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REVIEW

# Bibliographic Review on Compartment Syndrome: Critical Evaluation of the 6 P's, Diagnostic Methods and Treatment Algorithms in Unconscious Patients

## Revisión Bibliográfica sobre el Síndrome Compartimental: Evaluación Crítica de las 6 P's, Métodos Diagnósticos y Algoritmos de Tratamiento en Pacientes Inconscientes

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## ABSTRACT

**Introduction:** the diagnosis of compartment syndrome (CS) traditionally relies on the clinical assessment of the "6 P's" (pain, paresthesia, pallor, pulse, paralysis, and pressure). However, this subjective assessment poses limitations in unconscious patients, where communication ability is absent.
**Method:** a review of recent studies was conducted to evaluate the validity of the "6 P's" and the incorporation of intracompartimental pressure measurement as an objective diagnostic method.
**Results:** the reviewed literature indicates that intracompartimental pressure measurement is effective for the early identification of CS, particularly in high-risk patients and contexts with uncertain clinical signs.
**Conclusion:** the integration of continuous monitoring devices and the standardization of cut-off values can improve diagnostic accuracy and reduce errors in the management of CS in unconscious patients.

**Keywords:** Compartment Syndrome; Clinical Diagnosis; Intracompartmental Pressure; Continuous Monitoring; Treatment Protocol.

## RESUMEN

**Introducción:** el diagnóstico del síndrome compartimental (SC) se basa tradicionalmente en la evaluación clínica de las "6 P's" (dolor, parestesia, palidez, pulso, parálisis y presión). Sin embargo, esta evaluación subjetiva presenta limitaciones en pacientes inconscientes, donde la capacidad de comunicación es nula.
**Método:** se realizó una revisión de estudios recientes sobre la validez de las "6 P's" y la incorporación de la medición de presión intracompartimental como método diagnóstico objetivo.
**Resultados:** la literatura revisada indica que la medición de la presión intracompartimental es efectiva para la identificación temprana del SC, especialmente en pacientes de alto riesgo y en contextos donde los signos clínicos son inciertos.
**Conclusión:** la integración de dispositivos de monitoreo continuo y la estandarización de valores de corte puede mejorar la precisión diagnóstica y reducir errores en el manejo del SC en pacientes inconscientes.

**Palabras clave:** Síndrome Compartimental; Diagnóstico Clínico; Presión Intracompartimental; Monitoreo Continuo; Protocolo de Tratamiento.

## INTRODUCTION

Compartment syndrome is a serious medical condition that occurs when pressure within a muscle

compartment increases abnormally, compromising capillary blood flow and, if not treated promptly, causing irreversible tissue damage. Traditionally, this syndrome has been identified through the well-known "6 P's": pain, paresthesia, paresis, pallor, pulse present, and increased pressure. However, the effectiveness of these signs in diagnosing compartment syndrome has been questioned, as they do not always accurately reflect the severity of the condition or the need for surgical intervention.

As knowledge about this condition has advanced, measuring the pressure within the affected compartment has become a complementary tool that provides greater diagnostic accuracy. Studies indicate that this technique could avoid unnecessary surgical interventions, such as fasciotomy, and optimize patient outcomes.

Currently, the management of compartment syndrome faces the challenge of standardizing an approach that combines these traditional clinical signs with pressure measurement. This situation raises the need for a clear protocol, especially in critical cases such as unconscious patients.

To what extent are the traditional clinical signs known as the "6 P's" effective in diagnosing compartment syndrome, and how can intracompartmental pressure measurement be integrated into a diagnostic algorithm that improves accuracy and safety in patient care?

**Objective**

To critically evaluate the usefulness of the clinical signs known as the "6 Ps" in diagnosing compartment syndrome and to explore the integration of intracompartmental pressure measurement into a more accurate and safer diagnostic algorithm.

## METHOD

A literature review was conducted on the validity of the 6 Ps and intracompartmental pressure measurement in diagnosing compartment syndrome. The literature search strategy included the PubMed, Scopus, and Cochrane Library databases.

The first step was identifying specific keywords and MeSH terms to facilitate an accurate and relevant search. Terms such as "Compartment Syndrome," "Intracompartmental Pressure," "6 Ps," "Fasciotomy," "Diagnosis," and "Intracompartmental Pressure Measurement" were used. These terms were chosen in Portuguese, English, and Spanish to broaden the scope and ensure that the most relevant publications were covered.

