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Case Report

The Supracondylar Process of the Humerus: Clinical Implications of a Rare Vestigial Structure–Case Report and Comprehensive Literature Review

El Proceso Supracondíleo del Húmero: Implicancias Clínicas de una Rara Estructura Vestigial – Reporte de Caso y Revisión Exhaustiva de la Literatura

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SUMMARY: The supracondylar process (SP) of the humerus is a rare congenital bony projection occurring in approximately 0.5–2.7 % of individuals. Arising from the anteromedial distal humeral shaft, the SP may form a fibro-osseous tunnel with the ligament of Struthers, potentially compressing the median nerve or brachial artery and producing "supracondylar process syndrome." Although often asymptomatic and incidentally detected, the SP can mimic a tumor, or aberrant ossification, creating diagnostic challenges. We present a 17-year-old male with an incidental SP identified following minor trauma. We made a brief literature review that highlights the evolutionary context of the SP, its morphologic variations, clinical complications, fracture patterns, imaging characteristics, and management strategies. Enhanced awareness of this vestigial structure can prevent misdiagnosis and ensure appropriate treatment in symptomatic cases.

KEY WORDS: Supracondylar process; Humerus; Radiology; Clinical significance; Review.

INTRODUCTION

The supracondylar process (SP) of the humerus is an uncommon anatomic variant involving a bony projection from the anteromedial surface of the distal humeral shaft, typically 4-7 cm proximal to the medial epicondyle and pointing distally toward the joint line (Kessel & Rang, 1966; Natsis, 2008). Initially identified in anatomical writings from the early 19th century and later thoroughly described by Struthers and others (Kessel & Rang, 1966), the SP has been known by various names-such as supracondyloid process, supratrochlear spur, supraepitrochlear process, avian spur, and humeral spur (Martin-Schütz *et al*., 2019), which hint at its complex evolutionary background.

The SP is generally interpreted as the vestigial remnant of a complete supracondylar foramen - a bony tunnel found in many climbing mammals (e.g., felines, prosimians) and some reptiles, through which the median nerve and brachial artery traverse for protection (Jenkins *et al*., 2022). In humans, the foramen typically regresses during development, leaving only a partial structure (the spur) in a minority of individuals (Martin-Schütz *et al*., 2019; Jenkins *et al*., 2022). A second theory suggests that the SP represents the regressed insertion point of an atavistic muscle-latissimus dorsi condyloideus - whose tendon persists today as the ligament of Struthers (Paraskevas *et al*., 2012; Jenkins *et al*., 2022). This ligament spans from the SP to the medial epicondyle and may form a fibrous or fibro-osseous tunnel capable of entrapping the median nerve or brachial artery (Martin-Schutz *et al*., 2019).

Prevalence estimates vary widely depending on population and method of detection. Large radiographic and anthropological studies report SP frequencies between 0.1 % and 3 % (Baruah *et al*., 2012; Martin-Schütz *et al*., 2019). In a detailed cadaveric study of 375 Caucasian subjects in Cologne, the prevalence was approximately 1 % (Natsis, 2008). A meta-analysis of 26.415 humeri found an overall prevalence of 0.68 %, with the SP more common in females and on the left side

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(Martin-Schütz *et al*., 2019). Bilateral SPs are rare but documented (Subasi *et al*., 2002).

Clinically, the SP is relevant when accompanied by the ligament of Struthers, which can create a compressive tunnel beneath which the median nerve and brachial artery (or, in cases of high brachial artery bifurcation, the ulnar artery) may pass (Mizia *et al*., 2021).Several publications note further variations, including aberrant pronator teres origin (Jelev & Georgiev, 2009; Narayanan & Adikesavan, 2020), coracobrachialis slips and hypertrophied triceps fibers (Kunc *et al*., 2023), or supratrochlear apertures (Paraskevas *et al*., 2012) - that may complicate presentation or mimic pathology. These anatomical nuances increase the likelihood of neurovascular compression or misinterpretation of radiographs (Engber *et al*., 1974; Bhatnagar *et al*., 2021).

We present a rare incidental SP in a teenage patient and provide a comprehensive review concerning morphological, clinical, and radiological understanding of this vestigial structure.

