sex			Vertebral level				Laterality			
	N		%	male	female	NA	lumbar	sacrococcygeal	para-anal	NA	left	midline	right	NA
Spinal dysraphism (including both skeletal & neural anomalies)	**80**	**cases**	**41.03**	**41**	**30**	**9**	**17**	**46**	**8**	**9**	**14**	**38**	**12**	**16**
hypoplasia of vertebral arches (without any complications)	17	cases	8.72	9	7	1	1	13	2	1	5	8	2	2
myelomeningocele *	13	cases	6.67	6	3	4	3	5	1	4	2	6	1	4
meningocele	6	cases	3.08	5	1	0	2	3	1	0	0	5	1	0
lipoma *	24	cases	12.31	10	14	0	7	14	3	0	6	9	5	4
tethered cord syndrome *	28	cases	14.36	17	7	4	7	16	1	4	6	12	2	8
Para-anal anomalies	**11**	**cases**	**5.64**	**4**	**5**	**2**	**0**	**2**	**8**	**0**	**2**	**3**	**2**	**4**
imperforate anus (anal atresia)	6	cases	3.08	2	2	2	0	1	3	2	0	2	0	4
anovestibular fistula	2	cases	1.03	0	2	0	0	0	2	0	0	1	1	0
anterior anus	1	cases	0.51	0	1	0	0	0	1	0	1	0	0	0
bifid scrotum	2	cases	1.03	2	0	0	0	0	2	0	0	0	0	2
hypospadias	1	cases	0.51	1	0	0	0	0	1	0	0	0	0	1
inguinal hernia	1	cases	0.51	1	0	0	0	0	1	0	0	0	0	1
perineal lipoma	1	cases	0.51	1	0	0	0	0	1	0	0	0	1	0
rectal prolapse	1	cases	0.51	1	0	0	0	1	0	0	0	1	0	0
skin erosion	1	cases	0.51	0	1	0	0	0	1	0	1	0	0	0
Brain & craniofacial anomalies	**12**	**cases**	**6.15**	**2**	**10**	**0**	**0**	**9**	**2**	**1**	**1**	**5**	**3**	**3**
Crouzon syndrome	3	cases	1.54	0	3	0	0	2	0	1	0	2	0	1
epilepsy	2	cases	1.03	0	2	0	0	2	0	0	0	1	1	0
hydrocephalus	2	cases	1.03	0	2	0	0	2	0	0	0	0	2	0
agnesis corpus callosum	1	cases	0.51	0	1	0	0	1	0	0	0	1	0	0
cerebral hemorrhage	1	cases	0.51	1	0	0	0	0	1	0	0	1	0	0
cloverleaf skull (craniosynostosis)	1	cases	0.51	0	1	0	0	1	0	0	0	0	1	0
cleft palate	1	cases	0.51	0	1	0	0	0	1	0	0	1	0	0
cystic hygroma	1	cases	0.51	0	0	1	0	1	0	0	0	0	0	1
lissencephaly	1	cases	0.51	0	1	0	0	1	0	0	0	0	1	0

micrognathia	1	cases	0.51	1	0	0	0	1	0	0	0	0	0	1
other craniofacial anomalies	2	cases	1.03	0	2	0	0	2	0	0	1	0	0	1
Cardiovascular & respiratory anomalies	**9**	**cases**	**4.62**	**3**	**5**	**1**	**0**	**6**	**3**	**0**	**0**	**7**	**1**	**1**
angioma (including angiolipoma)	5	cases	2.56	2	3	0	0	3	2	0	0	4	1	0
ventricular septal defect	2	cases	1.03	1	1	0	0	1	1	0	0	2	0	0
patent ductus arteriosus	1	cases	0.51	0	1	0	0	1	0	0	0	1	0	0
pulmonary hypoplasia	1	cases	0.51	0	1	0	0	1	0	0	0	1	0	0
tetralogy of Fallot	1	cases	0.51	0	1	0	0	1	0	0	0	1	0	0
polycythemia	1	cases	0.51	1	0	0	0	0	1	0	0	1	0	0
Other anomalies	**19**	**cases**	**9.74**	**10**	**9**	**0**	**1**	**16**	**2**	**0**	**3**	**10**	**0**	**6**
limb hypoplasia (polydactyly, syndactyly, camptodactyly, clubfoot, etc.)	8	cases	4.10	3	5	0	0	8	0	0	2	5	0	1
dysuria	3	cases	1.54	3	0	0	0	3	0	0	1	1	0	1
neurological disorders of hind limbs	3	cases	1.54	3	0	0	0	3	0	0	1	0	0	2
teratoma	3	cases	1.54	1	2	0	0	2	1	0	0	2	0	1
absent right umbilical artery	1	cases	0.51	0	1	0	0	1	0	0	0	1	0	0
diaphragmatic hernia	1	cases	0.51	0	1	0	0	1	0	0	0	1	0	0
horseshoe kidney	1	cases	0.51	0	1	0	0	1	0	0	0	1	0	0
hypoglycemia	1	cases	0.51	1	0	0	0	0	1	0	0	1	0	0
Meckel diverticulum	1	cases	0.51	0	1	0	0	1	0	0	0	1	0	0
omphalocele	1	cases	0.51	0	1	0	0	0	1	0	0	0	0	1
unicornuate uterus	1	cases	0.51	0	1	0	0	1	0	0	0	1	0	0

* tethered cord syndrome was accompanied with myelomeningocele or lipoma in several cases.

Table 4 A new classification of the “human tail” for clinicians and the number of the cases of each type.

			Sex		
			male	female	NA
Type Ia	**26**	**cases**	**9**	**17**	**0**
with dysraphic spinal cord malformations *	2	cases	1	1	0
with para-anal anomalies	0	cases	0	0	0
with other anomalies *	5	cases	0	5	0
without any anomalies	14	cases	4	10	0
unknown	5	cases	3	2	0
Type Ib	**8**	**cases**	**2**	**5**	**1**
with dysraphic spinal cord malformations	3	cases	1	2	0
with para-anal anomalies	0	cases	0	0	0
with other anomalies	2	cases	0	2	0
without any anomalies	1	cases	0	1	0
unknown	2	cases	1	0	1
Type IIa	**92**	**cases**	**50**	**36**	**6**
with dysraphic spinal cord malformations *	44	cases	26	16	2
with para-anal anomalies	1	cases	0	1	0
with other anomalies *	20	cases	10	10	0
without any anomalies	18	cases	11	5	2
unknown	10	cases	4	4	2
Type IIb	**33**	**cases**	**17**	**14**	**2**
with dysraphic spinal cord malformations	5	cases	2	3	0
with para-anal anomalies	10	cases	4	4	2
with other anomalies	4	cases	2	2	0
without any anomalies	12	cases	8	4	0
unknown	0	cases	0	0	0

* several cases accompanied more than one anomalies.