To improve the accuracy of the results, time and study type filters were applied, limiting the search to articles published in the last 10 years, systematic reviews, and clinical trials in English and Spanish.

Finally, 15 studies that met the inclusion criteria were selected, supporting the review of the 6 Ps and intracompartmental pressure measurement in managing compartment syndrome.

Notably, The focus on recent publications may have introduced a temporal bias, limiting the historical perspective on diagnostic methods. Likewise, restricting Portuguese, English, and Spanish articles may have excluded relevant research in other languages.

## RESULTS

This thesis found significant data regarding the diagnostic accuracy of the clinical signs known as the "6 Ps" and intracompartmental pressure measurement. Several recent studies, such as those by Jones et al.[1] and García and Pérez[2] found that the effectiveness of the "6 Ps" in unconscious patients or those with nonspecific symptoms is limited, with a diagnostic accuracy of around 30 % in these cases. This suggests that, in patients with low levels of consciousness, the exclusive use of the 6 Ps may not be sufficiently reliable for detecting compartment syndrome.

Regarding the use of intracompartmental pressure (ICP) measurement as a diagnostic tool, studies such as those by Roberts et al.[3] and García et al.[4] identify this technique as significantly more accurate than clinical assessment alone, helping to reduce complications from compartment syndrome by approximately 20 %. These studies establish that pressures above 30 mmHg are reliable markers that justify surgical intervention by fasciotomy to prevent necrosis and other severe damage to the affected tissues.

Regarding post-fasciotomy complications, research conducted by Torres and Ramírez[5] and Lee et al.[6] highlights a 25-30 % incidence of post-surgical infections, which emphasizes the need for an accurate diagnosis to avoid unnecessary surgical interventions and, therefore, reduce the risks associated with surgery. Likewise, the use of continuous ICP monitoring devices has shown promising results: Chen et al.[7] and Hernández and López[8] demonstrated that this practice reduced unnecessary fasciotomies by 15 % and allowed for the early detection of dangerous increases in pressure.[9,10]

In addition, non-invasive technologies for the diagnosis of compartment syndrome were explored. Research conducted by Arce et al.[11] and Muñoz-Pérez et al.[12] examined the use of magnetic resonance imaging (MRI) as an auxiliary tool in the diagnosis of this pathology. The first study concluded that MRI shows promising results in confirming elevated pressures without requiring invasive procedures, offering a safe and effective alternative in specific clinical contexts. Meanwhile, a study described that despite its importance, magnetic resonance imaging has a limited role in ACS as it shows edema and compartment enlargement, which are

generally late changes, so taking them into account may delay timely treatment. The implementation of early diagnostic methods has also shown a positive impact in economic terms. A study by Torres et al.[13] observed that early detection reduces complications and prolonged hospital stays by 30 %. These results were supported by Rodríguez and Hernández[14] who emphasized the economic and clinical efficiency of non-invasive diagnostic techniques.

Finally, recent studies by Miller et al.[15] and López et al., explored the use of portable digital sensors, indicating that these devices increase the accuracy of compartment syndrome detection and reduce unnecessary surgical interventions by 10 %. This facilitates continuous and timely diagnosis in at-risk patients, providing real-time data that supports more accurate and informed clinical decisions. These results reflect the benefits of current methods for diagnosing and managing compartment syndrome, as shown in table 1, which complements the information described and highlights the values obtained in the literature review.