CASE REPORT

A 17-year-old male presented after a fall onto his outstretched left arm during sports activity. His primary complaint was mild lateral elbow pain. He denied numbness, tingling, weakness, previous elbow trauma, or systemic symptoms. Past medical and family histories were unremarkable. Inspection revealed no deformity or swelling. Elbow range of motion was full and pain-free except for mild tenderness over the lateral epicondyle, consistent with contusion. Motor examination revealed normal strength across all nerve territories. Sensation in the radial, median, and ulnar nerve distributions was intact. Provocative maneuvers for proximal median nerve entrapment—including pronator compression and resisted elbow flexion with supination—were negative. Radial and ulnar pulses were normal. Standard AP and lateral radiographs revealed a slender, well-corticated bony spur on the anteromedial aspect of the distal humeral shaft (Fig. 1). The spur measured approximately 13 mm in length and was positioned 32 mm proximal to the medial epicondyle. The cortex and medullary canal were continuous with the humeral diaphysis, confirming a SP. No soft tissue abnormality or periosteal reaction was noted. Given the absence of neurovascular symptoms and the radiographic appearance, conservative management with physiotherapy and anti-inflammatory drugs for 7 days was recommended. The patient remained asymptomatic at 2 months follow-up.

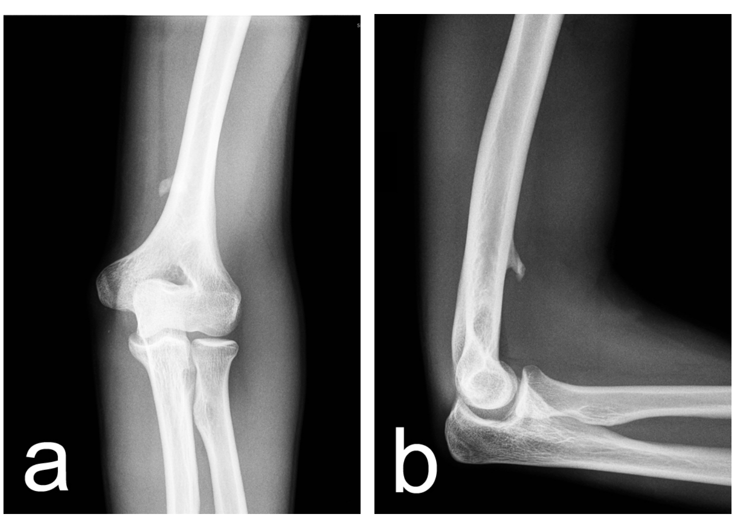

Fig. 1. a) AP view of the distal humerus with the elbow joint, visualizing the SP; b) lateral view of the distal humerus and elbow joint allowing us to measure the size of the process.

DISCUSSION

The SP of the humerus represents one of the most intriguing vestigial structures encountered in the human upper limb (Jenkins *et al*., 2022). Although rare, its anatomical complexity, variability, and potential for clinical significance make it an important topic for clinicians and anatomists alike (Natsis, 2008; Martin-Schütz *et al*., 2019).

The SP arises from the anteromedial aspect of the distal humerus and typically extends distally toward the medial epicondyle, a directional orientation that reflects its phylogenetic origins. In climbing mammals and some reptiles, a complete supracondylar foramen protects the brachial artery and median nerve as they course along the humerus (Jenkins *et al*., 2022). This foramen regresses during human evolution, leaving only the partial remnant identifiable as the SP in a minority of individuals (Martin-Schütz *et al*., 2019; Jenkins *et al*., 2022). The ligament of Struthers, which may accompany the spur, is considered a residual tendon of the ancient latissimus dorsi condyloideus muscle — another evolutionary feature preserved only in vestigial form (Paraskevas *et al*., 2012; Jenkins *et al*., 2022). Together, these structures create a potential fibro-osseous tunnel that, while typically silent, may in certain anatomical configurations compress adjacent neurovascular elements (Opanova & Atkinson, 2014; Mizia *et al*., 2021).

Morphological variation plays a major role in determining whether an SP remains asymptomatic or becomes clinically relevant (Subasi *et al*., 2002; Opanova & Atkinson, 2014). Studies have shown that the SP may coexist with numerous anatomical variants, including a high origin of the pronator teres (Jelev & Georgiev, 2009), accessory slips of the coracobrachialis (Kunc *et al*., 2023), aberrant branches of the brachial artery (Mizia *et al*., 2021), or the presence of a supratrochlear (septal) aperture (Paraskevas *et al*., 2012).These variations narrow the available space beneath the ligament of Struthers and increase the likelihood of neurovascular entrapment (Narayanan & Adikesavan, 2020). Narayanan & Adikesavan (2020) demonstrated that an anomalous pronator teres origin, when present alongside an SP, significantly reduces the cross-sectional area of the fibro-osseous canal, predisposing patients to symptomatic median nerve compression. Such findings underscore why some SPs cause clinically significant symptoms while others remain incidental radiographic curiosities (Engber *et al*., 1974).

SP syndrome arises when the SP-ligament complex compresses the median nerve or, less commonly, the brachial artery (Sener *et al*., 1998; Bain *et al*., 2016). Clinical presentation may include diffuse forearm pain, paresthesia in the median nerve distribution, weakness of thumb and finger flexion, or anterior interosseous nerve palsy manifested by difficulty forming the characteristic "OK" sign (Opanova & Atkinson, 2014; Narayanan & Adikesavan, 2020). Symptoms typically worsen during elbow extension combined with forearm pronation, a position that increases tension within the ligament of Struthers (Narayanan & Adikesavan, 2020). Although rare, vascular compression may lead to coldness, pallor, diminished pulses, and exertional forearm pain analogous to claudication (Sener *et al*., 1998). These manifestations highlight the dynamic nature of the compression, which is influenced not only by the presence of the SP but also by limb position and muscular activity. Ulnar nerve involvement is exceedingly uncommon but may occur in exceptional cases of variant neurovascular anatomy (Narayanan & Adikesavan, 2020).

Fractures of the SP constitute another important though infrequent clinical manifestation (Spinner *et al*., 1994). Spinner *et al*. (1994) described early cases of SP fractures resulting from direct trauma or traction forces, occasionally complicated by nerve irritation or persistent pain requiring surgical intervention. More recent reports highlight the role of repetitive stress in athletes. Pedet *et al*. (2015), documented a stress fracture of the SP in a professional tennis player, attributed to repeated traction from the pronator teres during forceful serving (Pedet *et al*., 2015). Similarly, Wininger *et al*. (2020), described an adolescent throwing athlete who sustained a displaced SP fracture believed to result from avulsion forces during explosive pronation (Wininger *et al*., 2020). These findings reinforce the functional role of the SP as an anchoring point for muscular or ligamentous structures, even in its vestigial form. Fortunately, many SP fractures heal uneventfully with conservative management, provided there is no neurovascular compromise (Nihalani *et al*., 2024).

Radiologically, the SP is often overlooked or misinterpreted (Bhatnagar *et al*., 2021; Nihalani *et al*., 2024). Its distinguishing features include cortical and medullary continuity with the humerus and its characteristic distal projection, which contrasts with the proximal or divergent orientation of osteochondromas (Engber *et al*., 1974). In addition to standard anteroposterior views, internal oblique radiographs often enhance visibility of the anteromedial humeral margin where the SP resides (Nihalani *et al*., 2024). Misinterpretation may occur when the SP is mistaken for an exostosis or osteochondroma (Bhatnagar *et al*., 2021). Advanced imaging modalities offer further diagnostic clarity (Camerlinck *et al*., 2010; Bain *et al*., 2016). Ultrasound, as demonstrated by Camerlinck *et al*. (2010), can directly visualize the ligament of Struthers and dynamically assess median nerve compression during limb movement. MRI is beneficial for evaluating soft-tissue relationships, excluding neoplastic processes, and assessing nerve morphology (Camerlinck *et al*., 2010), while CT facilitates precise morphometric analysis is useful for preoperative planning (Bain *et al*., 2016).

Epidemiologically, the SP remains uncommon, with prevalence estimates consistently below 2 % in most populations (Natsis, 2008; Martin-Schütz *et al*., 2019). The meta-analysis by Martin-Schutz *et al*. (2019), reported a prevalence of 0.68 % and demonstrated that SPs are statistically more common in females and on the left side. Regional variation also exists; for example, Hralicka's classical anthropological work found markedly different prevalence rates across racial groups (Table I). The Cologne study of 375 Caucasian subjects reported a prevalence of approximately 1 %, providing a valuable modern benchmark for European populations (Natsis, 2008). Such diversity reflects both genetic variation and methodological differences between cadaveric and radiographic studies (Martin-Schütz *et al*., 2019).