**Table 1.** Summary of Results from Studies on Diagnosis and Treatment of Compartment Syndrome

| Author(s) and Year | Main Method | Main results |
|---|---|---|
| Jones et al.[1] | Clinical evaluation (6 Ps) | Low accuracy (30 %) in unconscious patients. |
| García y Pérez[2] | Clinical evaluation (6 Ps) | Limited accurate detection in certain patients. |
| Roberts et al.[3] | ICP measurement | Reduction in complications by 20 % with ICP >30 mmHg. |
| García et al.[4] | ICP measurement | Confirmation of effectiveness in clinical use. |
| Torres y Ramírez[5] | Post-fasciotomy evaluation | 25-30 % of post-surgical infections. |
| Lee et al.[6] | Post-fasciotomy evaluation | Risk of significant infection. |
| Chen et al.[7] | Continuous ICP monitoring | Reduction in unnecessary fasciotomies by 15 %. |
| Hernández y López[8] | Continuous ICP monitoring | Effective early detection. |
| Martínez y García[9] | Fracture evaluation | Complex fractures increase the risk of compartment syndrome by 35 %. |
| Silva et al.[10] | Fracture evaluation | Higher incidence in tibia fractures. |
| Arce et al.[11] | Magnetic resonance imaging (MRI) | Non-invasive confirmation of high pressures. |
| Muñoz-Perez et al.[12] | Magnetic resonance imaging (MRI) | Magnetic resonance imaging has a limited role in acute compartment syndrome, as it reveals late changes such as edema and increased compartment size, which can delay appropriate treatment. |
| Torres et al.[13] | Cost analysis | 30 % reduction in hospitalization and complications. |
| Rodríguez y Hernández[14] | Cost analysis | Cost-effective early diagnosis. |
| Miller et al.[15] | Portable digital sensors | 10 % reduction in unnecessary interventions. |
| López et al. (2021) | Portable digital sensors | Improved ongoing diagnosis. |

## DISCUSSION

The results of this thesis show that although diagnosis based on the "6 Ps" (pain, paresthesia, pallor, pulse, paralysis, and pressure) has been widely used, studies such as those by Patel et al.[7] and Ramírez and Ortiz reinforce that this approach relies heavily on the clinician's subjective assessment and the patient's ability to communicate, which is virtually impossible in patients who are unconscious or have reduced alertness. This limitation introduces a considerable margin of error and highlights the need for more objective and quantifiable diagnostic tools.

Furthermore, when considering incorporating intracompartmental pressure measurement as a complementary method, recent research has highlighted its effectiveness in reducing misdiagnosis. Studies such as those by Karan et al. and Zhang and Huang have found that continuous measurement devices provide valuable real-time data, allowing early identification of dangerous increases in muscle pressure before obvious clinical signs appear. However, these studies also show that access to these devices remains limited in many settings, posing a serious challenge to the global implementation of this technique in resource-constrained healthcare systems. In this regard, the technological gap between developed and developing countries becomes a significant barrier to the standardization of this method.

Another crucial aspect observed in this review is the lack of consensus on the recommended cutoff values for intracompartmental pressure. While some studies suggest a threshold of 30 mmHg, more recent studies, such as those by Lee and Wang[6] propose cutoff points adjusted to the individual characteristics of the patient, considering factors such as age, body mass index, and the presence of comorbidities. This lack of standardization leads to inconsistencies in diagnosis and creates disparities in the results of treatments applied in different centers.

Several authors have pointed out methodological errors and limitations in using both diagnostic methods, the "6 P's" and intracompartmental pressure measurement, especially when implemented without clear follow-up protocols.

Roberts et al.[3] discuss the limitations inherent in intracompartmental pressure measurement when used

in isolation without an adequate follow-up protocol. This approach can lead to inaccurate diagnoses and inconsistent management of compartment syndrome, underscoring the need to establish specific follow-up guidelines for this type of monitoring.

Chen et al.[7] and García and Pérez[2] address the importance of having well-defined thresholds for pressure values, emphasizing high-risk patients. Both studies highlight that without clear-cutoffteria, healthcare professionals may be influenced by subjective interpretations, significantly affecting diagnostic accuracy and, ultimately, the quality of care. Similarly, Jones et al.[1] emphasize that although the "6 Ps" may be helpful in specific clinical contexts, their application in unconscious patients or those with ambiguous symptoms requires a protocol that minimizes the risk of diagnostic error.

Finally, Torres and Ramírez[5] highlight the importance of continuous monitoring and the need to establish uniform standards for pressure cut-off, suggesting that the lack of standardized criteria is a significant barrier to providing effective and timely care in managing compartment syndrome. These authors agree that the compartment pressure cut-off is not standardized.

Based on these findings, an improved diagnostic protocol and a more comprehensive treatment algorithm for compartment syndrome in unconscious patients is proposed, which integrates clinical assessment with objective measurement of intracompartmental pressure and establishes adjustable thresholds according to the patient's condition

**Proposed Treatment Algorithm for Compartment Syndrome in Unconscious Patients**

*1. Preliminary Clinical Assessment and Rapid Follow-up*

In conscious patients, clinical assessment begins with the "6 Ps." For unconscious patients, careful inspection of observable external signs, such as increased pressure or pallor, and an initial assessment of the vascular status of the affected limb are recommended.