Taken together, the available evidence underscores that the SP is typically benign but capable of producing a broad range of clinical presentations-from clinically silent radiographic findings to symptomatic neurovascular entrapment or stress fractures in athletes (Pedret *et al*., 2015; Wininger *et al*., 2020). Awareness of this variant is essential for orthopaedic surgeons, radiologists, anatomists, and hand specialists. Early recognition prevents misdiagnosis, reduces unnecessary investigations, and ensures timely management when compression or fracture occurs (Spinner *et al*., 1994; Subasi *et al*., 2002).

To contextualize the rarity of the SP, Table I summarizes findings from representative studies across cadaveric, radiographic, and meta-analytic sources.

Most SPs are asymptomatic and do not require active intervention (Opanova & Atkinson, 2014). In these cases, management consists primarily of patient education, reassurance, and periodic observation (Nihalani *et al*., 2024). Patients should be informed of the benign nature of the anatomical variant and advised to monitor for symptoms of neurovascular compression, although the majority will remain entirely symptom-free throughout life (Natsis, 2008). Because incidental SPs have no functional consequence and rarely progress to complications, unnecessary imaging or surgical treatment should be avoided in the absence of clinical indications (Subasi *et al*., 2002; Opanova & Atkinson, 2014).

In contrast, symptomatic SPs require a more structured clinical approach (Ay *et al*., 2002). Surgical treatment is considered when the patient develops median nerve neuropathy, vascular compromise, persistent pain that does not respond to conservative measures, or when the SP is fractured and produces instability or compression of adjacent structures (Spinner *et al*., 1994; Wininger *et al*., 2020). Median neuropathy is the most frequent indication, characterized by pain, paresthesia, weakness, or anterior interosseous nerve dysfunction (Opanova & Atkinson, 2014). Vascular involvement, although less common, may present with ischemic symptoms or diminished pulses (Sener *et al*., 1998). Displaced or mobile SP fractures may also demand operative management because they risk sharp irritation or compression of the neurovascular bundle (Spinner *et al*., 1994; Sener *et al*., 1998; Ay *et al*., 2002).

When surgery is indicated, the standard procedure involves extraperiosteal excision of the SP combined with complete release of the ligament of Struthers (Ay *et al*., 2002; Subasi *et al*., 2002). Removing the lesion extraperiosteally reduces the likelihood of regrowth, and releasing the ligament is essential to ensure full decompression of the median nerve or brachial artery (Opanova & Atkinson, 2014). Intraoperatively, meticulous protection of the neurovascular structures is mandatory, as their course may vary, particularly in cases complicated by an aberrant pronator teres origin or atypical arterial branching (Jelev & Georgiev, 2009; Narayanan & Adikesavan, 2020). Most authors report that postoperative outcomes are excellent, with neurological symptoms fully resolving in most patients (Ay *et al*., 2002; Subasi *et al*., 2002).

Minimally invasive endoscopic techniques have also been described and appear promising (Bain *et al*., 2016). Endoscopic excision offers the advantages of smaller incisions, reduced soft-tissue disruption, and enhanced magnification of deep structures, potentially improving visualization of the median nerve-ligament complex (Bain *et al*., 2016). Successful endoscopic decompression of both the median nerve and brachial artery has been reported, although widespread adoption remains limited by the need for specialized equipment and experience (Bain *et al*., 2016).

CONCLUSION

The SP is a rare but clinically meaningful vestigial structure. Although most SPs are incidental findings, the presence of a fibro-osseous tunnel formed by the ligament of Struthers may result in significant median nerve or brachial artery compression. Anatomical variations, including aberrant pronator teres origin or accessory ossicles, may complicate diagnosis. Radiographs—supplemented by ultrasound, CT, or MRI when needed—allow accurate identification and differentiation from pathological entities. Asymptomatic cases require observation, while symptomatic

Table I. Reported incidence of SP of the humerus in selected studies.

Study (Year)	Population (Sample Size)	Reported Prevalence of SP	Notes
Martin-Schütz *et al. (*2019)	Meta-analysis of 20 studies (26,415 humeri)	0.68 % (95 % CI: 0.47–0.92 %)	Higher in females (significant) and more common on left side.
Hrdlicka (1923)	Anthropological study (various races)	1.7 % in Whites; 0.0 % in Native Africans (example data)	Early report noting ethnic differences (range 0–3 %).
Kessel & Rang (1966)	Surgical cases (J Bone Joint Surg. series)	~1 % (incidental findings in cadavers)	Described anatomical features; coined term "avian spur."
Subası *et al*. *(*2002)	Clinical cases (3 patients, 4 arms)	Not population-based (4 cases)	All patients symptomatic; one bilateral SP; relief after excision.
Opanova & Atkinson (2014)	Literature review (43 reported cases)	~0.1–2.7 % (literature range)	Compiled case features; median nerve compression most common.
Mizia *et al*. *(*2021)	Meta-analysis (presence of ligament)	Struthers' ligament in 1.8 % of arms	Struthers' arcade (ulnar nerve) in ~52 % (distinct from SP). Rarely symptomatic.

compression or displaced fractures warrant surgical excision with excellent outcomes. Awareness and understanding of the SP can prevent misdiagnosis and guide clinicians toward appropriate, patient-specific management.

Ethical approval and consent to participate. Informed consent for treatment and open access publication was obtained or waived by all participants in this study.

LUCHEV, G.; AL-SADEK, A.; SLAVCHEV, S.A.; LANDZHOV, B.; GAYDARSKI, L. & GEORGIEV, G.P. El proceso supracondíleo del húmero: Implicaciones clínicas de una rara estructura vestigial – Reporte de caso y revisión exhaustiva de la literatura. *Int. J. Morphol., 44(2)*:498-502, 2026.

RESUMEN: El proceso supracondíleo (PS) del húmero es una rara proyección ósea congénita que se presenta en aproximadamente el 0,5-2,7 % de los individuos. Originado en la parte distal de la diáfisis de la cara anteromedial del húmero, el PS puede formar un túnel fibroóseo con el ligamento de Struthers, (banda fibrosa que une proceso el supracondíleo a la parte distal de la cara anteromedial de la diáfisis humeral) comprimiendo potencialmente el nervio mediano o la arteria braquial y produciendo el «síndrome del proceso supracondíleo». Aunque a menudo asintomático y detectado incidentalmente, el proceso supracondíleo (PS) puede simular un tumor o una osificación aberrante, lo que plantea dificultades diagnósticas. Presentamos el caso de un varón de 17 años con un PS incidental identificado tras un traumatismo leve. Realizamos una breve revisión bibliográfica que destaca el contexto evolutivo del PS, sus variaciones morfológicas, complicaciones clínicas, patrones de fractura, características radiológicas y estrategias de tratamiento. Un mayor conocimiento de esta estructura vestigial puede prevenir diagnósticos erróneos y garantizar un tratamiento adecuado en casos sintomáticos.

PALABRAS CLAVE: Proceso supracondíleo; Húmero; Radiología; Importancia clínica; Revisión.

REFERENCES

Ay, S.; Bektas U.; Yilmaz, C. & Diren, B. An unusual supracondylar process syndrome. *J. Hand Surg. Am., 27(5)*:913-5, 2002.

Bain, G.; Gupta, P.; Phadnis, J. & Singhi, P. K. Endoscopic excision of supracondylar humeral spur for decompression of the median nerve and brachial artery. *Arthrosc. Tech., 5(1)*:e67-e70, 2016.

Baruah, P.; Choudhury, P. R. & Talukdar, K. L. A study of supracondylar process of humerus. *J. Evol. Med. Dent. Sci., 1(5)*:817-22, 2012.

Bhatnagar, S.; Iwanaga, J.; Dumont, A. S. & Tubbs, R. S. Lateral supracondylar spur process of the humerus. *Cureus, 13(2)*:e13514, 2021.

Camerlinck, M.; Vanhoenacker, F. M.; & Kiekens, G. Ultrasound demonstration of Struthers' ligament. *J. Clin. Ultrasound., 38(9)*:499-502, 2010.

Engber, W. D.; McBeath, A. A. & Cowle, A. E. The supracondylar process. *Clin. Orthop. Relat. Res. (104)*:228-31, 1974.