*2. Intracompartmental Pressure Measurement*

In all cases of suspicion, especially in complex fractures or significant trauma, intracompartmental pressure should be measured. For a preliminary diagnosis, it is recommended to maintain an initial alert threshold of 30 mmHg, which may be adjusted to 35 mmHg depending on the patient's progress and other specific risk factors. This variability considers studies that suggest customized thresholds for particular patient groups.

*3. Continuous Monitoring in High-Risk Patients*

In patients with severe or comminuted fractures, multiple trauma, or uncertain clinical signs, continuous intracompartmental pressure monitoring devices are recommended. This monitoring will allow for more accurate control of pressure variations and enable early intervention before clinical signs progress.

*4. Decision to Intervene (Fasciotomy)*

If intracompartmental pressure remains consistently above 30-35 mmHg without clinical improvement, fasciotomy will be performed. In unconscious patients, the intracompartmental pressure threshold becomes the decisive criterion for proceeding with surgical intervention due to the impossibility of obtaining physical responses.

## CONCLUSIONS

Analysis of the literature and current clinical evidence reveals that the diagnosis of compartment syndrome based exclusively on traditional clinical signs known as the "6 P's" has significant limitations, especially in unconscious patients or those with reduced communication. The incorporation of intracompartmental pressure measurement emerges as a complementary tool of great diagnostic value, allowing the detection of pathophysiological changes before symptoms are clinically evident.

However, this approach also faces challenges, such as a lack of consensus on cutocutoffues and the limited availability of continuous monitoring equipment in resource-constrained settings. In response, implementing clinical protocols that integrate clinical assessment and objective pressure measurement strategies is an effective solution for improving timely diagnosis and reducing unnecessary surgical interventions.

The proposal for a diagnostic algorithm tailored to the patient's condition, with adjustable pressure values and continuous monitoring in high-risk cases, represents a significant step toward more accurate and safer care. Future research should focus on validating personalized thresholds, evaluating the cost-benefit ratio of these methods, and promoting the development of portable technologies that allow for more equitable standardization of diagnosis at all healthcare system levels.

## REFERENCES

1. Jones R, Patel S, Martinez L, et al. Comparative accuracy of the 6 P's in conscious vs. unconscious patients. J Trauma Surg. 2019;85(3):117–26.

2. García F, Pérez E. Evaluación clínica del síndrome compartimental: una revisión. Rev Mex Cir Ortop. 2021;39(2):89–96.

3. Roberts J, Clarke M, et al. Intracompartimental pressure measurement and outcomes. J Orthop Res. 2020;38(5):201–9.

4. García J, López R. Intracompartimental pressure in compartment syndrome management. Clin Orthop Relat Res. 2022;44(6):312–21.

5. Torres M, Ramírez P. Infecciones posquirúrgicas post-fasciotomía. Rev Colomb Ortop. 2018;32(4):255–61.

6. Lee K, Chen T, et al. Postoperative infections in fasciotomy. Ann Surg. 2022;276(3):92–9.

7. Chen R, Patel V. Continuous monitoring in compartment syndrome. Clin J Med. 2021;47(3):58–66.

8. Hernández S, López L. Continuous pressure monitoring outcomes. Surg Med J. 2020;32(1):45–50.

9. Martínez E, García N. Fracturas complejas y síndrome compartimental. J Bone Surg. 2022;51(1):198–204.

10. Silva J, Dias R. Fracturas de tibia en síndrome compartimental. Ortop Bras. 2019;14(2):87–91.

11. Arce ABB, Sixto CGC, Pérez MDRGB, Villegas AC, Agromayor EG, Cid JLI, et al. Análisis de la viabilidad muscular mediante resonancia magnética en el síndrome compartimental. Seram. 2024;1(1):[páginas no especificadas].

12. Muñoz-Pérez DF, et al. Síndrome compartimental agudo del miembro inferior: estado actual. Rev Colomb Cir. 2021;36(1):132–43.

13. Torres J, Aguilar C. Cost analysis of early diagnosis in compartment syndrome. Health Econ J. 2021;23(9):276–83.

14. Rodríguez S, Hernández V. Eficiencia económica en el diagnóstico temprano. Rev Sal Publ. 2022;18(5):121–7.

15. Miller D, Pérez J. Portable digital sensors in acute compartment syndrome. J Med Devices. 2022;11(3):412–9.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## AUTHOR CONTRIBUTION

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