Gaydarski, L.; Landzhov, B.; Tubbs, R. S.; Olewnik, L.; Piagkou, M. & Georgiev, G. P. The enigmatic os supratrochleare anterius: from rarity to recognition in elbow pathology. *Surg. Radiol. Anat., 46(4)*:483-7, 2024.

Hrdlicka, A. *Anthropological Studies. The Humerus: Racial Anatomy and Variations*. Washington D.C., Smithsonian Institution, 1923.

Jelev, L. & Georgiev, G. P. Unusual high-origin of the pronator teres muscle from a Struthers' ligament coexisting with a variation of the musculocutaneous nerve. *Rom. J. Morphol. Embryol., 50(3)*:497-9, 2009.

Jenkins, S.; Iwanaga, J.; Loukas, M.; Dumont, A. S. & Tubbs, R. S. Comprehensive review of the supracondylar process with translation of Adachi. *Clin. Anat., 35(4)*:434-41, 2022.

Kessel, L. & Rang, M. Supracondylar spur of the humerus. *J. Bone Joint Surg. Br., 48(4)*:765-9, 1966.

Kunc, V.; Benes, M.; Veigl, D. & Kachlik, D. Anatomical variants complicating the posterior approaches towards the elbow joint. *Surg. Radiol. Anat., 45(5)*:587-92, 2023.

Martin-Schütz, G. O.; Arcoverde, M.; Barros, G. D. R.; Babinski, M. A.; Manaia, J. H. M.; Silva, C. R. C. D. M.; Chagas, C. A. A. & Pires, L. A. S. A meta-analysis of the supracondylar process of the humerus. *Int. J. Morphol., 37(1)*:43-7, 2019.

Mizia, E.; Zarzecki, M. P.; Pekala, J. R.; Baginski, A.; Kaythampillai, L. N.; Golebiowska, M.; Pekala, M. A.; Walocha, J. A. & Tomaszewski, K. A. Rare upper limb neuropathies due to Struthers' ligament or arcade: a meta-analysis. *Folia Morphol. (Warsz.), 80(2)*:255-66, 2021.

Narayanan, S. & Adikesavan, P. N. Variant pronator teres muscle and variant neurovascular course in the arm. *Surg. Radiol. Anat., 42(3)*:249-52, 2020.

Natsis, K. Supracondylar process of the humerus: study on 375 Caucasian subjects in Cologne, Germany. *Clin. Anat., 21(2)*:138-41, 2008.

Nihalani, S.; Frith, K. & Conklin, M. Pediatric supracondylar process fracture: radiographic distinction, misdiagnosis, and conservative management. *Cureus, 16(9)*:e68547, 2024.

Opanova, M. I. & Atkinson, R. E. Supracondylar process syndrome: case report and literature review. *J. Hand Surg. Am., 39(6)*:1130-5, 2014.

Paraskevas, G. K.; Natsis, K.; Anastasopoulos, N.; Ioannidis, O. & Kitsoulis, P. Humeral septal aperture associated with supracondylar process: case report and literature review. *Ital. J. Anat. Embryol. ,117*:135-41, 2012.

Pedret, C.; Balius, R.; Alomar, X.; Vilaró, J.; Ruiz-Cotorro, A. & Minoves, M. Stress fracture of the supracondylar process in a professional tennis player. *Clin. J. Sport Med., 25(1)*:e20-e22, 2015.

Sener, E.; Takka, S. & Cila, E. Supracondylar process syndrome. *Arch. Orthop. Trauma Surg., 117(6-7)*:418-19, 1998.

Spinner, R. J.; Lins, R. E.; Jacobson, S. R. & Nunley, J. A. Fractures of the supracondylar process of the humerus. *J. Hand Surg. Am., 19(6)*:1038-41, 1994.

Subasi, M.; Kesemenli, C.; Necmioglu, S.; Kapukaya, A. & Demirtas, M. Supracondylar process of the humerus. *Acta Orthop. Belg., 68(1)*:72-5, 2002.

Wininger, A. E.; Liberman, S. R. & Jafarnia, K. K. Fracture of the supracondylar process in an adolescent athlete. *JSES Int., 4(4)*:1018-20, 2020.

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